Smart and adaptive interfaces for INCLUSIVE work environment

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Deliverable 6.1 – Report on methods and tools to measure worker satisfaction

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Executive Summary

This deliverable reports on methods and tools to measure worker satisfaction. Specifically, a literature review on methods and tools to measure worker satisfaction with HMI in particular and work in general has been conducted. On the basis of this review as well as previous Deliverables, a model of worker satisfaction has been proposed and a questionnaire to measure worker satisfaction with the adaptive HMI and working conditions has been developed. The questionnaire consists of two main parts: I. Working conditions (psychosocial and physical); and II. Satisfaction with the adaptive Human Machine Interface (HMI), including safety issues. It has also been proposed to use physiological data measurement in WP7 as an objective method to monitor worker satisfaction.

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1. Introduction

The INCLUSIVE project aims at developing smart human-machine interfaces (HMIs) that adapt to human skills and capabilities, and provide training and support.

The WP6 of the project focuses on developing a methodology of measurement and evaluation of worker satisfaction in the industrial environment, with examples taken from the three industrial use cases. The methodology to measure worker satisfaction will be based on subjective and objective measures. The result of this WP is a methodology to assess the adaptive working environment from the human point of view.

In this regard, this deliverable reports on outcomes of literature review conducted in order to analyse methods and tools to measure worker satisfaction. Worker satisfaction is understood in this project as a specific case of user satisfaction, which refers to working environments, and work-related products or services, including HMI interfaces and other ICT-based solutions implemented in control systems of industrial machinery and automated manufacturing systems. Therefore, the literature review has been focused on measures and tools to evaluate the usability and satisfaction with HMI and with work in general. Results of the review are presented in the Paragraph 2.

Next, a model of worker satisfaction has been proposed. It includes three main factors: user satisfaction with HMI (including health & safety issues), physical working conditions, and psychosocial working conditions & ethical aspects, taking into consideration individual differences, such as age, experience, capabilities, perception, cognition or motor skills. The model of satisfaction with the adaptive HMI and working conditions is presented in the Paragraph 3.

On the basis of the literature review and the proposed work satisfaction model, a questionnaire entitled 'Satisfaction with the adaptive HMI and working conditions' has been developed. It is presented in the Paragraph 4. The questionnaire contains two main parts: I. Working conditions; and II. Satisfaction with the adaptive Human Machine Interface (HMI), surveying also skills and capabilities of the users. In order to ensure workers' satisfaction and participation, the questionnaire contains questions on proposed changes to the HMI. The questionnaire will be pilot tested in Task 6.2 and then adjusted for implementation in the WP7.

As the worker satisfaction evaluation should be conducted by means of both subjective and objective measurement, the idea of physiological data measurement in the WP7 as part of the Measure Module is briefly described in the Paragraph 5.

Finally, the Paragraph 6 follows with some concluding remarks.

2. Literature review on methods and tools to measure worker satisfaction

The user satisfaction derives from the usability concept. A high system usability is a goal of users, employers, developers and researchers. It facilitates safe, productive and enjoyable work in the working environment (Ovaska, 1991). Hence, accounting for the HMI usability is one of the key project and WP6 goals. In order to measure the HMI user satisfaction, we need to first understand what the usability principles are. In the literature review we present usability concepts and measurement methods based on an expert evaluation and end-user (worker) satisfaction measurement, both subjective and objective. It was a groundwork for choosing appropriate metrics to be included in the worker satisfaction measurement.

2.1. Usability concepts

Usability is a broad term with various definitions, depending on the concept or context.

Other, more broad usability definitions are:

- Ensuring that interactive products are easy to learn, effective to use and enjoyable from the user perspective (Rogers et al., 2011)
- Multidimensional characteristic in the context of users performing tasks with a product in a specific environment (Bevan, Kirakowski & Maissel, 1991)
- The extent to which a product can be used by specified user to achieve specified goal with effectiveness, efficiency and satisfaction in a context of use (ISO 9241)

According to ISO 9241, effectiveness means the accuracy and completeness with which specified users can achieve specified goals in a particular environment. Efficiency means the resources expended in relations to the accuracy and completeness of goals achieved. Satisfaction is defined as user comfort and user acceptability of the work system and in relation to other people affected by its use.

In attempt of creating most comprehensive approach, Wang & Huang (2015) combined three different usability principles: Nielsen's (1993), Norman's (2003) and Yeh's (2010).

Nielsen (1993) defined the following usability principles: memorability, errors, learnability, efficiency, satisfaction.

Norman's (2003) conception of usability included such principles as: visibility, a good conceptual model, good mappings, feedback.

Yeh's (2010) usability definition included following principles: ease, enjoyment and effectiveness.

On the basis of these concepts and components, Wang & Huang (2015) proposed the following usability principles (fig. 1):

- **Visibility**: clear instructions and information
- **Ease**: easy to learn and familiarise, time of learning is minimal
- **Efficiency**: once learned it is easy to use the functions of the system at full capacity
- **Enjoyment**: users are satisfied upon completing a task when using the system

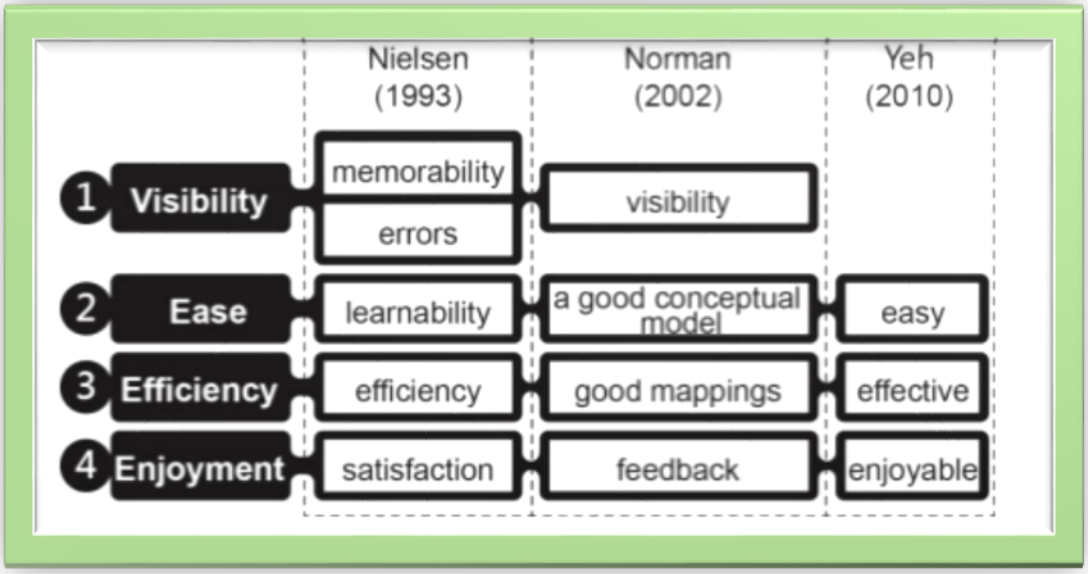

Fig. 1: Usability principles. Source: Wang & Huang, 2015

In the context of Human-Computer Interaction (HCI), Shackel (1991) defined usability as 'the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfill the specified range of tasks, within the specified range of environmental scenarios'.

Preece (1993) stated: `The goals of HCI are to develop and improve systems that include computers so that users can carry out their tasks: safely, effectively, efficiently and enjoyably. These aspects are collectively known as usability'.

2.2. Methods and tools to measure usability and user satisfaction

The usability can be evaluated by means of a subjective and objective measurement, whereby the subjective evaluation of usability includes scales and questionnaires, whilst objective measures comprise behavioural or physiological measures. The usability is also measured by or with help of expert evaluators, and by end-users in terms of user satisfaction.

The most common usability evaluation techniques are inspection methods and test methods. Inspection methods identify usability problems and possibilities for improvement by checking it against established standards. Usability test methods include testing usability with end users, in the presence of expert evaluators or by means of subjective user satisfaction questionnaires (Holzinger, 2005). Although it is common to understand the expert usability evaluation as an objective measurement, we describe three groups of usability measurement methods: expert usability evaluation, end-user satisfaction and objective measurement, understood as monitoring behavioural or physiological data.

2.2.1 Expert usability evaluation

Several approaches can be used to evaluate the interface usability (Lin, Choong & Salvendy, 1997), e.g.:

- **Thinking-aloud approach** – end-users think aloud while they are using the system that is being evaluated. Although this method includes end-users, there is an expert evaluator to interpret and assess user reactions to the system. It is a form of a test method.
- **Guidelines /checklists** – interface guidelines to be followed by designers. It is a form of a usability inspection method.

- **Heuristic evaluation** - is the application (by evaluators) of a set of heuristics to judge the adequacy of the prototype design. It is a form of a usability inspection method.

Ovaska (1991, p. 51) noticed that usability inspection methods such as guidance and checklist are designed to be used as engineering tools. Usually, they involve testing the interface in laboratory settings using example tasks. The main disadvantage of such measures is that they evaluate inadequate aspects of the system, because some aspects of the system particularly important to users could be overlooked (Ovaska, 1991, p. 51).

Guidance/checklists are an example of a measure used by the development team together with the users or external evaluators. The evaluation is conducted on the basis of an exemplary task designed by the system developers after the user completes the task. An example of such a method is the Evaluation Checklist developed by Ravden and Johnson (1989). This checklist includes the following usability aspects:

- Visual clarity
- Consistency
- Compatibility
- Informative feedback
- Explicitness
- Appropriate functionality
- Flexibility and control
- Error prevention and correction
- User guidance and support

The tool proposed by Ravden and Johnson (1989) consists of 9 sections, each from 13 to 17 questions. Example questions are: 'Does the system validate user inputs before processing, wherever possible?', 'Where interface metaphors are used are they relevant to the tasks carried out with the system?'. As Ovaska noticed, such a checklist can be difficult for the users to fill in because of developers' terminology or the length of the tool. It also does not include user feedback and suggestions on corrective actions.

Most popular usability inspection methods are heuristic evaluation, together with cognitive walkthrough and heuristic walkthrough (Cockton et al., 2008).

- **Cognitive walkthrough** provides evaluators with step-by-step instructions on the action sequence to be performed by users, where evaluators should determine whether the user would follow the correct action (Lucas & Babaian, 2015, p. 844). Questions to be answered are:
  - Will the user be trying to achieve the right effect?
  - Will the user notice that the correct action is available?
  - Will the user associate the correct action with the desired effect?
  - If the correct action is performed, will the user see that progress is being made?

Although this method proved to be able to identify unique problems, not identified using other methods, it also has a tendency to overlook problems related to missing functionalities or error recovery (Lucas & Babaian, 2015).

- **Heuristic evaluation** (Nielsen, 1994) is a method where an evaluator assesses a part of the interface according to the following heuristics:

  - Visibility of system status
  - Match between system and the real world
  - User control and freedom
  - Consistency and standards
  - Error prevention

- Recognition rather than recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Helps users recognise, diagnose and recover from errors
- Help and documentation

As Lucas and Babaian stated (2015), evaluators using this method are given little guidance concerning the users or the tasks to perform.

• **Heuristic walkthrough** (Sears, 1997) is a two-pass process, where evaluators are provided with a list of heuristics and questions, but also with a prioritised list of user tasks. This method includes a free-form and task-specific evaluation. This method, comparing to the cognitive walkthrough and heuristic evaluation, was proven to identify more intermediate, minor and severe usability problems than the cognitive walkthrough. The heuristic walkthrough and cognitive walkthrough methods tended to yield less false positives than the heuristic evaluation, but this is explained by the fact that the heuristic evaluation method does not test specific tasks, unlike two other methods (Lucas & Babaian, 2015).

Another method for expert evaluation of the user interface usability is the **collaborative critique**, designed for testing Human – Computer Collaboration (Lucas & Babaian, 2015). The aim of this method is to lower mental load of users. According to this concept, the system should serve its users to meet their goals. Hence, the focus is on the system usability in the context of the current task, user and interaction, and not on user capabilities to use the system efficiently. Collaborative critique method conducts the assessment step by step. On every stage, experts-evaluators answer questions assessing the quality and possibility of the collaboration and the system's reactions to errors. Evaluators are asked to familiarise themselves with a given task and employee's profile. Every task is divided into sub-tasks which are the stages to be evaluated. The evaluators should be supported by experts in the field in the process of usability assessment. The collaborative critique method is conducted using the following questions:

- Will the user find the options for what she wants to do in the current screen?
- For the user to figure out what to do now, how much exploration is involved?
- For the user to figure out what to do now, how much confusion is involved?
- Is the system using knowledge of the task in general, the current user, and the context of the current action to the fullest extent in order to a) appropriately guide the user?; b) reduce the effort involved in user input?
- After execution of the current action, will the user understand: a) what progress has been made so far toward completing the overall task?; b)what does remain to be done in order to complete the overall task?
- Does the system display information that clearly explains the problem to the user?
- Does the system present steps the user can take for possible corrective actions?
- Does the system present an easy way to take corrective actions?

Although this method seems to be comprehensive in the context of the system's ability to collaborate with the user, it does not contain the main usability components and a more subjective dimension, e.g. user satisfaction. Moreover, the evaluation has to be conducted by usability experts and experts in the field, not by employees.

The usability testing conducted by external expert evaluators usually in laboratory settings is a popular method to design usable systems or products. However, it is characterised by some disadvantages such as lack of the end-user involvement in the process or lack of a real industrial environment and a failure to test the usability in everyday working processes. Including the user assessment of usability seems to be of a particularly high importance.

2.2.2 End-user satisfaction evaluation

Other approach includes measuring end-user satisfaction with the Human-Machine Interaction/Human-Machine Interface which is also a form of usability measurement (Ovaska, 1991). The user satisfaction is considered as the most prevalent measure of an information system's success thanks to its applicability and ease of use, and it is directly related to the system's success (Zviran & Erlich, 2003). Although the subjective evaluation of usability tends to be neglected in favour of objective performance measures, Lund (2001) stated that the subjective measurement is most closely related to user behaviour. Other authors also suggested that less tangible factors of usability (e.g. enjoyment) are becoming of a higher importance and should be incorporated in the system usability testing (Lin et al., 1991).

The most popular and widely-used tools are: the Computer User Satisfaction scale (CUS), the Questionnaire for User Interaction Satisfaction (QUIS), the System Usability Scale (SUS), and the USE Questionnaire, which are characterised below.

The **Computer User Satisfaction** (CUS) questionnaire (Bailey & Pearson, 1983) is a 39-factor scale, with each factor measured with five ratings. Among the 39 factors, there are: confidence in the systems, security of data, output format, convenience of access, personal job effects resulting from the computer-based support, precision of information output and system flexibility , and others.

The first four response items are for quality ratings and the fifth is an importance rating. Authors found that most important factors were: accuracy, reliability, timeliness, relevancy and confidence in the system. The factors of least importance were: feelings of control, volume of output, vendor support, degree of training, and organisational position of electronic data processing.

Each item has to be answered using a 7-point scale and the length of the questionnaire could result in errors of attrition (Ives, Olson and Baroudi (1983).

Questionnaire for User Interface Satisfaction (QUIS; Chin et al., 1988) contains five areas of user satisfaction:

- Overall reaction to the software
- Screen - Reading characters on the screen, organisation of information and sequence of screens
- Terminology and system information – use of terms throughout system, terminology, position on messages on screen, prompts for input, error messages
- Learning – Learning to operate the system, performing tasks
- System capabilities – system speed, system reliability, noise level, design for all levels of users

The answers are pair-wise/dichotomous and focused mainly on interface's consistency, helpfulness and clearness.

The QUIS questionnaire consists of four factors: screen, terminology and system information, learning, and system capabilities. however, factor analysis failed to confirmed the proper loading of defined factors. As Lewis noticed (1995, p. 61), "the lack of correspondence between item groups and underlying factors and the paucity of information regarding subscale reliability are problems that limit the usefulness of the QUIS".

Computer System Usability Questionnaire (CSUQ; Lewis, 1995) contains 19 questions measuring such computer system characteristics as:

- Ease of use
- Ease of learning
- Simplicity
- Effectiveness
- Information
- User interface

Example items are: “Overall, I am satisfied with how easy is to use this system”, “I feel comfortable using this system”, “The interface of this system is pleasant”. The scale is reliable, Cronbach’s alpha = 0.95 for the whole scale and high Cronbach’s alpha coefficient for the subscales: system usefulness, information quality and interface quality. the questionnaire proved to be reliable and useful also in non-laboratory setting and is open to use by researchers.

System Usability Scale (SUS) is a ten-item scale developed by Brooke (1986). It is a validated tool for measuring the usability of a wide variety of products and services, including hardware, software, mobile devices, websites, applications. It was designed to meet the need of a short, simple tool that could be used in industrial settings. SUS has been made freely available for use in usability assessment. The exemplary items are: “I think that I would like to use this system frequently”, “I found the system unnecessarily complex”, “I felt very confident using the system”. However, there is no information on the usability/user satisfaction principles that would determine factors included in the tool. Results from the analysis of Bangor, Kortum and Miller (2008) show that the SUS is a highly robust and versatile tool for usability professionals.

USE Questionnaire is a public-access tool developed by Lund (2001), dedicated to measure the most important dimensions of usability for users, across domains. It can measure the usability of interface, software, hardware, services, user support materials. The questionnaire contains 30 items (17 items in the short-form version) on four subscales, corresponding to most important usability dimensions:

- Usefulness
- Ease of Use
- Ease of Learning
- Satisfaction

Example items are: “It makes the things I want to accomplish easier to get done”, “It requires the fewest steps possible to accomplish what I want to do with it”, “I learned to use it quickly”, “It is wonderful”.

Less common questionnaires are: ASQ, CUSI, UIS and PUTQ.

The **After-Scenario Questionnaire** (ASQ) is another tool developed as a part of the IBM questionnaire set (Lewis, 1995). It contains only three questions corresponding to the following system usability satisfaction factors: ease of task completion, time to complete a task, adequacy of support information. The exemplary item is: “Overall, I am satisfied with the amount of time it took to complete the task in this scenario”. The length of the questionnaire is an advantage but it is a questionnaire designed for the usability experts to answer using predefined scenarios and tasks. However, the questionnaire has been also validated in the office-application studies. It has been shown that three ASQ items should be condensed into a single scale. That is why it cannot be specified, which usability dimension needs an improvement.

Computer Satisfaction Inventory (CUSI) is a scale developed by Kirakowski and Dillon (1988; in: Lewis, 1995). It is a 22-item questionnaire containing two subscales: affect and competence. competence factor addresses users’ feeling of mastery over the computer system. affect factor addresses users’ feeling of fear or pleasure. the overall internal consistency is 0.94, with 0.91 for affect and 0.89 for competence. it is designed to be used in laboratory environment with tasks developed by researchers. Unlike the QUIS, researchers who wish to use the CUSI must purchase it from the authors, which limits its general availability and usefulness (Lewis, 1995, p. 61). Also, Ovaska stated (1991, p. 56) that although this measure is validated, “usability is much more than user friendliness or user competence and affect”.

User Information Satisfaction (UIS) is a short form of the CUS questionnaire, developed by Ives et al. (1983). This questionnaire contains 13 factors with two ratings per each factor (instead of five) with maintaining satisfactory psychometric characteristics. Unfortunately, authors have not published the full version of the questionnaire but it is available upon request.

Purdue Usability Testing Questionnaire (PUTQ) is a questionnaire developed by Lin et al. (1997). The main advantage of this tool is that it was dedicated for the end users. The questionnaire is based on following usability principles:

- Compatibility
- Consistency
- Flexibility
- Learnability
- Minimal action
- Minimal memory load
- Perceptual limitation
- User guidance

Although these principles were dedicated to man-machine systems' usability in general, the questionnaire developed on the basis of these principles (PUTQ) was designed specifically for a conventional graphical user interface software with a visual display, keyboard and mouse, that is why it can be used in specific usability evaluation environments.

Zviran and Erlich (2003) suggested that future studies on system usability should include modern world challenges, e.g. security of the system, as well as other dimensions receiving less attention, e.g. organisational support. Other factors that should be considered in the industrial environment are health & safety issues or the rapid changes in technology, allowing for adapting the interface to the users' capabilities and skills. Questionnaire developed in the Task 6.1 was an attempt to include these factors.

2.2.3 Objective usability measurement

Physiological data

The monitoring of physiological data, such as eye-tracking (Poole & Ball, 2006), stress level (Mullins & Treu, 1991), human movement analysis (Belda-Lois et al., 2010), Heart Rate Variability - HRV, Electrodermal Activity - EDA, Electroencephalograph – EEG, Electromyography – EMG, Critical Flicker Frequency - CFF (Hercegfi, 2011) is considered as a usability testing method in the Human-Computer Interaction environment, although there is still lack of research in this area.

Behavioural data

This group of objective measurement factors can include primary-task performance, secondary-task performance, interaction times, time to execute task, number of mistakes, usage time, number of reports/queries issued over a specific period, number of file updates (Zviran & Erlich, 2003; Kamp et al., 2001, Harvey, 2009). This sort of measurement is regarded to be more accurate but in some cases it could be difficult to apply or to measure, depending on the field/environment. There are few reasons considered in Zviran and Erlich (2003) review: such methods are perceived by business owners as expensive because they often require financial investment (e.g. installing dedicated software). Moreover, users are aware of being monitored and they may alter their behaviour for the measurement period. Finally, according to Zviran and Erlich (2003) these methods do not always reflect the success or usability of the system.

The subjective and objective methods of measuring system usability have got their own advantages and disadvantages. However, as Kissel (1995) has demonstrated, subjective ratings of usability often differ from objective performance measures. Recognising the value of both objective and subjective measurement, Harvey (2009) proposed to combine different approaches when measuring the usability.

2.3 Satisfaction with work in general

The job satisfaction is often defined as 'an emotional reaction to the job' (e.g. Spector, 1997; in: Rafferty & Griffin, 2009) or as 'an individual's evaluation of the job, beliefs about the job, and affective experiences on the job' (Weiss, 2002; in: Rafferty & Griffin, 2009).

The worker satisfaction is a factor that constitutes healthy and productive companies. Poor job satisfaction is related with mental-health problems and increases the risk of sickness absence and disability pension (Andersen et al., 2017).

The most common method of measuring worker satisfaction is a questionnaire measurement, usually being a part of working conditions surveys.

The **European Working Condition Survey** (EWCS) includes a single-item scale of satisfaction with working conditions, which is considered as a prerequisite for worker motivation. Answers are given on a 5-point Likert scale, ranging from 'not at all satisfied' to 'very satisfied'. The survey has shown that factors positively related to satisfaction with working conditions are: good quality of management, good work-life balance, having career prospects. Supervisory role is also related to higher satisfaction with working conditions, which should remind about giving special attention to workers on the bottom of the organisational ladder. Factors that are likely to lead to low satisfaction with working conditions are: adverse social behaviour, feeling that one's health is at risk because of work, holding a temporary contract and having experienced restructuring in the company.

In terms of association with job quality indices, satisfaction with working conditions is most strongly related to social environment, prospects, and skills and discretion. The last factor – skills and discretion – is a foundation of worker's autonomy/ control, which is one of most crucial aspects of maintaining employees' wellbeing (e.g. Karasek, 1979).

Another single-item scale is also widely used in working condition surveys. This question is: 'How satisfied are you with your job in general – all things considered?' (Rafferty and Griffin, 2009)

The **Copenhagen Psychosocial Questionnaire** (COPSOQ; Peterjsen et al., 2011) measures work satisfaction with four items, asking about satisfaction with work prospects, physical working conditions, the way one's abilities are used, and job as a whole, everything taken into consideration.

However, according to Rafferty's and Griffin's review of studies measuring job satisfaction, the most popular job satisfaction measures have been Michigan Organizational Assessment Questionnaire (Cammann et al., 1983; in: Rafferty & Griffin, 2009) and Job Descriptive Index (Smith et al., 1969; in: Rafferty & Griffin, 2009).

The **Michigan Organizational Assessment Questionnaire** (Camman et al., 1983; in: Rafferty & Griffin, 2009) is a tool measuring an overall job satisfaction with three items, e.g. 'All in all, I am satisfied with my job'. This scale demonstrated a sufficient reliability and it is a part of an instrument measuring working conditions.

The **Job Descriptive Index** (JDI; Smith et al., 1969; in: Rafferty & Griffin, 2009) measures job satisfaction with 72 items, assessing five dimensions of job satisfaction: satisfaction with work itself, pay, promotion opportunities, supervision, and co-workers.

The above-mentioned examples of methods and tools to measure job satisfaction in general vary between 1-item to 72-item scales. All of these instruments are widely used and validated. The choice of the instrument should be dictated by the research goals, but the length of the scale is an important factor when the questionnaire contains other scales and should be respondent-friendly.

The worker satisfaction can be also measured by means of a physiological parameters monitoring. The use of the objective measurement is based on scientific evidence, stating that workers' wellbeing, including work satisfaction, is related to physiological reaction on the level of cardiovascular system, endocrine system or

immune system (Kuykendall, 2015) that are involved in the organism stress response. The stimulation of the nervous system is reflected, among others, in an increased hear rate, stimulation of sweat glands. Therefore, the changes in heart rate, galvanic skin response, skin temperature can be used to evaluate stress and, in turn, satisfaction level.

2.4 Conclusions for measuring worker satisfaction in the INCLUSIVE project

In the literature review, we presented current approaches to the measurement of usability/user satisfaction and satisfaction with work in general. This review has shown that user satisfaction with the system (e.g. HMI) is a form of usability. As the main group of interest in the INCLUSIVE project are end-users – employees working with the adaptive HMI – we therefore decided to put an emphasis on their assessment of the HMI, instead of conducting external expert usability evaluation. However, the questionnaire needs to be tailored to the real work environments and the new, adaptive interface, reflecting three HMI Modules: Measure, Adapt, and Teach (described in Deliverable D1.1).

Moreover, traditionally, the satisfaction with work is commonly measured as affective reactions to one's job. However, in INCLUSIVE project worker satisfaction is understood as a specific case of users' satisfaction, which refers to working environments, and work-related products or services, including HMI interfaces and other ICT-based solutions implemented in industrial machinery control systems and automated manufacturing systems. It is a more broad understanding than the classic approach presented in the literature review (although some of the reviewed tools considered the satisfaction with working conditions). Accordingly, we are proposing a user satisfaction with the adaptive HMI and working conditions model, understood as a worker satisfaction model. Consequently, we needed to develop a new questionnaire, measuring user satisfaction with HMI, including satisfaction with the three INCLUSIVE modules, and satisfaction with psychosocial and physical working conditions, taking into account individual variables, such as capabilities and skills.

It is also foreseen to analyse the objective data obtained in the WP2 and WP7 tests as satisfaction indicators, in addition to the subjective measurement.

3. The user satisfaction with the adaptive HMI and working conditions model

When developing the model of HMI user satisfaction with work, we assumed that some other factors present at the workplace can influence its assessment or are particularly important in the context of inclusive industrial environment. These are physical factors, such as noise, temperature, dust or posture, as well as psychosocial working conditions, such as autonomy, participation, justice or social support. Equally, as the system will process sensitive personal data, which discloses barriers of human capabilities, different ethical and legal requirements to protect the user against harm and disadvantages have also be taken into account. Based on the ELSI model of ethical, social and legal aspects (ELSI) which are described in the Deliverable D1.2 – 'Summary of all safety, health and ethics recommendations for the working environments' we have also included some ethical and social aspects in the 'Satisfaction with the adaptive HMI and working conditions' model.

Its main component, namely satisfaction while working with the HMI, itself accounts for health and safety requirements which were identified and specified in the WP1 and described in the abovementioned Deliverable D1.2.

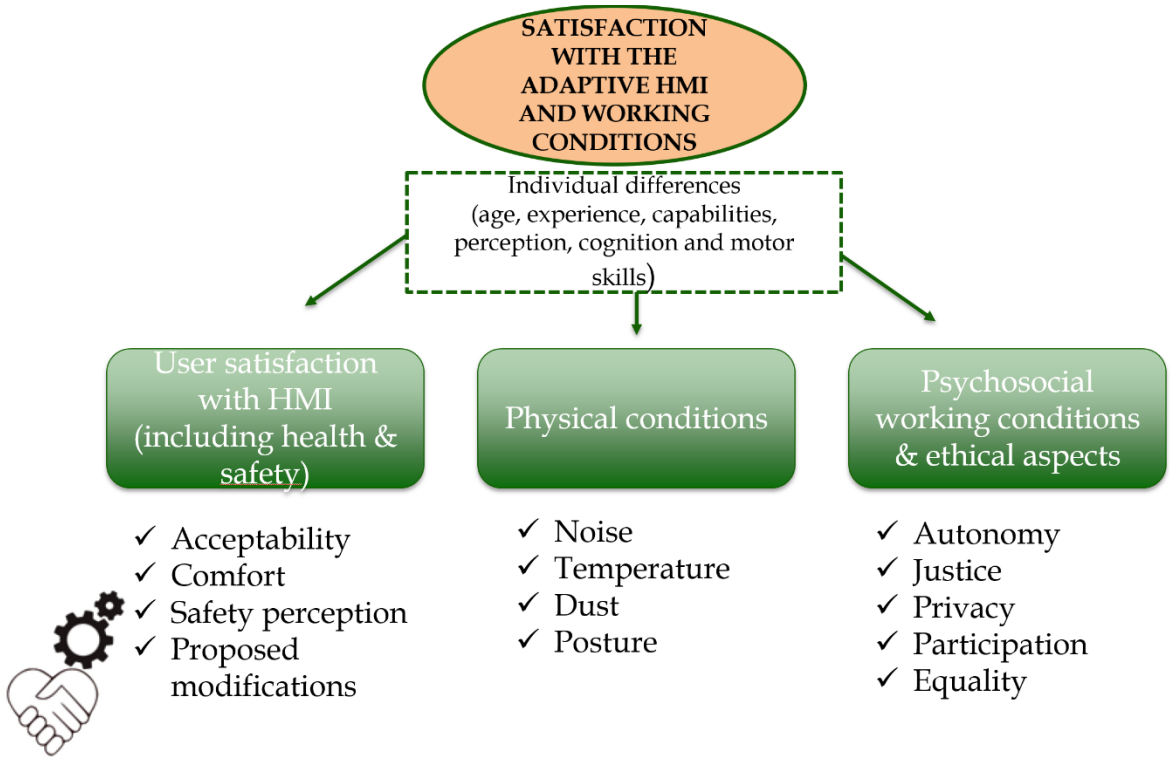

Fig. 2: Proposed model of worker satisfaction in the INCLUSIVE project framework.

Based on this model we then developed the questionnaire that would cover all mentioned sections and aspects.

4. The questionnaire

Before starting to develop the questionnaire, we had reviewed some other existing questionnaires (see Paragraph 2). When the first draft of our survey had been ready we sent it to the Consortium Partners, so they could comment on it or add some missing issues. After receiving these comments, we included the majority of them into the attached version of the questionnaire (see Apendix 1).

4.1. Questionnaire's preamble

This questionnaire starts with a preamble explaining the questionnaire's aim, which is the assessment of satisfaction with the implementation of the adaptive HMI, as well as its general structure. In the questionnaire preamble its potential respondents are assured that survey is anonymous, and that the individual data will not be disclosed to any of their supervisors.

4.2. Occupational and demographic data

The first data to be collected in the questionnaire is the data related to the company, approximate number of employees and job position structure.

As the interactive system is being designed for ageing workers or workers with language fluency difficulties, the next set of items relates to such data factors as: age, level of education, nationality, level of language officially used in the work environment.

We are also interested in users' work experience, so the questions about the length of professional work experience, including any training to perform current tasks, are also posed in this section.

From the point of view of system adaptability, some aspects related to users' health and capabilities are also important. Hence, users are asked questions on potential problems with vision, hearing, hand movements, precise movements, memorising information, concentration or understanding and following instructions.

At the end of this section, the user is asked to assess his/her general health, and how often he/she is being stressed during worktime. In order to get users familiar with what it means, the notion of stress has been explained.

4.3 Working Conditions

4.3.1 Physical Working Conditions

In this section, we ask users how frequently they are exposed to difficult working environment conditions such as: excessive noise, extreme temperatures, dust, too bright/too dark light. We also ask whether user's work require to maintain awkward body position, lifting, bending or hands up.

The answers format is a 4-point Likert scale where 4 = most of the time, and 1= never.

4.3.2 Psychosocial Working Conditions

In order to cover all possible psychosocial conditions present at the workplace, we included a standardised and well validated scale - The Copenhagen Psychosocial Questionnaire (COPSOQ) developed by Kristensen et al. (2005) in its revised version (Pejtersen et al., 2010). Conceptually, it includes the main dimensions of the most influential psychosocial theories at work, including the Job-Strain, Demand-Control-Support (Karasek & Theorell, 1990) and Effort-Reward-Imbalance (Siegriest, 1996) models, but also other theories and aspects ignored in previous tools, for instance emotional demands or role clarity. This makes COPSOQ useful in any workplace either in the industrial or in the services branch. Among psychosocial risk assessment tools COPSOQ is unique, because it includes population-based reference values to assess the need for action and to help the decision making process on preventive measures at the workplace level. A strength of

COPSOQ is that it has been tested in many countries all over the world. These validation studies show the questionnaire‘s capacity and usability in the local context.

Trying to keep the questionnaire as short as possible, we did not include whole scales from COPSOQ, only chosen questions, most appropriate to the working conditions present in the inclusive HMI environment.

We used questions assessing psychological work demands, such as: ‘Do you have enough time for your work tasks?’ or ‘Do you have to keep your eyes on a lot of things while you work?’. The aspect of learning new things was also included using such questions as: ‘Does your work demand that you are good at coming up with new ideas?’ and ‘Do you have the possibility of learning new things through your work?’.

The workers’ influence on how he/she performs his/her tasks is assessed using the questions like: ‘Can you influence the amount of work assigned to you?’ and ‘Do you have a large degree of influence concerning your work?’. Social support is another important aspect of psychosocial working conditions, in the questionnaire it is assessed using questions like: ‘How often do you get help and support from your colleagues if you need it?’, ‘How often can you get help and support from your nearest superior if you need it?’.

The meaning of work will be evaluated using the question: ‘Do you feel that the work you do is important?’, and management style in the organisation with the questions, such as ‘Do you feel motivated and involved in your work?’ or ‘Is your work recognised and appreciated by the management?’.

An important factor of worker’s satisfaction is also organisational justice, which will be assessed with the questions, such as: ‘Are you treated fairly at your workplace?’ or ‘Is the work distributed fairly?’. Work insecurity, specifically related to the modern technologies could also be a significant predictor of worker’s fear and work dissatisfaction, in the questionnaire it would be measured with the questions: ‘Are you worried about new technology making you redundant?’ and ‘Are you worried about being transferred to another job against your will?’.

A potential discrimination could also significantly influence the worker’s satisfaction, we are going to check it using the following questions: ‘Is there space for employees of a different race and religion?’, ‘Is there space for both men and women?’, ‘Is there space for elderly employees?’ or ‘Is there space for employees with various illnesses or disabilities?’.

4.4 Satisfaction with the adaptive HMI

4.4.1 Safety

As mentioned above in the Paragraph 3 and based on Deliverable D1.2 – ‘Summary of all safety, health and ethics recommendations for the working environments’, we are going to ask whether the safety functions (Emergency stop, Guard locking functions, Indications and alarms) and the control buttons (Manual Reset, Mode selection/muting, Hold-To-Run, Enabling Device Function, Two-hand control function, Locking – unlocking of the panel) are: clearly identifiable, clearly visible, readily accessible. Similarly, error messages and warning messages are very important from the point of view of safety, so the question ‘Are error messages and warning messages clear, informative/sufficiently detailed, unambiguous?’ is also included in this section.

The answer format is a 5-point Likert scale, where 0 = Never/Hardly Ever, and 4 = Always.

4.4.2 Satisfaction with the design/visibility of the interface

In this section, questions on characters, visibility and clarity of texts/messages, signs/symbols on the interface, buttons were included. We also ask users about the sequence of screens, position of messages on the screen, the colours used in the HMI, the HMI layout. Example items on this scale are: ‘In general, the organisation of information is clear’, ‘The sounds distract and/or annoy me’.

The answer format is a 5-point Likert scale, where 0 = Never/Hardly Ever, and 4 = Always.

4.4.3 Satisfaction with ease

In this section, a user is asked about the ease of the system – one of the usability principles defined in the Paragraph 2.1. It means that the system is easy to learn and become familiarised with as well as time of learning is minimal. The items related to the process of becoming familiar with the system's functions and operations, memorising the system's functions and operations, finding the information needed, performing tasks, etc. Example items are: 'I can easily withdraw an accidental command/action', 'Use of terms throughout the system is consistent and understandable'.

The answer format is a 5-point Likert scale, where 0 = Never/Hardly Ever, and 4 = Always.

4.4.4 Satisfaction with efficiency

Satisfaction with efficiency is another section directly related to usability principles. In this section the user is asked about the system efficiency. The items cover the amount of information presented, number of operations to perform the task, having sense of control over the system, cooperation with the machine/robot. Example items are 'I feel fully in control of the machine' and 'In general, the HMI helps me to be more productive in my work'.

The answer format is a 5-point Likert scale, where 0 = Never/Hardly Ever, and 4 = Always.

4.4.5 Satisfaction with the Adapt module

This section covers satisfaction with one of the three core INCLUSIVE modules: Adapt Module (see Deliverable D1.1). Users are here asked about their reactions to the newly developed system and its adaptation to their capabilities and skills. The items verify whether the HMI has been adapted to capabilities/mental states and user guidance. Example items are 'I can get started easily on the system's newly added functions', 'I feel I make less mistakes/errors using the adaptive HMI', 'I feel I can complete the tasks even if I am tired'.

The answer format is a 5-point Likert scale, where 0 = Never/Hardly Ever, and 4 = Always.

4.4.6 Satisfaction with the Measure module

Accordingly, this section covers satisfaction with the Measure Module (see Deliverable D1.1) – users reactions to monitoring their physiological parameters with an eye-tracker, wristband or speech detector. Items are preceded by a short explanation of the aim of the measurement module, i.e. enabling the system to detect higher stress levels and to react (adapt). Example items are: 'I feel that monitoring my strain can be advantageous for me', 'I feel it can challenge my physical comfort'.

The answer format was a 4-point Likert scale, where 0 – Never/Hardly Ever,1 – Seldom, 2 – Sometimes, 3 – Often, 4 – Always.

4.4.7 Satisfaction with the Teach module

This section covers user reactions to the Teach Module (see Deliverable D1.1). As this module includes both an on-line and off-line teaching system, items have also been developed to measure satisfaction with different teaching techniques. Example items are 'The chosen way of assistance (AR-based assistance, Speech-based assistance, Support assistance) in the on-line teaching was appropriate', 'The off-line teaching was helpful to master the HMI'.

The answer format is a 5-point Likert scale, where 0 = Never/Hardly Ever, and 4 = Always.

4.4.8 Overall Satisfaction with the adaptive HMI

The final section covers the overall satisfaction with the adaptive HMI and it is measured with the question: 'Regarding the adaptive HMI in general. How pleased are you with it as a whole, everything taken into consideration?'.

The answer format is a 5-point Likert scale, where 1 = Very satisfied, and 5 = Very unsatisfied.

In order to ensure the engagement of workers in the design and adaptation of their workplaces to their needs, which is the prerequisite to ensure the attractiveness of these novel solutions for workers, the questionnaires will include collected users' opinions and/or proposals on preferred modifications of the HMI design and its operating mode. Therefore we ask two open questions: 'If you are satisfied, what do you like the most in the adaptive HMI?' and 'What should be improved in the adaptive HMI?'.

5. Objective measurement of worker satisfaction

As mentioned earlier, the aim of the WP6 is to measure worker satisfaction, both subjectively (with the questionnaire developed) and objectively. In order to conduct an objective assessment, the data obtained from the objective indicators for measuring workers' capability in the demonstrators (WP7) will be analysed. The results of real-time measurements of indicators selected in WP2 (e.g. eye-tracking, galvanic skin response) will be correlated with the results of questionnaire-based subjective measurements of worker satisfaction.

6. Conclusion

The aim of this Deliverable was to propose methods and tools to measure worker satisfaction in framework of the INCLUSIVE project. The literature review conducted as part of this work package task has described the commonly used methods for assessing system's usability, user satisfaction and satisfaction with work. Based on this review as well as on previous Deliverables (D1.2), we have selected factors to be considered in the worker satisfaction model and the questionnaire to measure worker satisfaction with the adaptive HMI and working conditions. The questionnaire will be translated, pilot tested and adjusted in the Task 6.2.

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Appendix 1 – 'Satisfaction with the adaptive HMI and working conditions' questionnaire

Company:
Code:
Approximate number of employees:
Job Position:

Satisfaction with the adaptive HMI and working conditions

Dear Participant!

The survey is conducted within the Inclusive Project that your company is involved in.

This questionnaire is aimed at assessment of satisfaction with the implementation of the adaptive human machine interface (HMI). It consists of two main parts: satisfaction with working conditions and satisfaction with the new adaptive interface. **The survey is anonymous.** The individual data will not be available to any of your supervisors. We are really interested in what you think about the adaptive interface. We encourage you to give your honest opinion!

Demographic DATA

1. Age _____
2. Gender: ❑ Man ❑Woman
3. Level of education:

   ❑ Primary school ❑ Secondary school ❑ University (Bachelor) ❑ University (Master)
4. For how long do you work in the company? _____
5. How long have you been involved in the present work tasks? _____
6. Did you receive any training to perform your current task? ❑ YES ❑ NO
7. Nationality? ……
8. Is your nationality the same as the majority of your colleagues? ❑ YES ❑ NO
9. Your level of language officially used in your work environment is:

❑ Basic ❑Communicative ❑ Advanced ❑ Native speaker

HEALTH AND CAPABILITIES

1. I have problems with vision: ❑ YES (check below) ❑NO

   If YES: ❑ Near ❑Far ❑ I am colorblind ❑ Other (please describe) …….

2. If an answer to the question 1 is yes, my vision with correction glasses/lenses is:

   ❑ Excellent ❑ Good ❑Moderate ❑ Poor

3. I have problem with hearing: ❑ YES ❑ NO

4. If an answer to the question 3 is yes, my hearing with hearing aid is:

   ❑ Excellent ❑ Good ❑Moderate ❑ Poor

5. I have problems with moving my hands:

   ❑ Not at all ❑ To a small extent ❑ Somewhat ❑ To a large extent

6. I have problems with precise movements (e.g. manipulating small objects):

   ❑ Not at all ❑ To a small extent ❑ Somewhat ❑ To a large extent

7. I have difficulties to remember things:

   ❑ Not at all ❑ To a small extent ❑ Somewhat ❑ To a large extent

8. In general I have problems with concentration:

   ❑ Not at all ❑ To a small extent ❑ Somewhat ❑ To a large extent

9. I have problems with understanding instructions and following instructions:

   ❑ Not at all ❑ To a small extent ❑ Somewhat ❑ To a large extent

10. In general, I would say my health is:

    ❑ Excellent ❑Very good ❑ Good ❑ Fair ❑ Poor

11. How often have you been stressed* during the last 4 weeks:

    ❑ Every day ❑ Most of the week ❑ Once a week ❑ Never/Hardly Ever

** **Stress** means the situation when a person feels tense, restless, nervous, or anxious, or is unable to sleep at night because his mind is troubled all the time.*

I. Working Conditions

PHYSICAL WORKING CONDITIONS

1. **During work are you frequently exposed to difficult conditions such as:**

a)	Excessive Noise	❑ Most of the time	❑ Sometimes	❑ Rarely	❑ Never
b)	Extreme Temperatures	❑ Most of the time	❑ Sometimes	❑ Rarely	❑ Never
c)	Dust	❑ Most of the time	❑ Sometimes	❑ Rarely	❑ Never
d)	Too bright/too dark light	❑ Most of the time	❑ Sometimes	❑ Rarely	❑ Never

2. **Does your work require to maintain:**

a)	Awkward body position	❑ Most of the time	❑ Sometimes	❑ Rarely	❑ Never
b)	Lifting	❑ Most of the time	❑ Sometimes	❑ Rarely	❑ Never
c)	Bending	❑ Most of the time	❑ Sometimes	❑ Rarely	❑ Never
d)	Hands up	❑ Most of the time	❑ Sometimes	❑ Rarely	❑ Never
e)	Other				

(Short description)……

……

PSYCHOSOCIAL WORKING CONDITIONS

		0 – Never/Hardly Ever ***1 – Seldom*** ***2 - Sometimes*** ***3 – Often*** ***4 – Always***	Never/Hardly Ever	Seldom	Sometimes	Often	Always
1.	Do you have enough time for your work tasks?		0	1	2	3	4
2.	Do you have to keep your eyes on a lots of things while you work?		0	1	2	3	4
3.	Does your work require that you remember a lot of things?		0	1	2	3	4
4.	Does your work demand that you are good at coming up with new ideas?		0	1	2	3	4
5.	Does your work require you to make difficult decisions?		0	1	2	3	4
6.	Can you influence the amount of work assigned to you?		0	1	2	3	4
7.	Do you have a large degree of influence concerning your work?		0	1	2	3	4
8.	How often do you get help and support from your colleagues if you need it?		0	1	2	3	4
9.	How often can you get help and support from your nearest superior if you need it?		0	1	2	3	4
10.	Do you feel part of a community at your place of work?		0	1	2	3	4
		0 – To a very small extent ***1 – To a small extent*** ***2 - Somewhat*** ***3 – To a large extent*** ***4 – To a very large extent***	To a very small extent	To a small extent	Somewhat	To a large extent	To a very large extent

11.	Is it necessary to keep working at a high pace?	0	1	2	3	4
12.	Do you have the possibility of learning new things through your work?	0	1	2	3	4
13.	Does your work require you to take the initiative?	0	1	2	3	4
14.	Can you use your skills or expertise in your work?	0	1	2	3	4
15.	Does your work give you the opportunity to develop your skills?	0	1	2	3	4
16.	Do you feel that the work you do is important?	0	1	2	3	4
17.	Do you feel motivated and involved in your work?	0	1	2	3	4
18.	Is your work recognized and appreciated by the management?	0	1	2	3	4
19.	Are you treated fairly at your workplace?	0	1	2	3	4
20.	Are you worried about new technology making you redundant?	0	1	2	3	4
21.	Are you worried about being transferred to another job against your will?	0	1	2	3	4
22.	Are conflicts resolved in a fair way?	0	1	2	3	4
23.	Are employees appreciated when they have done a good job?	0	1	2	3	4
24.	Is the work distributed fairly?	0	1	2	3	4
25.	Is there space for employees of a different race and religion?	0	1	2	3	4
26.	Is there space for both men and women?	0	1	2	3	4
27.	Is there space for elderly employees?	0	1	2	3	4
28.	Is there space for employees with various illnesses or disabilities?	0	1	2	3	4

Overall Satisfaction with working conditions

Regarding your work in general. How pleased are you with your job as a whole, everything taken into consideration?

❑ Very satisfied ❑ Satisfied ❑ Neither satisfied, nor dissatisfied ❑ Unsatisfied ❑ Very unsatisfied

II. Satisfaction with the adaptive Human Machine Interface (HMI)

SAFETY

0 – To a very small extent
1 – To a small extent
2 - Somewhat
3 – To a large extent
4 – To a very large extent
5 - Not applicable

		To a very small extent	To a small extent	Somewhat	To a large extent	To a very large extent	Not applicable
According to your opinion:							
1.	**Safety functions (Emergency stop, guard locking functions, indications and alarms) are:**						
a)	Clearly identifiable	0	1	2	3	4	5
b)	Clearly visible	0	1	2	3	4	5
c)	Readily accessible	0	1	2	3	4	5
2.	**The control buttons (Manual Reset, Mode selection/muting, Hold-To-Run, Enabling Device Function, Two-hand control function, Locking – unlocking of the panel) are:**						
d)	clearly identifiable	0	1	2	3	4	5
e)	Clearly visible	0	1	2	3	4	5
f)	Readily accessible	0	1	2	3	4	5
3.	**Error messages and warning messages are:**						
g)	Clear	0	1	2	3	4	5
h)	Informative/Sufficiently detailed	0	1	2	3	4	5
i)	Unambiguous	0	1	2	3	4	5
4.	Overall, the adaptive HMI fulfills all the safety functions	0	1	2	3	4	5

SATISFACTION WITH THE DESIGN/VISIBILITY OF THE INTERFACE

	0 – To a very small extent ***1 – To a small extent*** ***2 - Somewhat*** ***3 – To a large extent*** ***4 – To a very large extent*** ***5 - Not applicable*** **According to your opinion:**	To a very small extent	To a small extent	Somewhat	To a large extent	To a very large extent	Not applicable
1.	Characters are easy to read.	0	1	2	3	4	5
2.	The texts / messages on the interface are visible	0	1	2	3	4	5
3.	The signs/symbols on the interface are unambiguous/clear	0	1	2	3	4	5
4.	The interface buttons (options) are visible on the screen	0	1	2	3	4	5
5.	The size of the buttons (options) is optimal (not too large, not too small)	0	1	2	3	4	5
6.	Sequence of screens is appropriate	0	1	2	3	4	5
7.	Position of messages on the screen is consistent	0	1	2	3	4	5
8.	The colours used in the HMI help to better perceive the information on the screen	0	1	2	3	4	5
9.	The colours used in the HMI do not distract me	0	1	2	3	4	5
10.	The HMI layout is aesthetic	0	1	2	3	4	5
11.	The HMI layout is minimalistic	0	1	2	3	4	5
12.	In general, the organization of information is clear	0	1	2	3	4	5
13.	In general, the layout of the adaptive HMI is appropriate	0	1	2	3	4	5
14.	The sounds of the HMI help me to better operate the HMI.	0	1	2	3	4	5
15.	The sounds distract and/or annoy me.	0	1	2	3	4	5
16.	The changing interface distracts me	0	1	2	3	4	5
17.	I can easily operate the adaptive HMI using my hands	0	1	2	3	4	5

SATISFACTION WITH EASE

According to your opinion:	*0 – To a very small extent* *1 – To a small extent* *2 - Somewhat* *3 – To a large extent* *4 – To a very large extent* *5 - Not applicable*	To a very small extent	To a small extent	Somewhat	To a large extent	To a very large extent	Not applicable
1.	The system is easy to learn.	0	1	2	3	4	5
2.	I quickly familiarized myself with the system's functions and operations.	0	1	2	3	4	5
3.	It was easy to memorize the system's functions and operations.	0	1	2	3	4	5
4.	Use of terms throughout system is consistent and understandable.	0	1	2	3	4	5
5.	The signs/symbols on the interface help me to navigate through the HMI	0	1	2	3	4	5
6.	I can easily find all the information I need.	0	1	2	3	4	5
7.	I can easily withdraw un accidental command/action.	0	1	2	3	4	5
8.	I can easily return to the earlier steps.	0	1	2	3	4	5
9.	Performing tasks is straightforward.	0	1	2	3	4	5

SATISFACTION WITH EFFICCIENCY

According to your opinion:	*0 – To a very small extent* *1 – To a small extent* *2 - Somewhat* *3 – To a large extent* *4 – To a very large extent* *5 - Not applicable*	To a very small extent	To a small extent	Somewhat	To a large extent	To a very large extent	Not applicable
1.	The HMI provides insufficient amount of information.	0	1	2	3	4	5
2.	The HMI provides excessive amount of information.	0	1	2	3	4	5
3.	The number of operations to perform a task/to achieve a goal/to set up a process is optimal.	0	1	2	3	4	5
4.	I feel fully in control of the machine.	0	1	2	3	4	5
5.	The HMI helps me to more efficiently cooperate with the machine/robot.	0	1	2	3	4	5
6.	In general, the HMI helps me to be more productive in my work.	0	1	2	3	4	5

SATISFACTION WITH ADAPT MODULE

	0 – To a very small extent ***1 – To a small extent*** ***2 - Somewhat*** ***3 – To a large extent*** ***4 – To a very large extent*** ***5 - Not applicable***	To a very small extent	To a small extent	Somewhat	To a large extent	To a very large extent	Not applicable
According to your opinion:							
1.	I can get started easily on the system's newly added functions	0	1	2	3	4	5
2.	I feel the adaptive HMI adjusts to my actual capabilities/mental states	0	1	2	3	4	5
3.	I feel I can complete the tasks even if I am tired	0	1	2	3	4	5
4.	I feel I can be easily guided when I get lost/commit an error	0	1	2	3	4	5
5.	I feel less stressed using the adaptive HMI	0	1	2	3	4	5
6.	I trust that the system allows me to perform my tasks smoothly	0	1	2	3	4	5
7.	I feel more confident using the adaptive HMI	0	1	2	3	4	5
8.	I feel I make less mistakes/errors using the adaptive HMI	0	1	2	3	4	5
9.	I feel less exhausted after my shift when using the adaptive HMI	0	1	2	3	4	5

SATISFACTION WITH MEASURE MODULE

Please answer the subsequent questions considering the following scenario: The working machines are equipped with sensors that are able to track strain of a working person by real-time measurement of his/her physiological parameters, e.g. heartrate, blood pressure, etc. If the measured strain indicators are too high, the human-machine-interface adapts to the situation resulting in a lower stress level.

How do you feel about monitoring your physiological parameters (e.g. using a wristband, eye tracker, etc.)?

	0 – To a very small extent ***1 – To a small extent*** ***2 - Somewhat*** ***3 – To a large extent*** ***4 – To a very large extent*** ***5 - Not applicable***	To a very small extent	To a small extent	Somewhat	To a large extent	To a very large extent	Not applicable
1.	I feel it can challenge my physical comfort	0	1	2	3	4	5
2.	I trust the system and that my personal data will not be abused	0	1	2	3	4	5
3.	I feel uncomfortable with not knowing what happens with my personal data	0	1	2	3	4	5
4.	I feel that monitoring my strain can be benfecial for me	0	1	2	3	4	5

SATISFACTION WITH TEACHING MODULE

0 – To a very small extent
1 – To a small extent
2 - Somewhat
3 – To a large extent
4 – To a very large extent
5 - Not applicable

		To a very small extent	To a small extent	Somewhat	To a large extent	To a very large extent	Not applicable
What do you think about the on-line and off-line training?							
1.	The chosen way of assistance (AR-based assistance, Speech-based assistance, Support assistance) in the on-line training was appropriate	0	1	2	3	4	5
2.	The way the on-line training system presented the information was adapted to my current work task.	0	1	2	3	4	5
3.	The information in the on-line training system was easy to read and perceive.	0	1	2	3	4	5
4.	I would have needed more detailed instructions to complete my tasks.	0	1	2	3	4	5
5.	The on-line training system was adequate in relation to my skills and capabilities.	0	1	2	3	4	5
6.	The interaction with the on-line training system was intuitive.	0	1	2	3	4	5
7.	I enjoyed using the on-line training system.	0	1	2	3	4	5
8.	The on-line training system makes work easier.	0	1	2	3	4	5
9.	The on-line training system was helpful to master the HMI.	0	1	2	3	4	5
10.	The off-line training system should have been more realistic to prepare me for the interactions with the HMI.	0	1	2	3	4	5
11.	I would have needed more detailed instructions from the off-line training systems to learn the task successfully.	0	1	2	3	4	5
12.	The off-line training system could replace teaching-in by a trainer for this procedure.	0	1	2	3	4	5
13.	The interaction with the off-line training system was intuitive.	0	1	2	3	4	5
14.	I enjoyed using the off-line training system.	0	1	2	3	4	5
15.	The off-line training system was adequate in relation to my skills and capabilities.	0	1	2	3	4	5
16.	The off-line training system was too complex.	0	1	2	3	4	5
17.	The off-line training system was helpful to master the HMI.	0	1	2	3	4	5
18.	The content of the off-line training was appropriate	0	1	2	3	4	5

Overall Satisfaction with the adaptive HMI

Regarding the adaptive HMI in general. How pleased are you with it as a whole, everything taken into consideration?

❑ Very satisfied ❑ Satisfied ❑ Neither satisfied, nor unsatisfied ❑ Unsatisfied ❑ Very unsatisfied

If you are satisfied, what do you like the most in the adaptive HMI?

_____

_____

What should be improved in the adaptive HMI?

_____

_____

Thank you for your answers!!!