



CoLLaboratE

Co-production CeLL performing Human-Robot Collaborative AssEmbly

D2.5 – Social Studies Analysis of the Implications Human-Robot Collaboration on Job Quality (preliminary)

Due date: M18

Abstract:

The present document presents the work that has been done for the T2.3: Social Studies Analysis of the Implications Human-Robot Collaboration on Job Quality. It is part of the framework design, requirements & social studies feedback. The report includes the findings of a literature review that was conducted to identify the relevant for the use cases factors that influence job quality. Furthermore, it includes the design of the study that will be conducted in order to assess the changes in job quality of the workers after the introduction of the use cases.

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PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	



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EXECUTIVE SUMMARY

The goal of T2.3 is to assess the changes in job quality of the workers that will be brought by the introduction of the collaborative robots in the use cases. To achieve the goal of the task, we conducted a literature review to pin down the factors that are responsible for influencing job quality. The main factors are the following: : Job Satisfaction, Physical Factors, Physical Demands, Social Support at Work, Work Intensity, Emotional Demands, Task Autonomy, Task Clarity and Feedback Performance, Working Flexibility, Job Insecurity, Training and Learning Opportunities, Intrinsic rewards, Perceived Usefulness of Technology, Perceived ease of Use of Technology.

Next, we designed a questionnaire that will allow us to measure these factors. Last, we came up with the design of the study. The study will include two rounds of distributing the questionnaire measuring the factors influencing job quality in the workers that will participate in the use cases. The first round will be conducted one month before the start of the use cases. The second round will be conducted one month after the end of the use cases. The data obtained from the two rounds will be compare to assess if there was a change in job quality of the workers by the introduction of the collaborative robots.



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ABBREVIATIONS AND ACRONYMS

Partner's short name	Partner's full name
AUTH	ARISTOTLE UNIVERSITY OF THESSALONIKI
CERTH	CENTRE OF RESEARCH AND TECHNOLOGY HELLAS
ARMINES	ASSOCIATION POUR LA RECHERCHE ET LE DEVELOPPEMENT DES METHODES ET PROCESSUS INDUSTRIELS
JSI	INSTITUT JOZEF STEFAN
IDIAP	FONDATION DE L'INSTITUT DE RECHERCHE
UNIGE	UNIVERSITA DEGLI STUDI DI GENOVA
KU Leuven	KATHOLIEKE UNIVERSITEIT LEUVEN
LMS	UNIVERSITY OF PATRAS
CRF	CENTRO RICERCHE FIAT SOCIETA CONSORILE PER AZIONI
BOR	BLUE OCEAN ROBOTICS
ASTI	AUTOMATISMOS Y SISTEMAS DE TRANSPORTE INTERNO SA
KOL	KOLEKTOR ORODJARNA NACRTOVANJE IN IZDELAVA ORODIJ TER ORODJARSKE STORITVE D.O.O.S
ARCELIK	ARCELIK A.S.
ROMAERO	ROMAERO S.A.

Abbreviation	Definition
WP	Work Package
D	Deliverable
EC	European Commission
EU	European Union
OECD	Organisation for Economic Co-operation and Development



1 INTRODUCTION

The goal of T2.3 is assess the changes in job quality of the workers that might be brought by the introduction of the collaborative robots in the use cases. To achieve the goal of the task, we conducted a literature review to identify the factors that are responsible for influencing job quality.

Next, we designed a questionnaire that will allow us to measure these factors. Last, we came up with the methodology and the design of the study. The study will consist of two parts. In every part we will distribute the questionnaire measuring the factors influencing job quality in the workers that will participate in the use cases. The first part will be placed one month before the start of the use cases. The second part will be placed one month after the end of the use cases. The results of the two rounds will be compare to assess if there was a change in job quality of the workers by the introduction of the collaborative robots.

2 LITERATURE REVIEW

2.1 INTRODUCTION

According to the Organisation for Economic Co-operation and Development (OECD) framework on job quality, the working environment is defined by “a combination of job characteristics”, which shape the place where people perform their jobs [1]. This includes a broad range of characteristics, which relate to the nature of the work tasks, the physical and social conditions under which these tasks are performed, the scheduling of working time, the prospects that the job provides to workers and the intrinsic rewards associated with the job. Among others, job quality is linked to the working environment and the workers’ well-being [1]. The factors influencing job quality are various. Below, we present the most relevant factors for our case studies.

2.2 JOB SATISFACTION

Even though the concept of “job satisfaction” has been widely used in scientific research, there is no specific definition of what job satisfaction is, as many authors have different approaches to what it means [2]. Dating back to 1935, job satisfaction was defined in [3] as “any combination of psychological, physiological and environmental circumstances” which makes a worker satisfied with his job. Further, Vroom [4] linked job satisfaction with a person’s role in a company, while according to another study [5], job satisfaction is defined by the peoples’ feelings towards their jobs, whether they like or dislike their job. Besides these, job satisfaction has also been associated with the worker’s behavior in a workplace, meeting of worker’s expectations and needs rather than their values [6] [7], with a person’s sense of achievement and success [8] or with the workers’ satisfaction towards job-related rewards [9].

Results of a study [10] showed that the factor which less affects job satisfaction is the salary, while the ones that affect it most are job security and how interesting the work is.

2.3 PHYSICAL FACTORS

This job characteristic makes reference to the working conditions in a specified work-environment, assessing safety, dangerous and health-related conditions. It is specifically important as it speaks to the workers’ well-being while performing their job, as they need to



evaluate how dangerous their work is. Physical factors have a significant impact on job quality, as they can negatively affect the workers' health [1].

2.4 PHYSICAL DEMANDS

Physical demands address work situations where workers are exposed to hard physical effort, such as lifting heavy objects, performing repetitive movements, etc. These affect the workers' quality of life and as a result the well-being in the long term [1].

2.5 SOCIAL SUPPORT AT WORK

This characteristic refers to the atmosphere at work, the relationship between the staff and management, and how easy and transparent communication is in relation to work problems [1]. In other words, the social support is related to collaborative problem solving and sharing information, receiving advice from various sources of social support (e.g. colleagues, supervisors and managers). Further, there has been shown that supervisor support has a positive impact on perceived job satisfaction, while there is a minimal influence caused by the social support offered by colleagues [11].

2.6 WORK INTENSITY

Work intensity can also influence job quality, taking into account aspects such as working time, speed and effort and the tightness of deadlines. It is an essential component of the working environment. Work intensity can have positive effects such as higher pay and promotions, but also negative ramifications on the workers' well-being, thus influencing job quality and satisfaction [1].

2.7 EMOTIONAL DEMANDS

The emotional demands related to work situations take into account the workers' predispositions to stress and being frustrated during their work. These can be a result of their interaction with other colleagues or work situations and can be observed by assessing the frequency of emotionally draining tasks, tasks that make workers hide their feelings or tasks that are in conflict with a worker's personal values. Therefore, emotional demands usually have a psychological cost, and can negatively influence job quality [1].

2.8 TASK AUTONOMY

Task autonomy refers to the ability of the worker to decide on how to do his work in regards to methods, speed, working partners or effort [1]. This is closely related to job satisfaction and quality, as it increases creativity, physical and psychological well-being of the workers, supporting learning and gaining new skills [12]. Moreover, in [13] it was observed that an increased job satisfaction is also closely associated with the workers' perceived job control, in relation to task autonomy.

2.9 TASK CLARITY AND FEEDBACK PERFORMANCE

These attributes refer to how well the work tasks are defined and communicated to the workers, but also whether the workers receive feedback on their performance. It is known that frequent feedback increases success among employees and can reduce the workers' stress at home in relation to work-related tasks. However, in order to correctly assess the influence of the feedback



on job quality, it is important to differentiate between useful and unconstructive feedback, which can positively, respectively negatively affect the quality of a job [1].

2.10 WORKING FLEXIBILITY

In addition to tasks autonomy, this job characteristic refers to the employees being able to choose their working times, when to start and finish their working days, or when to take holidays. This has a big impact on the work-life balance and contributes to the workers' well-being by allowing people to work when it best suits them. On the other hand, a lack of flexible working hours can cause dissatisfaction, thus affecting job quality [1].

2.11 JOB INSECURITY

Job insecurity concerns the employees' fears of losing their jobs, which has an impact on their well-being and health conditions. As well, high job insecurity can diminish the workers' commitment and effort to their work-related tasks, which can negatively influence job quality [1].

2.12 TRAINING AND LEARNING OPPORTUNITIES

Training and learning opportunities have an important role in the workers' well-being, being a driver of career advancement. The learning opportunities can be formal, which are structured and have a duration, incidence, and quality, while informal learning takes place throughout usual working activities. The training opportunities are increasing job satisfaction, motivation and career growth [1].

2.13 INTRINSIC REWARDS

Intrinsic rewards refer to the workers' ability to see their work in a bigger context than their work environment, such as acknowledging the purpose of their work in relation to society, without being influenced by their income. Thus, it relates to the employees' passion for their work, rather than their interest in the monetary reward. This has an impact on productivity and effort, implicitly on the job quality [1]

2.14 PERCEIVED USEFULNESS OF TECHNOLOGY

Nowadays, technologies such as cloud and mobile computing, machine learning or advanced robotics are changing the way we work, interact and communicate, but also how businesses create and capture value [14]. Thus, the workers' opinion towards new technologies represent an essential aspect when implementing new technologies in the workplace, as their fear can cause resistance to further use them [15]. [16] defines the perceived usefulness as "the degree to which a person believes that using a particular system would enhance his or her job performance". So, if a person believes a system, in our case the collaborative robots, has high usefulness, then it is more likely that a positive relationship will be developed. This in turn can have an impact on the satisfaction user gets from the use of the robot and influence the perceived quality of job [21].

2.15 PERCEIVED EASE OF USE

On the other hand, the perceived ease of use is defined in [16] as "the degree to which a person believes that using a particular system would be free of effort". Ease of use can influence how fast a user will accept a system (collaborative robots) which is beneficial for the satisfaction a user gets from the use of the system [21]. Furthermore, ease of use can influence the perceived usefulness of the system which in turn increase job satisfaction and perceived quality [21].



2.16 INDIVIDUAL DIFFERENCES

Apart from the certain characteristics and factors of the job itself that can influence the perception of job quality, there are certain individual differences concerning certain personality and demographic characteristics that can potential have an influence on the perception about the quality of job.

2.16.1 Big Five

During the past years, an increased interest in researching the link between personality traits and job satisfaction and perceived quality can be observed [17]. The “Big Five” is a result of extensive research on personality traits, being able to represent distinct structures of personality traits into one common framework [18]. As described in [18], these five factors are usually the following:

- Extraversion - talkative, assertive, energetic
- Agreeableness - cooperative, trustful, good-natured
- Conscientiousness - responsible, dependable, orderly
- Neuroticism - neurotic, upset, not calm
- Intellect - intellectual, imaginative, independent-minded

The personality traits are important to consider, as personality differences among workers can make some job characteristics more important than others. For instance, Extraversion and Consciousness have been found to be positively correlated with job satisfaction. People that are being more extravert and more responsible have reported higher levels of job satisfaction. On the other hand, Neuroticism has been found to be negatively correlated with job satisfaction. Workers that are more vulnerable to negative emotions report lower levels of job satisfaction [22].

2.16.2 Gender, Age, Education

The differences in age groups reveal different perceptions of job quality. One aspect is related to the work intensity, which for young people (16-24) is not that high compared to older workers. Moreover, the people who entered the labor market in times with high unemployment, have higher job insecurities, which affect the quality of the working environment. Another aspect refers to the physical demands, which for people aged over 55, is higher compared to younger people. Furthermore, older people have less access to training and learning opportunities, thus having fewer chances for career advancement, which also affects their well-being. On the other hand, older people feel more secure when it comes to the future of their job than younger people.

When referring to gender differences, the research shows that women tend to be disadvantaged when it comes to wages and access to high-skilled jobs, often being considered as “secondary earners”. However, gender inequalities do not directly influence job quality. In relation to task autonomy, the literature shows little evidence of differences between men and women, but men are most likely to have better control over wider aspects of their job. Moreover, when it comes to access to training and learning opportunities, it is believed that men and women both have good opportunities, thus not many differences have been proven from this point of view [1]. In relation to the overall quality of the working environment, studies show that it is better for women, as they tend to enjoy workplaces with lower health and safety risks [19]. Women also tend to report better job satisfaction than men, even when they have similar positions as they have lower expectations [20]. Moreover, when it comes to education, [20] discovered that higher education brings higher expectations, thus more educated persons have lower job satisfaction.



3 STUDY

3.1 METHOD

We created a questionnaire measuring several aspects of working quality of the employees and some potentially interesting personality traits and demographics (see questionnaire below). We will distribute the questionnaire to the workers participating in the use cases (and a control group, for details see below) two times: approximately one month before the introduction of the use cases and one month after the end of the use cases (if there will be a training period before the introduction of the use cases then the questionnaire has to be distributed before the training). The questionnaire can be distributed either printed (on paper) or electronically through email (depending on the needs of the partners participating in the use cases). The questionnaire has to be translated in the native language of the workers before we distribute it (for the translation we will probably need the help of the partners). Filling in the questionnaire will take approximately 15 minutes each time.

3.2 SAMPLE

We will like to include a two groups in the study: 1) Group A, workers who will participate in the use cases, 2) Group B (control group), workers from the same plants of the use cases that will not participate in the use case. The control group is needed to ensure that whatever differences we might detect in group A is due to the introduction of the robots and not some random factors or seasonality. We are opting for approximately 25 to 30 workers for each group to have the appropriate statistical power to conduct the analysis. 20 participants is the lowest threshold for an acceptable statistical analysis, therefore, we have to make sure that we will gather at least 25 questionnaires to account for the fact that usually you cannot use a 10% of the data as not all participant fill in the questionnaires correctly. Therefore, in total we need 50-60 workers (25-30 workers who will participate in the use cases and 25-30 workers who will not participate in the use cases).

3.3 PROCEDURE

The procedure will be led by researchers of KU Leuven in each site. The participation of the workers will be voluntary. For the success of the project, voluntary participation is paramount (as it is important the workers to be willing to work with the new technology). The management of the sites will not be directly involved in the recruitment and data gathering procedure.

Researcher will inform participants about the purpose of the study to the participants. They will explain that participation is totally voluntary and that there will be not penalty involved for not participating. Participants also will be informed that management is not involved in the recruitment process, the gathering and the analysis of the data. Furthermore, they will be informed that the questionnaire is completely anonymous and that the data will be treated with confidentiality by the principal investigators.

After signing up for the study, participants will receive the informed consent (see appendix A) together with the questionnaire.



3.4 QUESTIONNAIRE

Physical Factors [1]

- My health or safety is at risk because of my work: 1-4 (Not at all true - Very true)
- How often do you work in dangerous conditions?: 1-5 (Never - Always)
- How often do you work in unhealthy conditions?: 1-5 (Never - Always)

Physical Demands [1]

- How often applies: do hard physical work?: 1-5 (Never - Always)
- How often: come home from work exhausted?: 1-5 (Never - Always)

Social Support at work [1]

- I can get support and help from my co-workers when needed: 1-4 (Not at all true - Very true)

Work Intensity [1]

- Does your job involve working at very high speed?: 1-7 (All of the time - Never)
- Does your job involve working to tight deadlines?: 1-7 (All of the time - Never)
- How many hours do you usually work per week in your main paid job?: [Numeric]
- You have enough time to get the job done?: 1-5 (Almost always - Almost never)
- And how many times a month do you work more than 10 hours a day?: [Numeric]

Emotional Demands [1]

- You find your job emotionally demanding: 1-5 (Almost always - Almost never)
- Your job involves tasks that are in conflict with your personal values: 1-5 (Almost always - Almost never)
- You get emotionally involved in your work: 1-5 (Almost always - Almost never)
- You experience stress in your work: 1-5 (Almost always - Almost never)
- Your job requires that you hide your feelings: 1-5 (Almost always - Almost never)

Task autonomy [1]

- How much choice do you have over the way in which you do your job?: 1-4 (A great deal of choice - No choice at all)
- How much influence do you personally have on how hard you work?: 1-4 (Very true - Not at all true)
- How much influence do you personally have on deciding what tasks you are to do?: 1-4 (A great deal - Not at all)
- How much influence do you personally have on deciding how you are to do the task?: 1-4 (A great deal - Not at all)



- How much influence do you personally have on deciding the quality standards to which you work?: 1-4 (A great deal - Not at all)

Task clarity and feedback performance [1]

- You know what is expected of you at work: 1-5 (Almost always - Almost never)
- In general, your immediate manager/supervisor: Provides you with feedback on your work: 1-2 (Yes - No)
- Had a frank discussion with your boss about your work performance?: 1-2 (Yes - No)
- Have been subject to regular formal assessment of your work performance?: 1-2 (Yes - No)

Working flexibility [1]

- I can decide the time I start and finish work: 1-4 (Not at all true - Very true)

Job insecurity [1]

- You have a secure job: 1-2 (Yes - No)
- I might lose my job in the next 6 months: 1-5 (Strongly agree - Strongly disagree)
- If I were to lose or quit my current job, it would be easy for me to find a job with similar salary: 1-5 (Strongly agree - Strongly disagree)

Training and learning opportunities

European Working Conditions Survey

- Does your main paid job involve: learning new things?: 1-2 (Yes - No)
- The training has helped me improve the way I work: 1-2 (Agree - Disagree)
- I feel that my job is more secure because of my training: 1-2 (Agree - Disagree)
- I feel my prospects for future employment are better [because of training]: 1-2 (Agree - Disagree)
- At work, I have opportunities to learn and grow: 1-5 (Strongly agree - Strongly disagree)
- Does your main paid job involve: complex tasks?: 1-2 (Yes - No)
- Does your main paid job involve: solving unforeseen problems on your own?: 1-2 (Yes - No)

Intrinsic Rewards [1]

- My job is interesting: 1-5 (Strongly agree - Strongly disagree)
- In my job I can help other people: 1-5 (Strongly agree - Strongly disagree)
- My job is useful to society: 1-5 (Strongly agree - Strongly disagree)

Job satisfaction [23]



- I feel fairly satisfied with my present job: 1-7 (Strongly agree – Strongly disagree)
- Most days I am enthusiastic about my work: 1-7 (Strongly agree – Strongly disagree)
- Each day at work seems like it will never end" (reverse scored): 1-7 (Strongly agree – Strongly disagree)
- I find real enjoyment in my work: 1-7 (Strongly agree – Strongly disagree)
- I consider my job to be rather unpleasant (reverse scored): 1-7 (Strongly agree – Strongly disagree)

Perceived usefulness of the technology [24]

(Adapted for the technology will be tested in the pilots)

- Using “technology” in my job would enable me to accomplish task: 1-7 (extremely likely – extremely unlikely)
- Using “technology” would improve my job perf: 1-7 (extremely likely – extremely unlikely)
- Using “technology” in my job would increase my productivity: 1-7 (extremely likely – extremely unlikely)
- Using “technology” would enhance my effectiveness on the job: 1-7 (extremely likely – extremely unlikely)
- Using “technology” would make it easier to do my job: 1-7 (extremely likely – extremely unlikely)
- I would find “technology” useful in my job: 1-7 (extremely likely – extremely unlikely)

Perceived ease of use [24]

(Adapted for the technology will be tested in the pilots)

- Learning to operate “technology” would be: 1-7 (extremely likely – extremely unlikely)
- I would find it easy to get “technology” to do what I want to do: 1-7 (extremely likely – extremely unlikely)
- My interaction with “technology” would be clear and understandable: 1-7 (extremely likely – extremely unlikely)
- I would find “technology” to be flexible to interact with: 1-7 (extremely likely – extremely unlikely)
- It would be easy for me to become skillful at using “technology”: 1-7 (extremely likely – extremely unlikely)
- I would find “technology” easy: 1-7 (extremely likely – extremely unlikely)

Big Five Inventory [25]

I see Myself as Someone Who...: 1-5 (Strongly disagree – Strongly agree)

- Is talkative
- Tends to be lazy
- Tends to find fault with others
- Is emotionally stable, not easily upset
- Does a thorough job
- Is inventive



- Is depressed, blue
- Has an assertive personality
- Is original, comes up with new ideas
- Can be cold and aloof
- Is reserved
- Perseveres until the task is finished
- Is helpful and unselfish with others
- Can be moody
- Can be somewhat careless
- Values artistic, aesthetic experiences
- Is relaxed, handles stress well
- Is sometimes shy, inhibited
- Is curious about many different things
- Is considerate and kind to almost everyone
- Is full of energy
- Does things efficiently
- Starts quarrels with others
- Remains calm in tense situations
- Is a reliable worker
- Prefers work that is routine
- Can be tense
- Is outgoing, sociable
- Is ingenious, a deep thinker
- Is sometimes rude to others
- Generates a lot of enthusiasm
- Makes plans and follows through with them
- Has a forgiving nature
- Gets nervous easily
- Tends to be disorganized
- Likes to reflect, play with ideas
- Worries a lot
- Has few artistic interests
- Has an active imagination
- Likes to cooperate with others
- Tends to be quiet
- Is easily distracted
- Is generally trusting
- Is sophisticated in art, music, or literature

Gender

- What is your gender (1-Female, 2-Male, 3-I do not wish to answer)

Age

- What is your age (Numeric)



Education

- What is the highest level of education you have completed?

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APPENDIX

Inform Consent

Dear Participant

You are being invited to take part in a research study. Please take the time to read the following information carefully and decide if you want to take part in this study. Please feel free to ask questions if there is anything that is not clear or if you would like more information.

You will be asked to answer questions with regard to your levels of job satisfaction as well as some personality questions.

Participation in this study is totally voluntary, you are under no obligation to take part in this study. The data that you provide will be very useful for our study. You have the right to withdraw from the study at any time and without giving a reason.

The information you provide will be confidential. No one apart from the experimenter and principal investigator (names given below) will have access to the information you provide. Your consent form will be kept separate from the observations collected during the course of the study. Data will be stored for a maximum of seven years in accordance with the University data storage policy. Once the data is analysed a report of the findings may be submitted for publication. Only broad trends will be reported and it will not be possible to identify any individuals. A summary of the results will be available from the experimenter on request once the study is complete.

If you have any questions or require any further information, please contact the experimenter or the SOCIAAL-MAATSCHAPPELIJKE ETHISCHE COMMISSIE (SMEC).

SMEC can be contacted for ethical issues and complaints.

Name of experimenter: Angelos Stamos

E-mail: angelos.stamos@kuleuven.be

SMEC E-mail: smec@kuleuven.be

If you have read the information above and would like to participate in the study, please click “I consent.”

Alternatively, if you do not want to complete the study, please click “I do not consent” and you will be redirected to the end of the study.

- I consent
- I do not consent