COGNITWIN

Cognitive plants through proactive self-learning hybrid digital twins

DT-SPIRE-06-2019 (870130)

Deliverable Report

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The COGNITWIN project has received funding from the European Union's Horizon 2020 research and innovation programme under GA No. 870130

Executive Summary

This report presents the details of risk assessment carried out in the first 21 months of the project. During this period, an assessment of COVID 19 related risk was performed. A 6-month project extension as an amendment in the Grant Agreement (GA) was requested to the commission as a mitigation measure. Other inconsistencies found in the Description of Action (DoA) were also modified at the same time. This request was accepted by the commission.

An updated management action plan is also provided in this report. All the changes in the plan due to project extension are included. The updated version also presents any other changes occurred in the project after the submission of previous management action plan in M3 (November 2019).

Table of Contents

1 Risk Assessment 4
2 COGNITWIN Project Information 7
3 COGNITWIN Objectives 7
4 Management 8
4.1 Management Organization 9
4.2 Management Regulation 11
5 Work Plan 11
5.1 Periodic Management Reporting 13
5.1.1 Reporting periods and official periodic reports 13
5.1.2 Intermediate periodic deliverables 14
5.1.3 Documents Confidentiality 14
5.1.4 Internal Review of Deliverables 14
6 Communication Tools 14
6.1 COGNITWIN SharePoint site 14
6.2 Meeting 16
6.2.1 Teams Platform 16
7 Conclusion 17

List of Tables

Table 1: Major risks and proposed mitigation measures 4
Table 2: COGNITWIN project information 7
Table 3: General Assembly and Executive board of the COGNITWIN project 10
Table 4: Gantt diagram of the COGNITWIN project 12
Table 5: Summary of project effort in person months 13

List of Figures

Figure 1: Management organization of the COGNITWIN project 9
Figure 2: Work package structure of the COGNITWIN project 11
Figure 3: A screenshot of the COGNITWIN SharePoint room 15
Figure 4: Screenshots of the COGNITWIN website 16

1 Risk Assessment

Identification and assessment of potential risks is of utmost importance in complex and large projects. The remedial actions of such risks are prepared as and when identified.

The risk management measures take place follows:

- Potential risks are identified and assessed concerning their probability and level of (negative) impact.
- For those with medium to high probability and severe impact countermeasures and contingency plans are discussed, and they are flagged throughout the execution of the project as “risk items”.
- Risks are re-evaluated at the periodic consortium meetings.

The General Assembly continuously controls the project plan with its milestones and critical paths. In addition, the partners regularly report to the coordinator to ensure that the management is made aware of any potential problems in a timely manner and can initiate countermeasures long before a problem becomes critical.

Table 1 identifies the currently foreseen major risks. Their impact/consequences are estimated and in a proactive way a contingency approach is suggested.

Table 1: Major risks and proposed mitigation measures

No.	Risk	Probability	Impact	Work Packages involved (main)	Proposed risk-mitigation measures
1	Underperforming partners or partners leaving the consortium	L	M	All	Conduct meeting with all pilot leaders to see how experiences from other pilots can be used to benefit underperforming partner in order to improve performance.
2	Synergy of data-driven & model-driven approaches	L	M	WP 4	The effort of reaching KPIs will be moved to other pilots
3	Delays in the data/model collection	M	M	WP 1-WP 4	Start procedure development at the time of the protocols related to each pilot (once the project is notified as approved by the EC). A replication of the

					public data base is currently being processed so once the project is approved, data providers have the data already available
4	Components are not available for integration in time	M	M	WP 1-WP 5	Re-planning of the integration and potentially reduction of the release features.
5	Delay in integration due to ambitious requirements	M	M	WP 1-WP 5	Identify category of requirements (mandatory, optional, negotiable), review the requirements status as the integration work progresses. Additionally, the COGNITWIN platform will adapt agile methodologies in order to iteratively create features identified by pilots.
6	Critical needs measurement does not harmonize with existing available Sensor Technologies	M	M	WP 1-WP 5	Early in the co-innovative preparations parts this has to be clarified and solved by e.g. changes in the measurement strategies towards indirect measurements.
7	Multi format data/model integration more time consuming then expected	M	M	WP 4, WP 5	Test sample data from pilots already in the first project phases (M3-M12)
8	Total number of SPIRE members under presentations is lower than expected	M	L	WP 6, WP 7	We will utilize the large network of the partners and DIH (SINTEF) in order to contact SPIRE members in advance, and also European process industry Additionally, the project will not only prepare a commercialization and sustainability plan, it will also collect feedback regarding expectations from multiple target audiences. By

					analyzing and acting on this feedback, the project can take corrective actions and modify its focus and scope if required.
9	Chosen pilots are not generic enough for the development of the Best “Cognitive Twins technology” Practices	L	H	WP 1-WP 3	The risk is reduced by the expertise of the partners and know-how from their active involvement in the BDVA, IIC Digital Twins WG, IDSA and relevant R&D projects. We will possible redefine and specialize COGNITWIN output.
10	Low audience in activities and dissemination events	L	M	WP 6, WP 7	The current economic situation makes this difficult for organizations to attend due to costs. We will try to minimize these costs by bringing events close to its target audience and will use as much as possible on-line communication tools to avoid these situations (e.g. webinars).
11	Competitor technology appears	L	M	WP 4, WP 5, WP 6, WP 7	Study technology and determine how COGNITWIN results can be improved
12	No retrospective KPI data is available	L	H	WP 1-WP 3, WP 6, WP 7	We will adjust the definition of KPIs to the data available and include additional means of measurement and validation
13	Reduced access of pilot plants for employees due to pandemic situations. It will affect the installation of sensors for data collection.	L	H	All WPs	Perform an assessment of the situation and risk. Propose a request for project extension to the commission based on the situation.

During the COGNITWIN project status meeting held 06-May-2020 and 20-May-2020, the consortium has evaluated potential risks of delays on various deliverables and milestones caused by COVID-19 restrictions. The project is driven by 6 industrial pilots. All these pilots are facing restrictions in their operations which is imposing risks of delays in their M18 deliverables. Consequently, all the other deliverables and milestones are also delayed by 6 months.

During the status meetings, a consensus was made that the project should make a request of 6-months delay. Project coordinator communicated the intended request to the Project Officer (PO) and thereafter sought the approval from General Assembly (GA). After the approval from GA, an official request for the amendment in Grant Agreement was submitted to the European Commission through the participant portal. A modified plan of project (including the extended deadlines for deliverables, milestones) was submitted along with the request. Other inconsistencies found in the Description of Action (DoA) were also corrected at the same time. The request was accepted by the commission and granted a 6- month project extension.

It is noteworthy to mention that risk 13 (in Table 1) was not identified in the first version of the Description of Action (DoA). During the amendment, it was added as a risk due to COVID 19 situation. Apart from risk 13, no other risks are at critical stage at the project level.

2 COGNITWIN Project Information

Table 2 provides key information about the COGNITWIN project.

Table 2: COGNITWIN project information

Acronym	COGNITWIN
Grant Agreement No	870130
Starting date	1 September 2019
Duration	42 Months
Project total cost	€ 8 653 170,00
EC contribution	€ 6 982 431,38
Project Officer	Giuseppina Lauritano

3 COGNITWIN Objectives

While the concepts of digitalisation and Industry 4.0 are making rapid inroads into the European manufacturing sector, there are several aspects that can be still incorporated into the system to strengthen the goal of optimal process operations. One such aspect to the digitalisation vision is the "cognitive element", where the process plants can learn from pattern recognition in historical data and adapt to changes in the process, simultaneously being able to predict unwanted events in the operation before they happen. Through this project, COGNITWIN (Cognitive Digital Twin), we aim to add the cognitive elements to the existing process control systems and thus enabling their capability to self-organise and offer solutions to unpredicted behaviours.

Our strategic, high-level objective is to establish the fully digitalized concept of self-learning and proactive next generation of Digital Twins, which operate in the hybrid world and can i) recognize, forecast and communicate less optimal process behaviour well before these occur and ii) adjust itself in order to keep the process continuously close to or at optimum.

Specific Objectives are as follows:

COGNITWIN for Industry Process Excellence: Show improved performance in cognitive production plants by a technology demonstration of fully digitalized pilots.

Cognitive Digital Twins for Cognitive Retrofitting: Enabling an efficient and well-defined approach for "cognitive augmentation" of physical assets, processes and systems for Cognitive Digital Transformation in Process industry.

Hybrid Twins for Optimised Process Performance by hybrid models that combines first principle and data-driven models and use machine learning, AI and the connected data bases to pro-active forecast and communication, as well as self-learning by recognition of patterns in the data.

COGNITWIN Interoperability Toolbox as a Service: A reference architecture for the cognitive elements including of Big Data, Databases, IoT, Smart Sensors, Machine Learning, and AI technologies that realizes hybrid modelling, self-adaptivity and cognitive recognition, leveraging/extending the existing work into relevant communities.

COGNITWIN for increasing European Technology Dominance: Ensure the dominance of the Europe in technologies related to cognitive plants, thereby influencing the further development of Big Data, Databases, IoT, Smart Sensors, Hybrid Modelling, Machine Learning and AI technologies in relevant communities, focusing on the capabilities of the developed technologies for creating new generations of self-adaptive and cognitive algorithms and models.

COGNITWIN for SPIRE: Ensure the knowledge transfer of results and experiences from the COGNITWIN project to the SPIRE Process Industry community, focusing on active participation in the new SPIRE DG7 Digitalisation group and in SPIRE organized events.

COGNITWIN for boosting European Industry: Provide competitive advantage to the European industry, esp. SMEs in the global market, through better exploitation of the synergies between Big Data, Databases, IoT, Smart Sensors, Hybrid Modelling, Machine Learning and AI technologies for an efficient resolution of complex process industrial challenges.

Effective dissemination and ensuring transfer of knowledge and experience generated in the pilots to the wide (European) audience in different industrial sectors by providing practical experiences from large-scale pilots to hundreds of companies through associated entities.

4 Management

Annex 1 (Description of the action – DoA) in the Grant Agreement and the Consortium Agreement (in preparation) are the main guiding document of COGNITWIN project.

Part A of Annex 1 presents a list of beneficiaries, workplan tables, list of work packages, deliverables and milestones, critical implementation risks and mitigation actions, summary of project effort in person-months and tentative schedule of project reviews. The management structure, milestones and procedures are described in detail in part B of Annex 1.

Templates for meeting minutes and deliverable are prepared for Internal Communication.

The following aspects are currently being defined to ensure highest quality standards of the project outcome:

- The management structure in terms of different roles and responsible persons
- Work processes (delivery process for project deliverables, risk management, meetings, reporting, review preparation, routines for submission of publications etc.)
- Administrative processes (reporting of person-months, project costs etc.)

A collaborative project web-platform and an external website for COGNITWIN project is established.

4.1 Management Organization

The governing bodies of the COGNITWIN project are as follows:

- Project Coordinator
- General Assembly (GA)
- Executive Board (EB)
- Management Support Team (MST)

The coordinator is the legal entity acting as the intermediary between the Parties and the Funding Authority and shall perform all tasks assigned to it as described in the Grant Agreement and the Consortium Agreement.

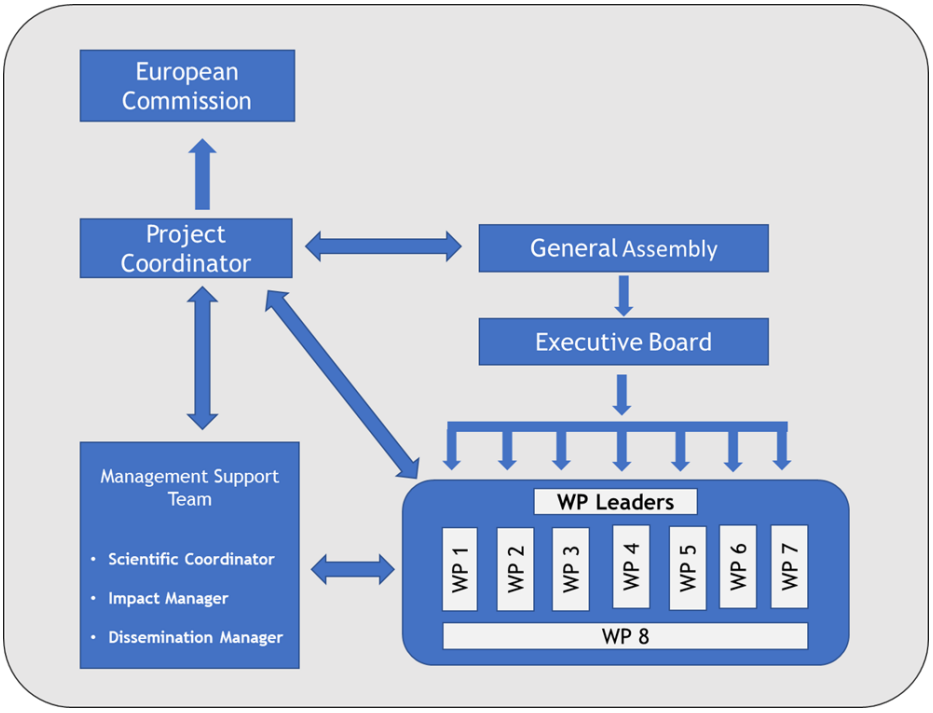

Figure 1: Management organization of the COGNITWIN project

Figure 1 presents management organization of the COGNITWIN project. General Assembly is the ultimate decision-making body of the consortium. It is chaired by the coordinator and attended by one representative of each partner. The GA is responsible for the overall strategic orientation and policy of the project.

Executive Board, chaired by the coordinator, is the supervisory body for the execution of the project which shall report to and be accountable to the General Assembly. During the kick-off meeting, some partners have mentioned their wish to include pilot leaders and management support team also into the EB. This suggestion was approved by GA members during the 1st GA meeting.

The day-to-day work is dealt within the Work Packages (WP). The WP is led by a Work Package Leader. The management support team (MST) members are not entitled to make decisions, but they assist and facilitate the work of the EB and the coordinator for executing the decisions of the General Assembly and carry out high level day-to-day management of the project. Four roles have been assigned in the MST:

- **Project Coordinator:** Frode Brakstad
- **Scientific Coordinator:** Arne Jørgen Berre
- **Impact Coordinator:** Peter Singstad
- **Dissemination Coordinator:** Ljiljana Stojanovic

An updated list of members of General Assembly and Executive Board of the COGNITWIN Project are provided in Table 3.

Table 3: General Assembly and Executive board of the COGNITWIN project

General Assembly	Executive Board
Frode Brakstad (SINTEF), Chair	Frode Brakstad (Project Coordinator)
Duncan Akporiaye (SINTEF)	Arne Berre (Scientific Coordinator)
Martin Segatz (HYDRO)	Nancy J. Holt (WP1 Leader)
Jenö Kovacs (SFW)	Ulrike Faltings (WP2 Leader and SAARSTAHL Pilot Leader)
Iñigo Unamuno Iriondo (SIDENOR)	Mika Liukkonen (WP3 Leader and SUMITOMO Pilot leader)
Aasgeir Valderhaug (ELK)	Nenad Stojanovic (WP4 Leader)
Michael Schäfer (SAG)	Stein Tore Johansen (WP5 Leader)
Tim Dahmen (DFKI)	Peter Singstad (WP6 Leader)
Peter Singstad (CYB)	Ljiljana Stojanovic (WP7 Leader)
Nenad Stojanovic (NISSATECH)	Akhilesh Kumar Srivastava (WP8 Leader)
Ljiljana Stojanovic (Fraunhofer)	Are Dyrøy (Hydro Pilot Leader)
Enso Ikonen (UOULU)	Kjetil Hildal (Elkem Pilot Leader)
Perin Unal (TEKNO)	Iñigo Unamuno Iriondo (SIDENOR Pilot Leader)
Aylin Demircioglu (NOKSEL)	Aylin Demircioglu (NOKSEL Pilot Leader)
Pierre Gutierrez (SCORTEX)	

4.2 Management Regulation

The Annex 1 of Grant Agreement and Consortium Agreement regulate all relevant issues concerning management (management bodies, roles, organisation, specific operational procedures for the consortium bodies etc.).

5 Work Plan

A detailed WP structure (and the interdependence of WPs`) of the COGNITWIN project is provided in Figure 2.

As the project has received 6-month extension, the submission deadlines of all the deliverables and milestones due after M12 are extended by 6 months. In addition to the changes in work plan due to COVID 19 related situation, some other changes amendments in the DoA were also requested. These requests were mainly due to discrepancies and inconsistencies found in the in the Description of Actions (DoA) after the kick-off meeting. These changes were also accepted by the commission during the amendment process. Consequently, the Gantt chart and project efforts were also modified. the current version of Gantt chart and summary of project efforts are presented in Table 4 and Table 5, respectively.

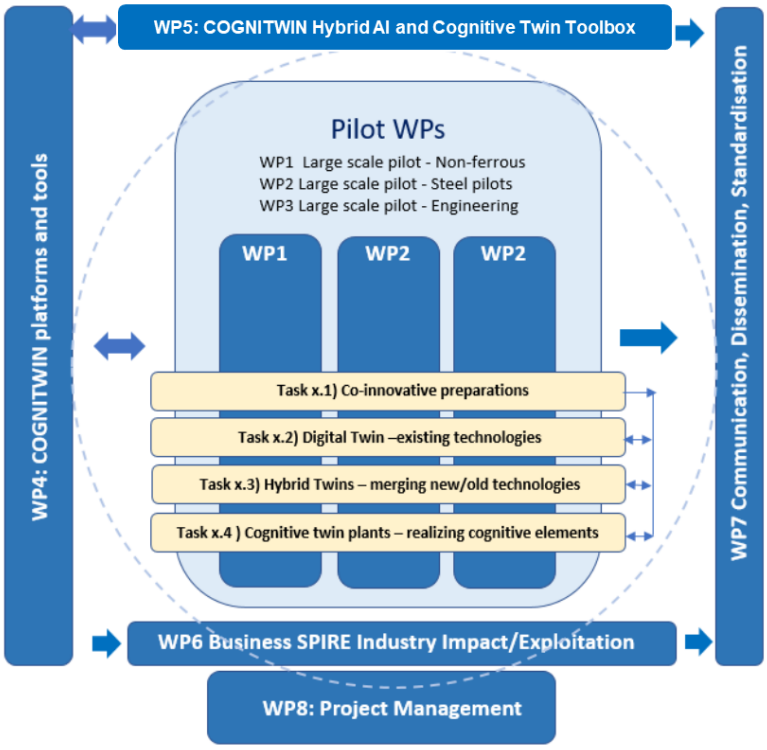

Figure 2: Work package structure of the COGNITWIN project

Table 4: Gantt diagram of the COGNITWIN project

	Year 1												Year 2												Year 3												Year 4					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
WP1 Large scale pilot Non-ferrous																																										
Task 1.1 Co-innovative preparations						**D1.1**																																				
Task 1.2 Digital twin: Existing technologies																		**D1.2**																								
Task 1.3 Hybrid Twins: Merging old and new technologies																																**D1.3**										
Task 1.4 Cognitive Twins: Realizing the cognitive elements																																										**D1.4**
WP2 Large scale pilot steel																																										
Task 2.1 Co-innovative preparations						**D2.1**																																				
Task 2.2 Digital twin: Existing technologies																		**D2.2**																								
Task 2.3 Hybrid Twins: Merging old and new technologies																																**D2.3**										
Task 2.4 Cognitive Twins: Realizing the cognitive elements																																										**D2.4**
WP3 Large scale pilot Engineering																																										
Task 3.1 Co-innovative preparations						**D3.1**																																				
Task 3.2 Digital twin: Existing technologies																		**D3.2**																								
Task 3.3 Hybrid Twins: Merging old and new technologies																																**D3.3**										
Task 3.4 Cognitive Twins: Realizing the cognitive elements																																										**D3.4**
WP4 COGNITWIN Platform, Sensor and Data Interoperability Toolbox																																										
Task 4.1 COGNITWIN Interoperability Toolbox Architecture						**D4.1**																																				
Task 4.2 Digital Twin Cloud Platform, Data Space and Cyber Security																		**D4.2**																								
Task 4.3 Sensors, Understanding the Sensor Data & Quality Assurance																														**D4.**												
Task 4.4 Realtime sensor/data processing																																										**D4.4**
WP5 COGNITWIN Hybrid AI and Cognitive Twin Toolbox																																										
Task 5.1 Plant Digital Twins with ML/AI						**D5.1**																																				
Task 5.2 Multivariate Sensor analytics with Deep Learning																																										
Task 5.3 Deep Learning Performance																																										
Task 5.4 Hybrid Digital Twins																																										
Task 5.5 Cognitive Digital Twins																		**D5.2**														**D5.3**										**D5.4**
WP6 Business SPIRE Industry Impact/Exploitation																																										
Task 6.1 Conduct the baseline KPI measurement based retrospective data						**D6.1**																																				
Task 6.2 Process Industry Impact																								**D6.2**																		
Task 6.3 Develop Best "Cognitive Twin" Practices																																										**D6.3, D6.4**
Task 6.4 Impact on education																																										**D6.5**
WP7 Communication, Dissemination, Standardisation																																										
Task 7.1 Communication plan and tools		**D7.1**																																								
Task 7.2 Industrial and scientific dissemination procedures and activities						**D7.2**																		**D7.3**																		**D7.6**
Task 7.3 International networking																																										**D7.4**
Task 7.4 Standardisation																																										**D7.5**
WP8 Project Management																																										
Task 8.1 Project Management, Coordination, Risk Assessment, Governance						**D8.1, D8.2**												**D8.6**														**D8.7**						**D8.8**					
Task 8.2 Scientific/Technical Coordination & Impact Measurement System			**D8.3**																					**D8.4**																		**D8.10**
Task 8.3 Innovation Impact Measurement and Governance			**D8.5**																		**D8.9**																						

Table 5: Summary of project effort in person months

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	**Total Person/Months per Participant**
1 - SINTEF	12	12	10	20	18	9	9	22	**112**
2 - HYDRO	27	0	0	4	4	0	1	2	**38**
3 - SFW	0	0	48	0	8	7	4	2	**69**
4 - SIDENOR	0	30	0	3	3	1	2	1	**40**
5 - ELK	34	0	0	3	3	1	1	1	**43**
6 - SAG	0	40	0	3	3	1	1	1	**49**
7 - DFKI	0	6	0	6	24	0	2	2	**40**
8 - CYB	20	1	1	4	10	10	1	1	**48**
9 - NISSATECH	4	4	4	28	24	8	3	1	**76**
10 - Fraunhofer	1	1	1	18	18	6	18	3	**66**
11 - UOULU	0	3	13	5	20	3	6	2	**52**
12 - TEKNO	0	30	0	16	12	0	2	2	**62**
13 - NOKSEL	0	40	0	0	0	6	2	2	**50**
14 - SCORTEX	2	2	0	22	6	0	2	2	**36**
Total Person/Months	100	169	77	132	153	52	54	44	**781**

5.1 Periodic Management Reporting

An updated plan for Periodic Management Reporting is provided in section 5.1.1 and section 5.1.2.

5.1.1 Reporting periods and official periodic reports

The action is divided into the following '**reporting periods**'

- RP1: from month 1 to month 18
- RP2: from month 18 to month 36
- RP3: from month 36 to month 42

The coordinator is responsible for submitting the following reports to the Commission, within 60 days after the last date of the reporting period:

- Periodic technical and financial reports: M18, M36
- Final report: M42

To enable an efficient workflow between tasks and to anticipate problems and delays, the coordinator performs the following actions:

- Send a reporting template to all partners and remind them for timely completion
- Partners send their input to the coordinator within a specified period

- The coordinator consolidates the input from all the partners, request for modifications if necessary and send the complete report to the EC

Technical and financial reports present an overview of the activities and progress to reach the project objectives, the milestones and deliverables, problem identification and corrective actions, a statement on the use of resources. Any significant deviations between actual and planned person-months are included in the report. A thorough explanation of the use of resources, a financial statement (see Annex 4 of the Grant Agreement) with detailed information on eligible costs and information from financial audits are included in the periodic financial report.

5.1.2 Intermediate periodic deliverables

Short interim management reports have been delivered in M6 and M18. Next short interim reports will be delivered in M30 and M36.

5.1.3 Documents Confidentiality

The confidentiality of all the COGNITWIN documents is maintained as per the Grant Agreement and Consortium Agreement.

5.1.4 Internal Review of Deliverables

Before submission at the participant portal, all the deliverables are internally reviewed by two members within the consortium.

6 Communication Tools

6.1 COGNITWIN SharePoint site

A SharePoint web-based platform named COGNITWIN is available for the project. This platform is administered by SINTEF. Figure 3 presents a screen shot of the platform.

This platform is being used as a tool to promote communication among the project participants. Easy and secure accessibility of technical and financial information related to the project and secure data exchange is enabled by this platform.

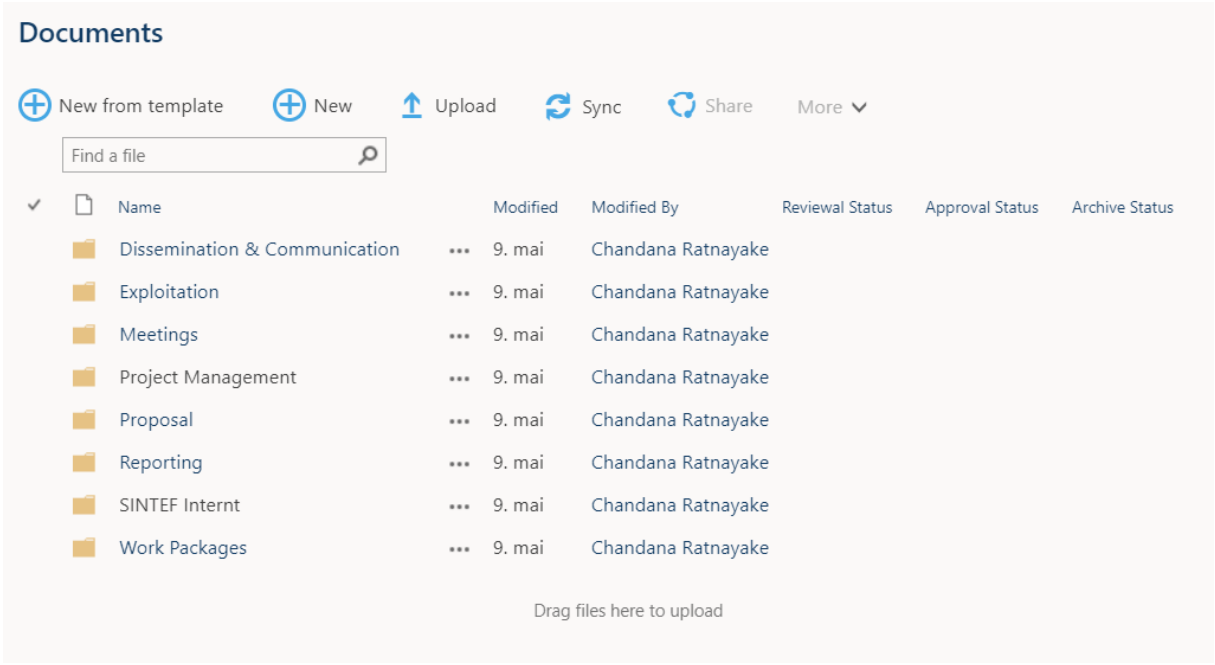

Figure 3: A screenshot of the COGNITWIN SharePoint room

An external project website (www.cognitwin.eu) is also established. This website provides general project information such as introduction, objectives, and consortium. It is regularly updated with publications and News & Events. Screen shots of this website are provided in Figure 4.

Figure 4: Screenshots of the COGNITWIN website

6.2 Meeting

Meetings are being organized to maintain and strengthen relationships among the partners, to promote information exchange. These meetings are also being used to make agreements and major decisions and planning for the execution of tasks and actions. Project and General Assembly meetings are represented by at least one representative from each partner. Based on requirements, technical work group sessions are organized among various WPs. During these sessions, coordination of activities and plans for next 6 months activities are being prepared.

A status update from all WPs, together with an updated risk assessment is presented in these project meetings. Meeting minutes from each meeting are prepared and distributed to all participants.

Recurring monthly meeting plan to track administrative and technical progress of the project has been established. All Executive Board members are invited in this meeting. These members are suggested to nominate other members to join the meeting based on the need.

Some WPs are also organizing regular meetings to discuss technical issues and to monitor and track the technical progress of the WP.

6.2.1 Teams Platform

The project has established dedicated channels for all the WPs and managerial forums. These channels can be used to organize meetings and share documents among the participants.

7 Conclusion

This report provides risk assessment details in COGNITWIN project until M21. An updated management action plan considering the impact of 6 months project extension and any other changes compared to the previous plan submitted in M3 is also presented. The purpose is to establish a quality policy covering all aspects related the management of COGNITWIN project, including management, work plan and communication in the project.