This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 820767

CoLLaboratE

Co-production CeLL performing Human-Robot Collaborative AssEmbly

D2.9 – Evolutionary Requirements Elicitation and Innovations (preliminary)

Due date: M18

Abstract: The present document is a deliverable of the CoLLaboratE project, funded by the European Commission's Directorate-General for Research and Innovation (DG RTD), under its Horizon 2020 Research and innovation programme (H2020). This deliverable aims at presenting the results of Task T2.5 "Evolutionary Requirements Elicitation and Innovations". It is developed within the scope of WP2 responsible for determining the "Framework Design, Requirements & Social Studies Feedback". This deliverable provides the methodology applied for continuous monitoring of initial user requirements that derived from the effort of T2.1, as well as the system specifications that are associated to these requirements. The initial user requirements are described in the project's corresponding deliverable (D2.1 "End-user requirements, use cases and industrial scenarios", whereas the corresponding technical specifications that have been extracted using the Volere methodology within T2.2 have been reported in deliverable D2.3 "CoLLaboratE Detailed Architecture & System Specifications". This is a resubmission of the preliminary version of D2.9 due in M18, whereas the final version (D2.10) with the updated requirements and specifications will be submitted in M28.

Dissemination Level		
PU	Public	x
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)	

Document Status

Document Title	D2.9 – Evolutionary Requirements Elicitation and Innovations **(preliminary)**
Version	1.1
Work Package	2
Deliverable	2.9
Prepared by	CERTH
Contributors	ALL
Checked by	ALL
Approved by	AUTH
Due Date	31/03/2020
Completion Date	31/03/2020
Confidentiality	Public

Document Change Log

Each change or set of changes made to this document will result in an increment to the version number of the document. This change log records the process and identifies for each version number of the document the modification(s) that caused the version number to be incremented.

Change Log	**Version**	**Date**
First draft	0.1	February 10, 2020
Updated	0.4	March 23, 2020
Partners' feedback	0.7	March 30, 2020
Final	1.0	March 31, 2020
Resubmitted	1.1	October 23, 2020

EXECUTIVE SUMMARY

The present document is a deliverable of the CoLLaboratE project, funded by the European Commission's Directorate-General for Research and Innovation (DG RTD), under its Horizon 2020 Research and innovation programme (H2020). This deliverable aims at presenting the results of Task T2.5 "*Evolutionary Requirements Elicitation and Innovations*". It is developed within the scope of WP2 responsible for determining the "*Framework Design, Requirements & Social Studies Feedback*". This deliverable provides the employed methodology for continuous monitoring of the user requirements that derived from the effort of T2.1, as described in the project's corresponding deliverable (D2.1 "End-user requirements, use cases and industrial scenarios" [1]), as well as of the system specifications as described in deliverable D2.3 "CoLLaboratE Detailed Architecture & System Specifications" [3].

CoLLaboratE User Requirements

In Section 2 we present an overview of the methodology for extracting the initial user requirements of the CoLLaboratE system and our approach for prioritizing them using multiple criteria and ranking perspectives.

CoLLaboratE System Specifications

We also present an overview of the functional and non-functional requirements of the CoLLaboratE system in Section 3. The Volere template employed for extracting and documenting the system requirements is briefly presented followed by the complete lists of the system requirements.

Continuous Monitoring using the Jira framework

We introduce the conceptual architecture of the CoLLaboratE system in Section 4. This is an overview of the CoLLaboratE platform, describing the major building blocks of the anticipated system in the form of software modules and dependencies.

Relation to other Deliverables of WP2

This report is the first of two deliverables describing the process of continuous monitoring user and system requirements of the CoLLaboratE system. Starting from this deliverable on the methodology for this continuous requirement monitoring, the following deliverable (D2.10, M28) will elaborate on the results of the proposed approach in full detail.

TABLE OF CONTENTS

Executive Summary 3
Table of Contents 4
List of Figures 5
List of Tables 5
Abbreviations and Acronyms 6
1 Introduction 7
1.1 Purpose 7
1.2 Objective and Scope 7
1.3 Document Structure 7
2 CoLLaboratE User Requirements 8
2.1 Methodology of formulation of user requirements 8
2.2 Stakeholder Questionnaire 8
2.3 User Requirements Elicitation 8
3 CoLLaboratE System Requirements 10
3.1 Methodology for specifying the System Requirements 10
3.2 Template for CoLLaboratE System Requirements 10
3.3 CoLLaboratE Functional Requirements 11
3.4 CoLLaboratE Non-Functional Requirements 12
4 Continuous Requirement Monitoring using the Jira framework 13
4.1 Introduction to Jira 13
4.2 Jira Space for CoLLaboratE Project 13
4.2.1 User Requirement Issues 14
4.2.2 Volere Requirement Issues 15
4.2.3 Children Issues 16
4.2.4 CoLLaboratE Dashboard 16
4.2.5 User Management 17
4.2.6 Confluence Space 18
5 Conclusion 19
References 20

LIST OF FIGURES

Figure 1: Priority Matrix for part of the CoLLaboratE User Requirements 9
Figure 2: The CoLLaboratE project at the JIRA platform 13
Figure 3: A User Requirement Issue type in CoLLaboratE's Jira space 14
Figure 4: An example User Requirement Issue in CoLLaboratE's Jira space 14
Figure 5: An example Volere Requirement Issue in CoLLaboratE's Jira space 15
Figure 6: An example Subtask Issue (ID COL-131) as Child Issue of F-Req-02(ID COL-11). 16
Figure 7: CoLLaboratE's Dashboard in Jira space. 16
Figure 8: Through Atlassian administration center we can manage the users of CoLLaboratE's Jira space. ... 17
Figure 9: Different pages can be created in confluence and linked to the Jira space. 18

LIST OF TABLES

Table 1: Ranking Criteria used for the extraction of the prioritization matrix of CoLLaboratE's User Requirements. 8
Table 2: Template for defining a system requirement. 10
Table 3: Overview list of the functional requirements. 11
Table 4: Overview list of the non-functional requirements. 12

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 DEVELOPMENT 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 CONSORTILE 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	Description
AGV	Autonomous Guided Vehicle
D	Deliverable
HIP	Human Intention Prediction
HRC	Human Robot Collaboration
HRI	Human Robot Interaction
M	Month
T	Task
WP	Workpackage

1 INTRODUCTION

1.1 PURPOSE

This deliverable (D2.9 "Evolutionary Requirements Elicitation and Innovations -preliminary", M18) provides the CoLLaboratE approach to continuous monitoring of the user and system requirements and their elicitation in through an iterative procedure. This deliverable builds upon the end-user requirements analysis provided by T2.1 and reported in D2.1 [1], as well as the system requirements analysis provided by T2.2 and reported in deliverable D2.3 [3].

This deliverable documents the steps and actions performed in T2.5 and will also provide valuable input for WPs 2, 3, 4, 5, and 6.

The main focus of deliverable D2.9 is reporting on the tools and interfaces (such as the Jira framework) utilized for managing the user and system requirements and their evolution. It capitalizes on the tasks for initial extraction of the user requirements and system specifications T2.1 and T2.2, respectively. In the corresponding preliminary deliverables (D2.1 and D2.3) of these tasks the methodology employed for achieving the tasks' goals is described in details, as well as the initial results. In the updated version of the deliverables (D2.2 and D2.4), the complete results of the first iteration of requirements and specifications extraction is presented.

1.2 OBJECTIVE AND SCOPE

The scope of this deliverable (D2.9 "Evolutionary Requirements Elicitation and Innovations -preliminary") is to provide an overview of the CoLLaboratE continuous requirement elicitation approach, addressing both user and system requirements. It also describes the basic functionality of the CoLLaboratE system, introducing functional descriptions for each module.

The above will constitute the basis for a more detailed elaboration of the CoLLaboratE system architecture and specifications that will be presented in the final version of this deliverable, Deliverable D2.6 (M24).

The main goals of this deliverable are:

- To present the methodology for continuous monitoring of the initial requirements of the CoLLaboratE system
- To provide an overview of the adopted Jira framework and its customisation for monitoring CoLLaboratE requirements

The inputs used for specifying the above are, first of all, the user requirements and CoLLaboratE use cases specified in Deliverable D2.1 [1], as well as, the system requirements in Deliverable D2.3 [3].

1.3 DOCUMENT STRUCTURE

The report begins with the specification of the CoLLaboratE user requirements in Section 2, whereas the system requirements are presented in Section 3. In Section 4, the CoLLaboratE approach to continuous requirement monitoring using the Jira framework is presented, introducing the basic tools offered by Jira and customized by CoLLaboratE partners for the project's needs. The report concludes in Section 5.

2 CoLLaboratE User Requirements

User requirements are statements, in a natural language plus diagrams, of what services the system is expected to provide to system users and the constraints under which it must operate. System requirements on the other hand, are more detailed descriptions of the software system's functions, services, and operational constraints. Although an analysis of CoLLaboratE's User Requirements has been performed in Deliverable D2.1 "End-user requirements, use cases and industrial scenarios", an overview is also presented here for completeness.

2.1 Methodology of formulation of user requirements

A combination of qualitative and quantitative methods for user requirements elicitation is applied. The qualitative perspective offers an understanding of the users' perceptions by considering non numerical data such as text, pictures or videos, while the quantitative approach uses numerical values, used here to quantify the data and validate choices. User requirements formulated within CoLLaboratE should answer a series of questions, retrieved from [2]. Sub-questions were also prepared, in order to facilitate the use case interviews, (see D2.1, Appendix A).

The process of formulating user requirements consists in data collection, analysis and interpretation. The data collection within CoLLaboratE includes interviews with use cases representatives to document their needs, conducting **semi-structured interviews** with three predefined areas of interest, allowing to facilitate open discussions. Besides the interviews, the use case representatives are asked to provide text, pictures and video files of the use cases, in order to better observe and understand their applications.

2.2 Stakeholder Questionnaire

Apart from the above interviews, a more general approach is adopted as well, to collect information from other representatives of industry and academia. A survey with 15 questions (see D2.1, Appendix B) was prepared to gather stakeholders' insights about collaborative robots. The target audience is stakeholders such as industrial experts, end-users and academia experts. The questionnaire focuses on the type of organization the subjects represent and depending on this, which their needs would be if they were to adopt collaborative robots to automatize their processes. A sample of minimum 20 subjects is expected to answer this survey to be able to match the results with the analysis of the CoLLaboratE user requirements. In the direction of continuous monitoring of the requirements, the stakeholder may be revisited with an updated questionnaire.

2.3 User Requirements Elicitation

Upon collection, the data are analyzed with the purpose of formulating a list of user requirements (see D2.1, Appendix C) and categorize them as use case specific and / or general, which can be applied to all use cases. Furthermore, all the results are integrated in a prioritization matrix and ranked based on multiple criteria. Thus, the matrix considers three ranking perspectives: operators, end-users, and development, each having three ranking criteria (see Table 1). A 1 to 5 Likert scale is used and an average for each identified user requirement is calculated (see Figure 1). Based on these perspectives, a prioritization of requirements is possible. This is important as it facilitates discussions when transforming the user requirements into system requirements.

Table 1: Ranking Criteria used for the extraction of the prioritization matrix of CoLLaboratE's User Requirements.

Perspective	Ranking Criteria		
Operator	High Usability	Intuitivity	Satisfaction
End-user	Low Costs	Added Value	Low Risk
Development	TRL	Feasibility	Integrability

	Operator Perspective												End-User Perspective												Development																								Dissatisfaction				Total score
	High Usability				Intuitivity				Satisfaction				Low Costs				Added Value				Low Risk				TRL							Feasibility							Integrability															
UR	15%				10%				10%				10%				15%				15%				5%							5%							10%															
	CRF	KOL	ROM	ARK	CRF	KOL	ROM	ARK	CRF	KOL	ROM	ARK	CRF	KOL	ROM	ARK	CRF	KOL	ROM	ARK	CRF	KOL	ROM	ARK	AUTH	IDIAP	JSI	ARM	CERTH	LMS	ASTI	AUTH	IDIAP	JSI	ARM	CERTH	LMS	ASTI	AUTH	IDIAP	JSI	ARM	CERTH	LMS	ASTI	CRF	KOL	ROM	ARK	
UR_1	1	3	5	5	2	3	4	5	2	4	5	4	1	3	1	3	1	4	3	4	1	4	2	4		3	4				5			5	4				4		5	3				4	1	4	5	4	3.37
UR_3	3	3	5	5	4	3	5	5	5	4	5	5	2	3	3	2	2	3	3	5	5	3	1	3	2	3	3		5		4	3	5	3			5		3	4	5	3		5		3	4	4	5	5	3.66
UR_8	3	5	4	5	3	3	1	5	4	4	3	5	5	3	4	2	5	4	5	5	5	3	1	3		3	3							4	3						4	3					3	4	4	4	3.75
UR_48	4	5	3	4	3	2	1	5	3	3	1	5	5	3	5	3	5	5	5	3	5	3	3	4		1	3				5			4	3				3		3	3				3	3	3	1	3	3.57
UR_50	5	4	2	5	3	2	1	5	5	3	3	5	5	4	5	2	5	4	5	4	5	4	4	3	4	1	3		4		5	5	4	4		4			3	4	5	4		4		3	5	3	1	5	3.92
UR_56	1	3	5	5	1	2	4	5	1	3	5	4	1	2	3	4	3	2	1	4	3	2	1	4		2	4		4		5		5	3		4			4		5	3				4	1	2	4	3	3.21
UR_59		3	3	2		3	1	3		3	1	2		3	5	5		3	5	3		3	3	5		1	4							5	4						4	4						3	1	5	3.39
UR_4	5	3	5	5	5	4	3	5	5	4	5	3	5	2	1	3	5	3	4	4	5	3	1	5			4		4		5			4		4		5			4		4			5	5	3	5	3	4.01
UR_12	4	4	1	5	4	2	1	5	5	3	1	4	5	3	1	4	5	3	1	5	5	3	1	4			3							2				2				2				5	3	1	3	2.98
UR_13	5	3	5	5	5	3	5	5	5	3	5	5	3	3	1	2	5	3	3	5	5	3	1	3	4	3	3		3		5	5	5	3		3		3	5	4	3		3		3	5	4	5	3	3.76
UR_14	5	3	5	5	5	3	4	5	5	4	5	4	3	3	1	4	5	3	1	5	5	3	1	4	4	3	2	2	4		5	5	4	3	4	4		4	5	4	3	4	4		4	5	3	5	3	3.82
UR_24	5	4	5	5	5	3	5	5	5	3	5	5	4	3	3	3	5	3	3	4	5	3	1	3		1	2							4	3						4	3					5	3	5	3	3.76
UR_27	3	4	5	3	4	3	5	3	3	4	5	4	3	3	4	2	4	3	5	5	3	4	4	4	4	2	3		4	4		5	5	3		4	3		5	4	3		4	4		4	3	5	2	3.78
UR_30	1	3	5	3	1	3	5	4	1	3	5	3	1	2	1	1	2	3	2	4	2	3	5	3		2	3		3	4				4	3		3	3			4	3		3	4			2	3	5	2	2.84
UR_35	1	2	3	4	1	3	1	4	1	3	3	4	1	2	1	2	1	3	1	4	1	3	1	3			3							3								3					1	2	2	2	2.44
UR_36	2	2	5	5	2	3	5	5	3	3	5	5	3	2	1	3	2	3	1	5	3	3	1	3			3				1			3				3				3				3	2	2	5	2	3.03
UR_42	1	2	4	2	1	3	4	2	1	3	3	2	1	3	1	4	1	3	1	4	1	4	1	3		3			5		5			5			5			5			5			5	1	3	4	4	3.03
UR_51		4	5	5		3	5	5		3	5	3		3	3	4		4	5	3		3	2	4			4								3							3					3	5	4	3.70
UR_66	3	4	2	5	3	2	2	5	3	3	2	4	3	2	1	2	1	3	1	5	3	3	1	3		1	3	1	3					3	3	1	3				3	3	1	3			3	3	2	4	2.65
UR_69	5	4	1	5	5	4	1	5	5	4	1	4	5	4	1	3	5	4	1	4	5	4	1	3		2	2		3	4				3	3		3	3			4	3		3	4			5	4	1	4	3.43
UR_16	3	4	5	5		3	3	5		4	5	5		3	3	2		4	4	5		3	1	2		3	3		3					5	3						4	3						3	4	3	3.64
UR_33	5	5	5	5	5	3	2	5	5	4	1	5	5	3	5	1	5	4	5	5	3	3	2	1		3	4		3	4	4			4	4		3	3	3		4	4		3	4	3		4	4	3	2	3.91
UR_34		5	5	5		2	5	5		4	5	5		3	3	3		4	5	5		4	1	3		2	4		3	4				4	4		3	3			5	4		3	4				4	5	3	4.01
UR_41		3	5	5		2	2	5		3	2	5		2	5	3		3	5	5		3	5	3		1								4							4					3	3	4	3.67
UR_61	5	5	5	5	4	4	1	5	5	3	1	5	5	3	5	5	5	3	5	2	3	3	5	5		1	3							4	3						4	3					3	3	2	5	3.86
UR_64	5	4	1	1	5	2	1	1	5	3	1	1	5	3	1	5	5	3	1	1	5	3	1	5			3							3								3					5	3	1	5	2.86
UR_70	5	5	4	5	5	3	1	5	5	3	4	5	5	2	3	3	5	3	3	3	5	3	1	3			4		3	4				4	3		3	4				4		3	4			5	3	3	4	3.72
UR_17	5	4	1	3	5	2	1	3	5	3	4	3	3	2	1	2	5	3	1	3	5	3	1	3				3							2							4					5	2	2	3	2.99
UR_44	4	4	5	1	4	3	5	1	4	3	5	1	3	3	1	3	2	3	3	1	2	3	4	2		2	4		4					5	4		4				5	4		4			4	4	5	1	3.28
UR_58		4	3	5		2	1	5		3	3	4		3	1	2		3	1	5		3	1	3		1	4				5			5	4				4		5	4			4		3	2	3	3.32
UR_7	3	4	2	4	3	3	1	4	2	3	2	4	2	3	1	3	2	3	1	4	2	3	1	3		2	4		3					5	4		3				5	4		3			3	3	1	3	3.01
UR_38		4	4	5		3	5	4		4	4	4		2	1	4		3	1	4		3	1	5			4		3						4		3					4		3				3	4	2	3.40
UR_54		4	5	4		3	5	4		4	5	3		2	1	4		3	1	2		3	1	5			4		3		5				4		3		5			4		3		5		3	5	3	3.45
UR_55	1	4	5	3		3	5	3		3	5	3		2	1	3		4	1	2		4	1	4			4		3						3		3					3		3				3	5	3	2.95
UR_57		5	5	5		4	1	5		4	1	3		3	5	3		4	2	2		4	5	5			3				5				3				5			3				5		3	2	5	3.73

Figure 1: Priority Matrix for part of the CoLLaboratE User Requirements (1st column). In the 1st row the ranking perspectives are listed, while in the 2nd row their corresponding criteria are presented. In the 3rd row the weighting factor for each ranking criterion is provided, while in the 4th row the source of the evaluation is provided. In the last column, the total ranking score is provided, within a 1 to 5 range. The higher the score, the higher the priority of the requirement.

3 CoLLaboratE System Requirements

This section performs a brief overview of the analysis of CoLLaboratE system requirements, as it has been thoroughly presented in deliverable D2.3 "CoLLaboratE Detailed Architecture & System Specifications", Preliminary Version, M12 [3]. We decided for completeness to include in this deliverable a summary of that analysis. The adopted methodology for extracting and modelling these requirements is summarised first.

3.1 Methodology for specifying the System Requirements

The Volere Requirements Specifications template [4] has been selected among several requirement specification methodologies that have been proposed over the past. It focuses on a highly detailed structure that tries to integrate the widest possible spectrum of requirement categories, covering the drivers, constraints, and the dynamically arising Issues of a project, in addition to its functional and non-functional requirements.

Based on the Volere template the requirements are separated into two fundamental categories namely functional and non-functional. The Functional Requirements describe the desired functionalities that the project should have and how they should be connected in a complete useful final product. The Non-Functional Requirements on the other hand describe the desired properties of all the components of the system such as their performance, efficiency, and usability.

As already mentioned, the main advantage and quality that separates the Volere methodology over its alternatives is the detail in which the functional and non-functional requirements are identified. In addition, Volere offers a formal template for the collection of the requirements in tabular format (requirements shell).

In order to adapt the Volere methodology to the needs of the CoLLaboratE system, a list of functional and non-functional requirements was selected.

3.2 Template for CoLLaboratE System Requirements

For the description of each specific requirement that belongs to each one of the categories listed above, a tabular template (see Table 2) has been created based mainly on the Volere requirements shell, after applying a number of modifications.

Table 2: Template for defining a system requirement.

ID	*A unique identifier.*
Name	*Title of the requirement.*
Requir. Type	*Functional / Non-functional*
Description	*A requirement must be described with as much detail as possible. If necessary, an example has to be added.*
Rationale	*A justification of the requirement.*
Fit Criterion (Measurable)	*The term measurable refers to the ability to identify if the requirement has been met at the final stages of the project, and after the system has been constructed. In other words this means the tests which must be performed in order to verify whether the requirement has been addressed.*
User satisfaction	*Degree of stakeholder satisfaction depending on the successful implementation of the current requirement (Scale from 1=uninterested to 5=extremely pleased). Definition for*

	every category of involved stakeholders (worker, supervisor, system technician, researcher).
User dissatisfaction	*Degree of stakeholder dissatisfaction if this requirement is not implemented (Scale from 1=hardly matters to 5=extremely displeased). Definition for every category of involved stakeholders (worker, supervisor, system technician, researcher)*
Priority	*The requirement is ranked according to the value that distinct categories of users attach to it (worker, supervisor, system technician, researcher). (Scale from 1=low priority to 5=highest priority).*
Conflicts	*Description of any relation of the current requirement with previously described ones. Special attention to conflict with other requirements whose implementation is blocked by this one.*
Constraints (Attainable)	*An attainable requirement will usually answer the question:* "How can the requirement be accomplished?" *Hence, here we explain any constraints / conditions for the requirement to be executed.*
Difficulty	*Level of difficulty for requirement implementation (estimation). (Scale from 1=low difficulty to 5=extreme difficulty).*
Actors	*An actor is someone or something outside the system that interacts with it or with one of its components (primary actor). If the actor is interacted by the system or one of its components is a secondary actor.*
Author	*The owner of each requirement that was recorded.*
Revision	*This section lists when a version of the requirement was created.*

3.3 CoLLaboratE Functional Requirements

This subsection contains an overview list of the requirements is contained in Table 3.

Table 3: Overview list of the functional requirements.

ID	Requirement name
F-Req-01	Loading of the 3D model of assembly component.
F-Req-02	Object Recognition Initialisation
F-Req-03	Assembly Keyframe Extraction
F-Req-04	Assembly Teaching Completion
F-Req-05	Output Location Indication
F-Req-06	Pickup Location Indication
F-Req-07	Keyframe Confirmation (in tablet)
F-Req-08	Assembly Sequence Confirmation in tablet virtual execution
F-Req-09	Automatic Robot Assembly Sequence of Actions Generation
F-Req-10	Final Assembly Task Confirmation
F-Req-11	Assembly Sequence Error Handling
F-Req-12	Train Assembly Phase Initialisation
F-Req-13	Error Notification During Training
F-Req-14	Teaching by Physical Interaction

F-Req-15	Workspace Constraints
F-Req-16	Motion Between Keyframes
F-Req-17	Data Logging
F-Req-18	Assembly Confirmation
F-Req-19	Assembly Load/Force Extraction
F-Req-20	User-friendly HRI interface for the communication of the workers with the system
F-Req-21	Real-time human skeleton tracking for safety constraints
F-Req-22	Human Touch Recognition and Classification
F-Req-23	Human gesture recognition
F-Req-24	Human intention detection for AGV navigation and collaborative assembly
F-Req-25	Human monitoring for injury prevention from normal work activities
F-Req-26	Autonomous exploration and learning of assembly tasks
F-Req-27	Multimodal data acquisition, processing, and learning
F-Req-28	Dynamic load sharing, application of counteractive forces, stiffness adaptation during HRC
F-Req-29	Teaching robot paths with variations
F-Req-30	Production plan generation for making efficient use of the available resources
F-Req-31	Production Plan supervision
F-Req-32	Assistive task modification during teaching
F-Req-33	Adaptation based on HIP during collaborative object transfer and manipulation
F-Req-34	Concurrent tracking accuracy and compliance
F-Req-35	Task encoding and accurate reproduction
F-Req-36	Autonomous policy improvement of assembly tasks

3.4 CoLLaboratE Non-Functional Requirements

This subsection contains a cumulative list of the non-functional requirements (Table 4),

Table 4: Overview list of the non-functional requirements.

ID	Type	Requirement name
L-Req-01	Usability, Look & Feel	Ease of Use
L-Req-02	Usability, Look & Feel	Real-time HRI Response
L-Req-03	Usability, Look & Feel	Help Menu
L-Req-04	Usability, Look & Feel	Mobile Robotic Manipulator
L-Req-05	Usability, Look & Feel	Reconfigurable H/W
P-Req-01	Performance	Fast Learning of new Assembly Tasks
P-Req-02	Performance	High Success Rate of Assembly Task
P-Req-03	Performance	Fast Execution of Assembly Task
R-Req-01	Reliability	Diagnostic and Error Handling
R-Req-02	Reliability	Robust Handling of Noisy Inputs
M-Req-01	Maintainability & Interoperability	Modular System Architecture
S-Req-01	Safety	Safety of Use

4 CONTINUOUS REQUIREMENT MONITORING USING THE JIRA FRAMEWORK

4.1 INTRODUCTION TO JIRA

Jira is a web-based ticketing tool for distributed and collaborative authoring and management, developed by Australian Company Atlassian. The name "Jira" is actually inherited from the Japanese word "GoJira" which means "Godzilla". It is used for bug tracking, Issue tracking, and project management. The basic use of this tool is to track Issues and bugs related to software and Mobile apps.

It provides a flexible and most importantly light-weight way of creating and managing information items, assigning responsibilities and supporting adapted levels of control for the design process by way of role-based workflows.

While JIRA has been developed primarily as an Issue and project tracker out of the box, the creators suggest that you can use JIRA for requirements management in conjunction with Confluence, a complementary product that is also offered by Atlassian.

4.2 JIRA SPACE FOR COLLABORATE PROJECT

A Jira space has been created for CoLLaboraTe project at atlassian.net:
https://collaborateproject.atlassian.net/Jira/software/projects/COL/boards/1

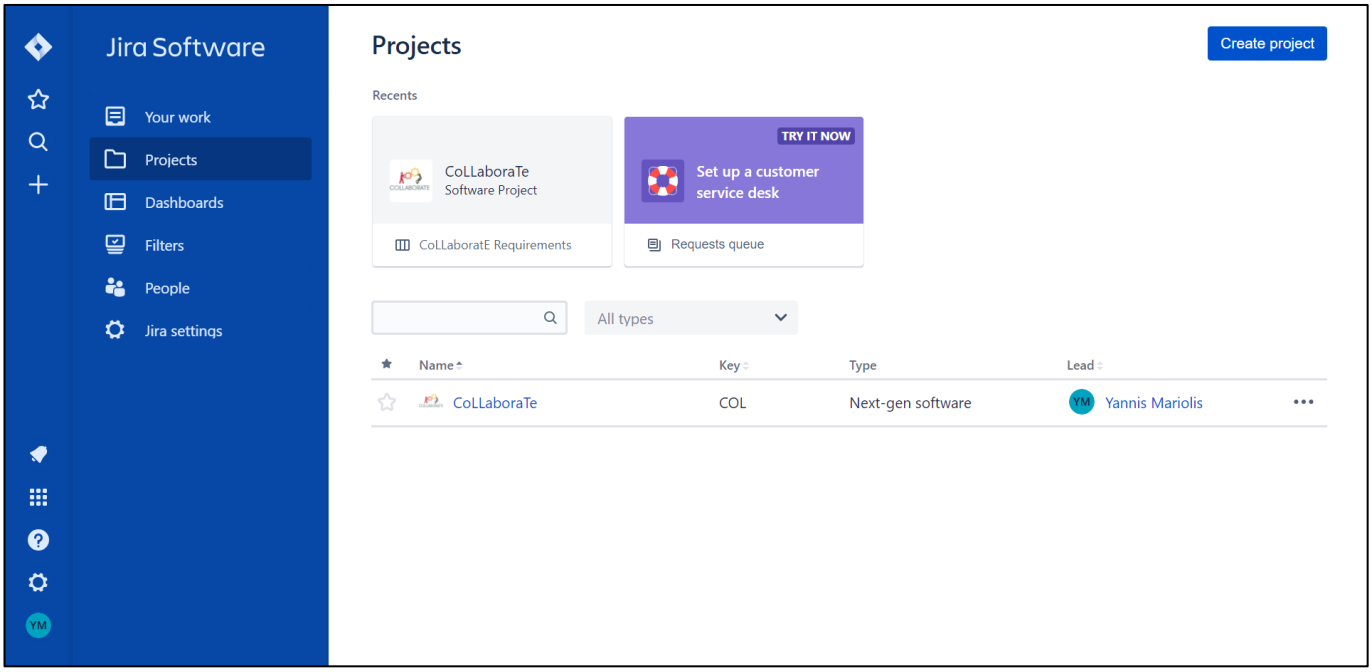

Figure 2: The CoLLaboratE project at the JIRA platform

In the CoLLaboratE Jira space (see Figure 2), as suggested by Atlassian, we created new JIRA Issue types specifically for requirements with their own workflow, custom fields and reporting. In our case, we created two new Issue types, one on user requirements and the other on system requirements following the Volere template, called **User Requirement Issue** and **Volere Requirement Issue**, respectively.

In each of these **Issues** one can add **Children Issues**, with **Sub-task Issue** type. Sub-tasks offer a quick way to add and manage your requirements, and you can link related requirements together or with feature requests.

4.2.1 User Requirement Issues

For the User Requirement Issue type, apart from the default fields of **Title** and **Description** we added a **Category** field with a drop down menu (see Figure 3) listing CoLLaboratE's 11 different user requirement categories, as classified by Task T2.1. We also added a **Source** field, where the end-user that posed the requirement is identified.

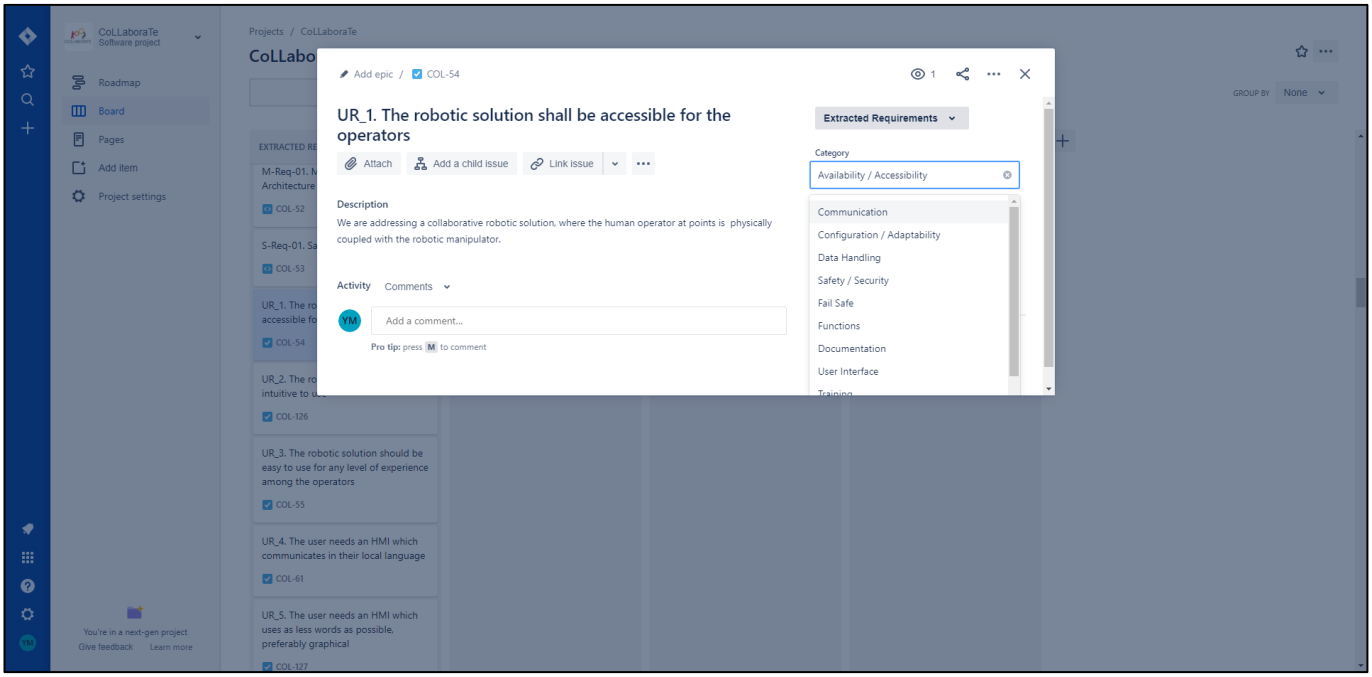

Figure 3: A User Requirement Issue type in CoLLaboratE's Jira space

In the provided example (see Figure 4) user requirement **Issue** *UR_1. The robotic solution shall be accessible for the operators* is presented, belonging to category *Availability/Accessibility* and the source is *CRF*.

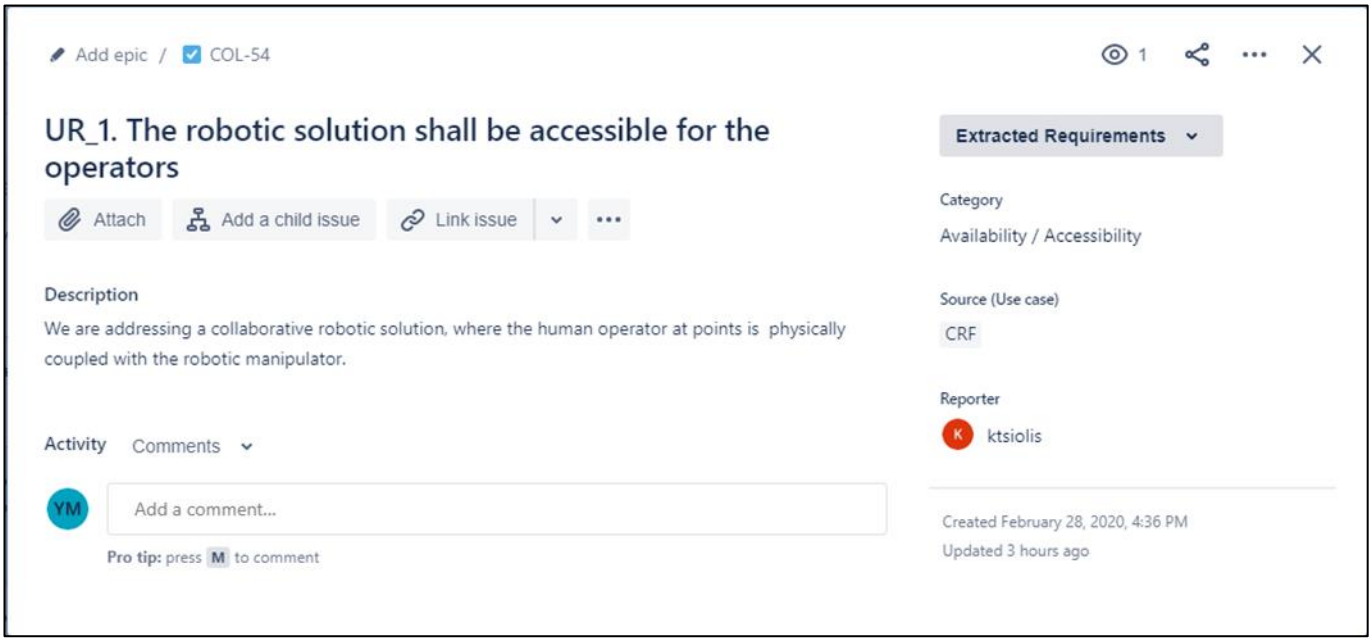

Figure 4: An example User Requirement Issue in CoLLaboratE's Jira space

All **77 User Requirements** extracted by Task T2.1 have been inserted into CoLLaboratE's Jira space as corresponding **User Requirement Issues**.

4.2.2 Volere Requirement Issues

A second **Issue** type has been created for the functional and non-functional requirements of the CoLLaboratE system, which was named Volere Requirement. We have added custom fields, in order to cover the structure of the Volere template as presented in Section 3. In Figure 5 you can see an example of a **Volere Requirement Issue** corresponding to the functional requirement *F-Req-01. Loading of the 3D model of assembly component*, which has high **Priority** and low **Difficulty**.

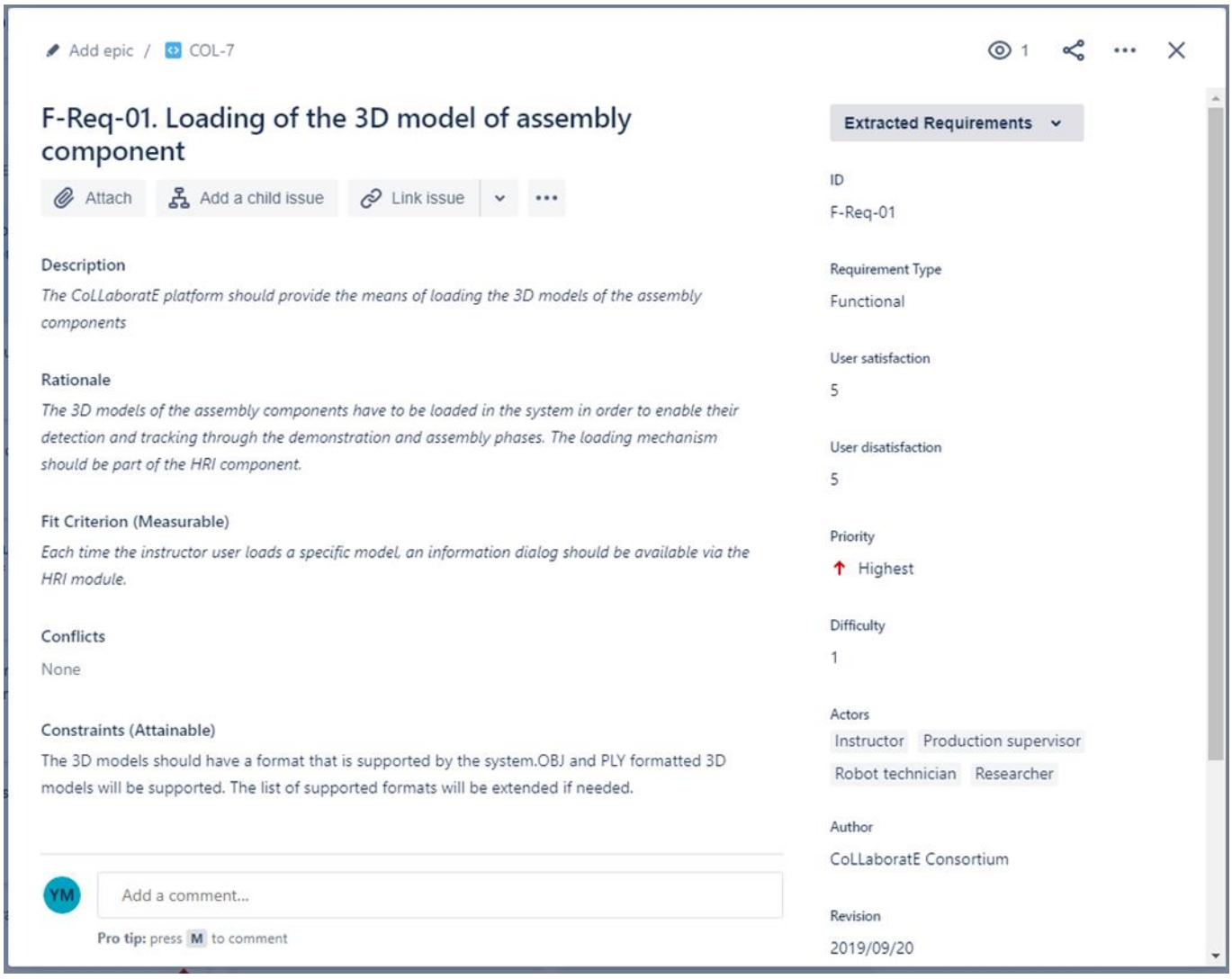

Figure 5: An example Volere Requirement Issue in CoLLaboratE's Jira space

All **36 functional** and **12 non-functional** requirements of the CollaboratE system, as extracted by Task T2.3 and listed in Section 3, have been inserted into CoLLaboratE's Jira space as corresponding **Volere Requirement Issues**.

4.2.3 Children Issues

Each **Issue** can have one or more **Children Issues** of type **Subtask** (see Figure 6). Subtasks track small pieces of work that are part of a larger task.

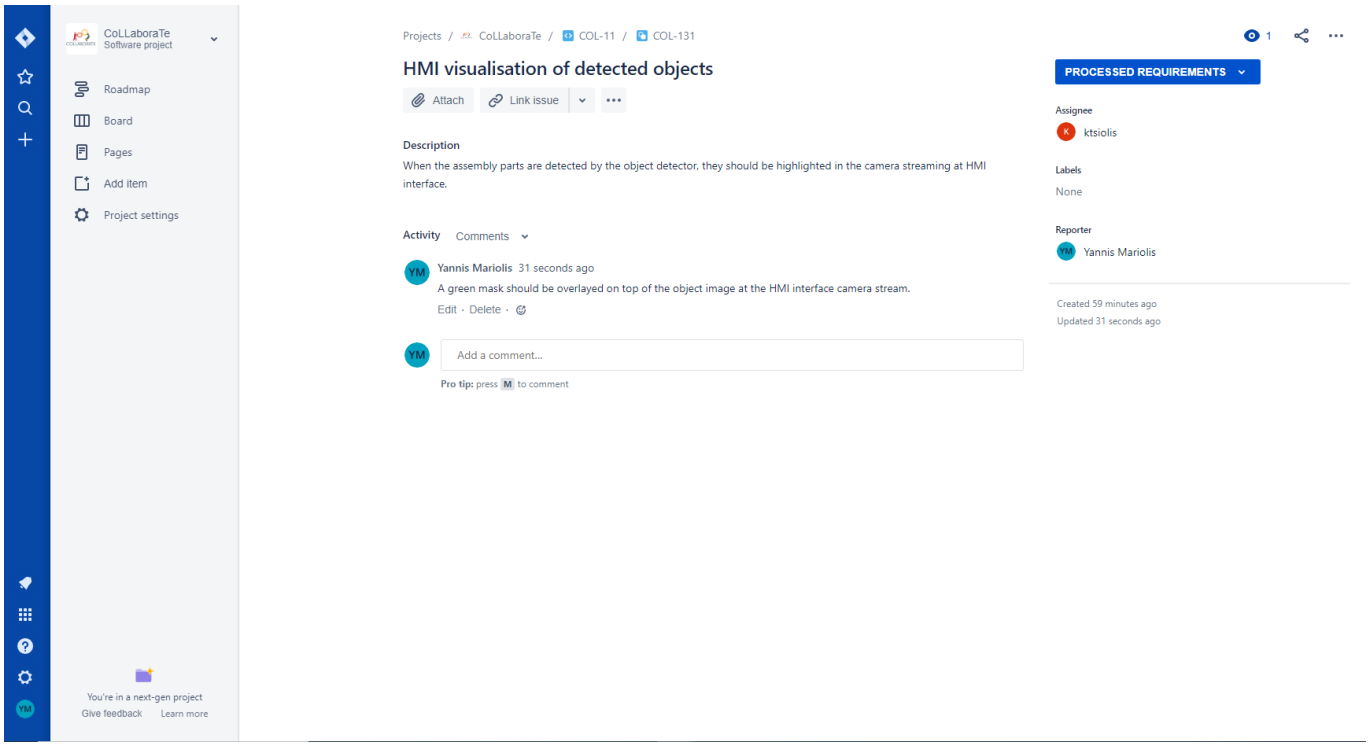

Figure 6: An example Subtask Issue (ID COL-131) as Child Issue of F-Req-02(ID COL-11).

4.2.4 CoLLaboratE Dashboard

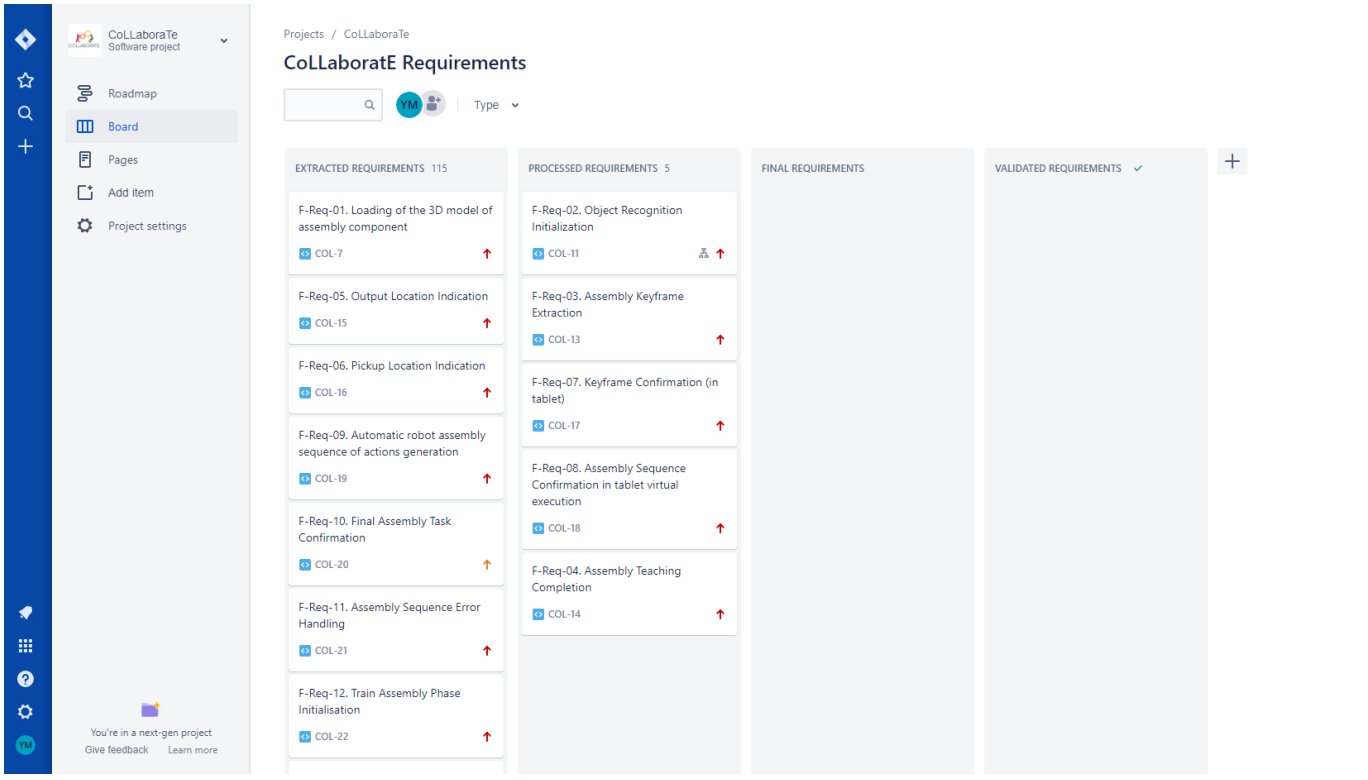

Figure 7: CoLLaboratE's Dashboard in Jira space. In each Column requirement issues are listed, and based on their status can move to the next Column until they get validated.

All created **User and Volere Requirement Issues** are registered in the **Dashboard** (see Figure 7). **Dashboard's Columns** keep **Issues** organized and reflect a requirement's workflow from **Extracted** to **Final** and **Validated**. As core developments in WP3, 4 and 5 progress, updates are expected to the Volere Requirements. In that case the corresponding Issues are moved to the second column of the dashboard named **Processed**. We are also expecting updates after the 1st validation phase (M21-M26). On the other hand, User Requirements may also be updated based on end-user feedback as the CoLLaboratE use case pilots are set-up and trials are performed. User Requirements can also be updated based on the questionnaire feedback from the stakeholders, which is gathered throughout the project, as explained in Section 2.

4.2.5 User Management

Different accounts have been created, mainly at the institutional level (see Figure 8). Thus, each end-user partner has a separate account for reporting Issues, whereas personal accounts have been created only for CERTH and CRF researchers that are administrating CoLLaboratE's Jira space.

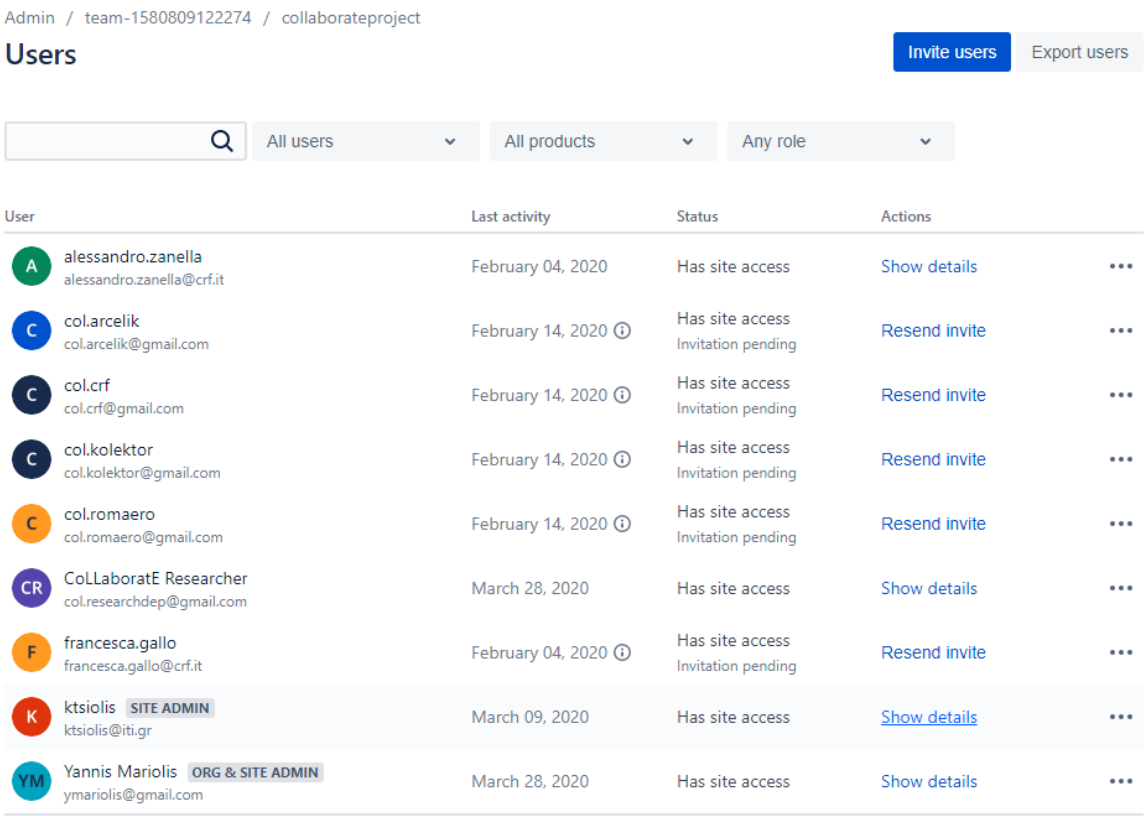

Figure 8: Through Atlassian administration center we can manage the users of CoLLaboratE's Jira space.

4.2.6 Confluence Space

As stated by Atlassian, Confluence integrates seamlessly with JIRA, allowing tracking of our requirements in JIRA, linked to our corresponding project documentation in Confluence. In order to facilitate documenting our requirements, we employed Confluence Product Requirements Blueprint template, provided for requirements writing. It is an editable template which we can customize accordingly to our needs. Thus, we created the Confluence page CoLLaboratE Requirements (see Figure 9), and in there a draft document called User and System Requirements, based on the Blueprint template. This kind of documents can be used for internal reporting on the elicitation of the requirements and their validation.

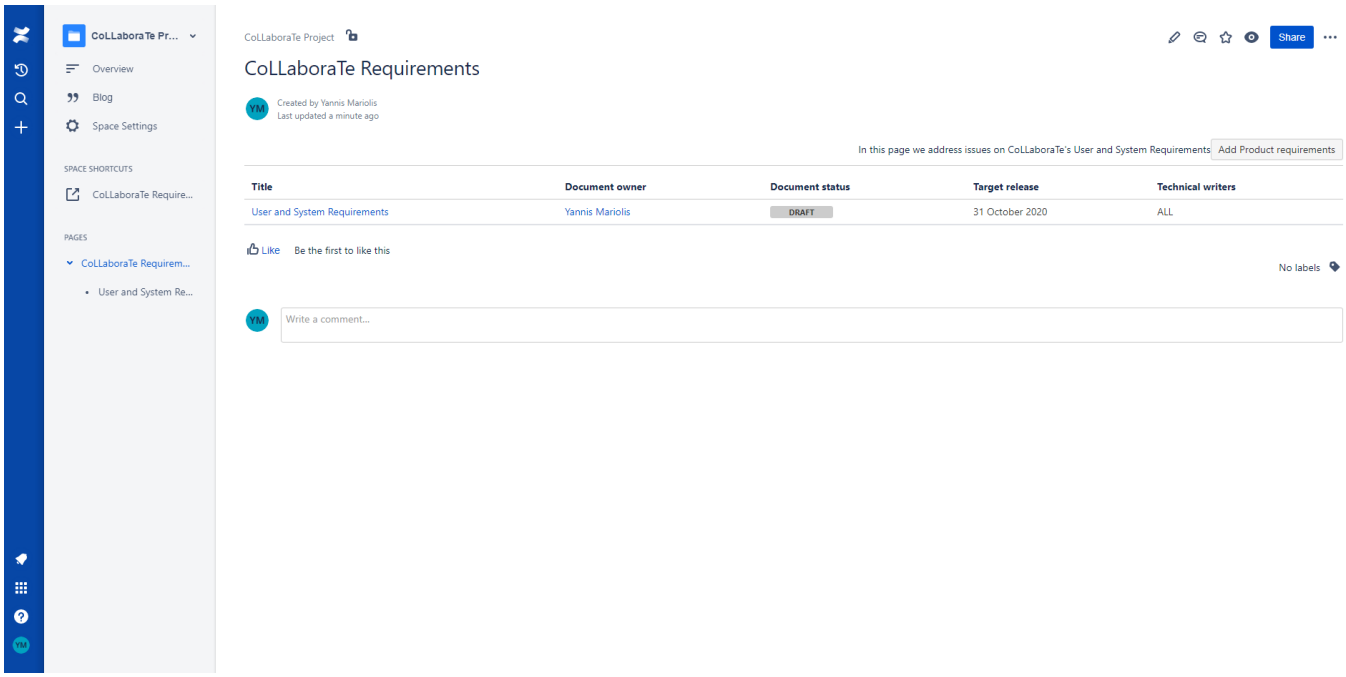

Figure 9: Different pages can be created in confluence and linked to the Jira space. Here is an example page hosting the "User and System Requirements" draft document.

5 CONCLUSION

This report presented the CoLLaboratE approach to requirement elicitation and continuous monitoring. After a comprehensive overview of CoLLaboratE User and System requirements, the Jira framework has been presented, along with the customized Jira Issues and Dashboard created for the need of the project.

The methodology followed in T2.1 for extracting the initial user requirements for the four CoLLaboratE use cases has been summarized here for completeness, whereas the ranking perspectives and criteria for these requirements have been presented together with their prioritization matrix. On the other hand, for the system requirements, the Volere template approach followed in T2.2 has also been briefly described her and the extracted functional and non-functional requirements of the CoLLaboratE system have been listed for completeness.

As explained in Section 3, the elicitation of the CoLLaboratE requirements is performed through an iterative process, where feedback from system development process, and system validation phases is utilized, along with revisited questionnaires on involved stakeholders. This iterative procedure is facilitated by the employment of the Jira framework, where each requirement is treated as a Jira Issue and is monitored until it is finalized and validated. An overview of the customization work of the Jira space for addressing the needs of the aforementioned elicitation procedure has also been presented in Section 3.

CoLLaboratE deliverable D2.10 “Evolutionary Requirements Elicitation and Innovations (final)”, M28, will go into further detail on the usage of the Jira space, the progress of the initial requirements, and their final validation status, reporting any changes/updates. In case there are also changes affecting the use cases deploymentthey will also be included in D2.10.

REFERENCES

[1] CoLLaboratE D2.1, Deliverable "End-user requirements, use cases and industrial scenarios"
[2] R. Goodwin, and A. Winfield,"A unified design framework for mobile robot systems", Diss. University of the West of England, Bristol, 2008
[3] CoLLaboratE D2.3, Deliverable "CoLLaboratE Detailed Architecture & System Specifications (preliminary)"
[4] Bass L., Bergey J., Clements P., Merson P., Ozkaya I., Sangwan R. (2006). A Comparison of Requirements Specification Methods from a Software Architecture Perspective. Technical Report. Carnegie Mellon, Software Engineering Institute. Available online http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA455888 Assessed 2019.