D6.2
Risk Assessment Plan

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Abstract:	The risk assessment plan shows how potential risks are assessed and mitigated in order to avoid any negative influence on the Safe4RAIL project objectives. The interrelated risk assessment plan – risk identification, handling and monitoring – were established.
Keywords:	Risk assessment, risk identification, risk monitoring, risk mitigation

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Executive Summary

The Safe4RAIL risk assessment plan describes how the project contemplates to manage risks, intends to predict risks, estimates impacts and defines mitigation measures. It outlines the management components, the approach and tools used. In order to be aware of the central project activities in relation to the project timeline, the critical path of Safe4RAIL has been defined. Within Safe4RAIL, the iterative and interrelated steps of risk identification, risk analysis and monitoring as well as risk handling are accompanied by easy-to-use tools, clear responsibilities and efficient communication channels towards effective risk management. On this basis, a probability/severity matrix supports the regular qualitative evaluation of risks. As the Safe4RAIL consortium is aware of the swift changing environment, risks are regularly monitored, mitigation plans updated and actions taken, if necessary.

This document outlines the risk management procedure established within Safe4RAIL based on scientific theoretical background. For confidentiality reasons, the latest status of WP-related and project-specific risks were removed from D6.2 and integrated in the 1st periodic report (at CO level) of Safe4RAIL.

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Chapter 1 Introduction

"Avoiding rocks on the road to success" [1] - following this guiding principle, the Safe4RAIL consortium has established an effective project risk management strategy to avoid tripping over rocks on the road to successfully reach the planned project outcomes or go even beyond.

The project Safe4RAIL (Safe architecture for Robust distributed Application Integration in roLling stock) aims to create safety concepts for mixed-critical Ethernet-based networking as well as a mixed-criticality application framework, including the brake-by-wire concept. Safe4RAIL will reinforce European competitiveness by offering fundamentally simplified electronic and Train Control and Monitoring architectures required for the optimization of railway systems, to minimize system lifecycle and operational costs.

Developing and dealing with such an ambitious and highly innovative project, only *"innovation, fused with an agile, sophisticated approach to risk management, can create a powerful, value-driving partnership."* [2]

According to the ISO 31000 standard on risk management, a **risk** can be defined as an "*effect of uncertainty*" towards parts of objectives. An effect is described as a positive or negative deviation from the expected work-plan. Every step towards the project objectives has an element of risk that needs to be managed. In the context of risk management, **uncertainty** exists whenever the knowledge or understanding of an event, consequence, or likelihood is inadequate or incomplete. **Risk management** describes a coordinated set of activities and methods which supports the control of risks that may affect the projects ability to achieve part of its objectives. The project risk management process is meant to from part of the project management routine at all stages of the project lifecycle [3].

In order to raise awareness for the central project activities and as a starting point for risk management, a critical path has been defined, which is described in Chapter 2. Failing to follow a structured project risk management process for projects in a self-disciplined manner would quickly lead to project failure [4]. Therefore, within Safe4RAIL a clear structured process of risk identification, risk monitoring & analysis and risk handling has been established (see Chapter 3). This process already started with the risk identification during the proposal phase, continued in all process steps within the first year of the project and will accompany Safe4RAIL throughout the project's lifetime. In order to settle this process as a vital one, communication as well as easy tools turned out to be critical factors. The practical risk assessment of Safe4RAIL including an evaluation of probability and severity as well as mitigation plans for defined risks is included in the Periodic Report.

Chapter 2 Critical Path of the Project

As a starting point for risk management, the critical path of Safe4RAIL has been defined in order to be aware of the central project activities. The critical path determines the targeted time to complete the project and the critical activities, which might be able to threaten the project objectives. The items of the critical path are mostly reflected by project milestones, presenting central and critical achievements during the project lifetime.

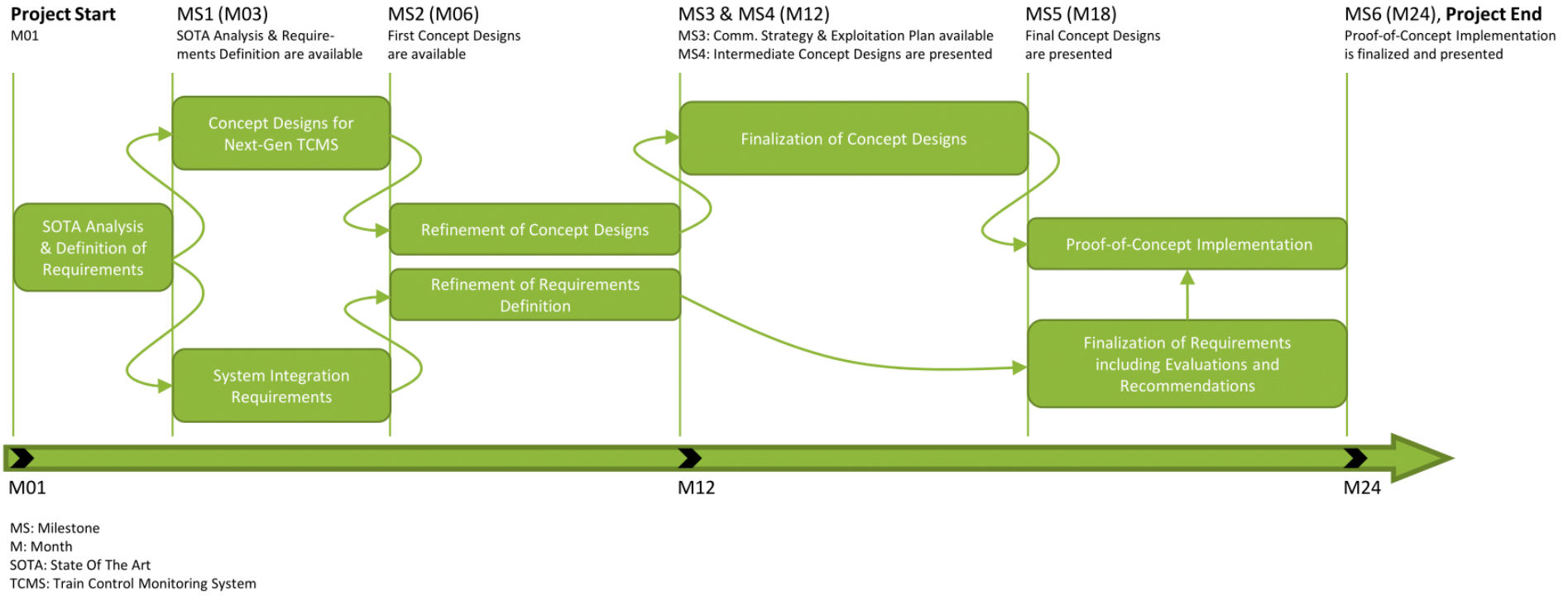

Figure 1: Safe4RAIL's Critical Path

Figure 1 indicates the key activities of Safe4RAIL that must be performed in order to meet the planned objectives successfully and on time. The items of the critical path are mostly reflected by project milestones, presenting central and critical achievements during the project lifetime. The timeline indicates that the key topics of the project differ during the project duration. The critical path analysis helps the consortium to predict whether the project can be completed on time and as it progresses, to keep the project's completion on track and ensure that deliverables are ready as scheduled. Besides the critical path, which the consortium is challenged to pass; risks will occur in different work packages and might influence the projects´ development if not handled carefully. Therefore, the critical observation and examination of risks has a central role during the project lifetime. The following chapters focus on the risk management process established within Safe4RAIL.

After a successful project kick-off in October 2016 the Safe4RAIL partners mainly focused on the analysis of the state-of-the-art and the definition of requirements. After reaching MS1 in M03, the consortium established the first draft of the next-generation TCMS (train control monitoring system) concept design and stated the main system integration requirements. The second milestone has been reached in time, and refinement of the concept design, as well as the requirements definitions could be performed. With reaching MS3 and MS4 in M12, the intermediate concept designs as well as the communication, strategy and exploitation plans are available. Besides that, the project partners have been intensely working on other WPs, in order to continue with the progress and successfully complete the first project period. The second project period will focus on the finalization of requirements and concept design and, finally, the proof of the concept implementations.

The most critical paths of the project are the requirements definitions and the creation of the concept designs. The future success of the project is reliant on their timely and precise fulfilment in order to reach the project objectives.

The right timing of the project is highly dependent on these WPs, and therefore, the partners will pay special attention to them. Further, the project consortium will publish scientific articles and present the project to external stakeholders. To conclude, it can be said that the analysis of the critical path helped to identify critical items and allows us to put necessary measures in place. The risks are continuously assessed (as explained in the tables in Chapter 4) within the consortium.

Chapter 3 Risk Management Procedure

This chapter is focussing on the risk management procedure that systematically applies management policies, processes and practices on project activities.
Within Safe4RAIL we basically established a risk management framework including three major strides, which are correlating and interacting continually:

- Risk identification (Section 3.1)
- Risk analysis & monitoring (Section 3.2)
- Risk handling (Section 3.3)

The set up of the risk management process needed to be aligned with the project objectives and might be adjusted if required due to changes in the research objectives. The risk management procedure has been established around the routine project work and is accompanying the project through its lifetime. Figure 2 indicates that project stakeholders (EC, related projects, suppliers etc.) and the project environment (regulations, duties, etc.) form the outermost layer, are influencing causes of risks, which may impact the project collaboration with the project objectives in the centre of attention.

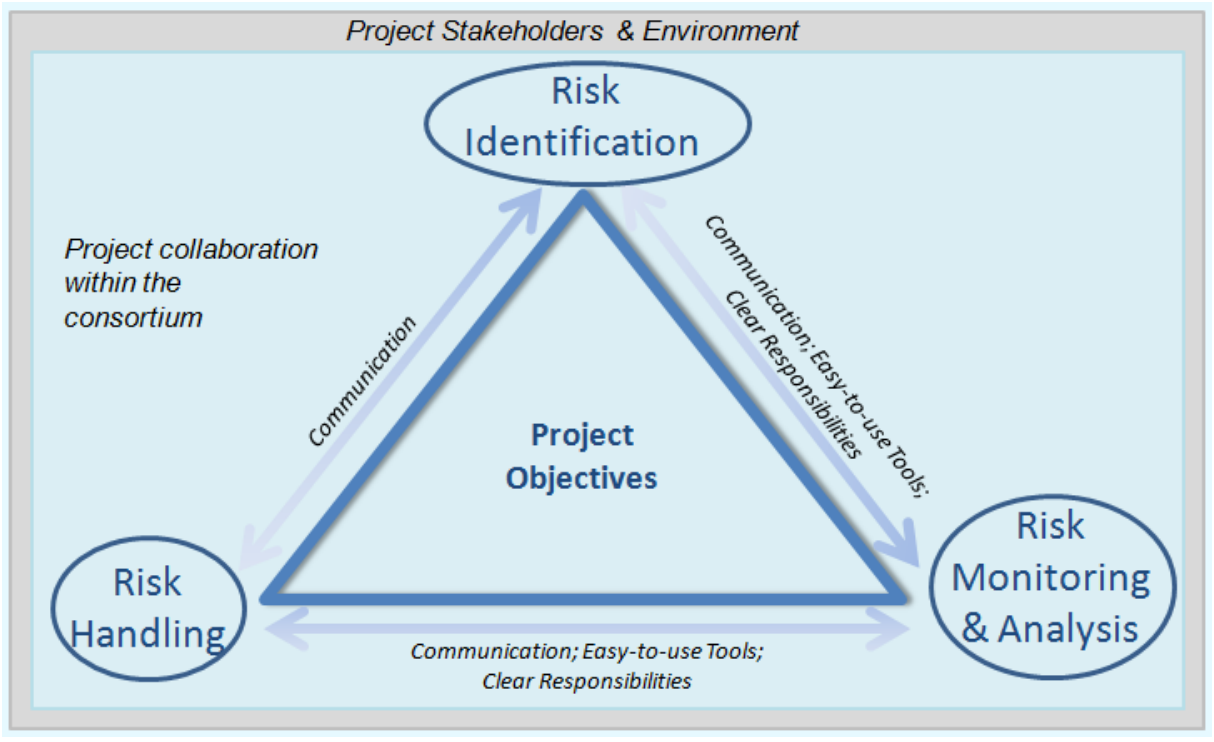

Figure 2: Risk Management Procedure

Taking into consideration all project-environmental factors, channels to allow the efficient implementation of the three major steps in the shown risk management procedure, needed to be established. On the one hand, a clear structure for communicating risks including clear responsibilities are required and need to be assured with all partners. On the other hand, it has to be easy for the partners to perform risk management by themselves through easy-to-use tools.

How the above mentioned tools and steps have been integrated into the project and how they will support to mitigate negative consequences for the project will be described within the following subchapters.

3.1 Risk Identification

"Risk identification is a process that is used to recognize, find, and describe the risks that could affect the achievement of objectives." [3]

The target of risk identification is being aware of possible risk sources in addition to the events and circumstances that could affect the achievement of objectives. Further, it includes the identification of possible causes and consequences.

The identification of risks started already during the proposal phase. When developing the idea for an innovative technological advancement, it needs to be formed the way it creates the most value at an acceptable level of risk. For the identification of risks in such a highly innovative field it is necessary to have experts, who understand on the one hand, the technical challenge and its impact and have on the other hand deep insights to the industry and market needs. The project consortium unifies all these know-how in its consortium and is therefore, capable of identifying the risks for the innovative action pursued in Safe4RAIL.

Risk identification has not terminated after the proposal phase, but it is rather a continuous process of attaching awareness for potential risks. To address this awareness best, the consortium defined the WP Leaders as risk managers for their WPs. The WP leader is an expert in the field his or her WP is concentrating on and therefore, the most capable person to identify risks. On project level, the technical lead and coordinator (TTT) along with the supporter (TEC), pay close attention to the identification of potential risks. This structure and distribution of responsibilities allows the continuous identification of new risks and encourages the discussion of potential risks within telcos, face-to-face meetings and the WPs themselves.

The risk table allows all partners to add new risks at any time. At the beginning of the project 19 different risks have been identified, two of them effecting all work packages, which sums up to 29 risks, During the course of the project the risks have been assessed several times, which led to 5 additional risks. Further, the first risk has been added to every work package, which adds 5 more risks to the total number, while two risks of work package 1 are not valid anymore. This sums up to a total of 37 risks.

3.2 Risk Analysis & Monitoring

"Risk analysis is a process that is used to understand the nature, sources, and causes of the risks that you have identified and to estimate the level of risk. It is also used to study impacts and consequences and to examine the controls that currently exist. To monitor means to supervise and to continually check and critically observe - it means to determine the current status." [3]

The process of risk analysis and monitoring is iterative, which means that the risks are evaluated, mitigation measures are re-considered and updated, if necessary, as well as the progress, are monitored on a regular basis.

Before setting up the structure and requesting inputs from the project partners, the consortium faced the challenge of making our risks measureable and tangible. While a merely quantitative approach is not applicable due to the high degree of innovation, a pure qualitative approach would be hard to evaluate. Therefore, a mixture of quantitative and qualitative elements has been chosen and is described in the following.

"Qualitative Risk Analysis assesses the priority of identified risks using their probability of occurrence, the corresponding impact as well as other factors such as the time frame and

risk tolerance. When using quantitative analysis the risk level can be estimated by using statistical analysis and calculations combining severity and probability." [3]

While qualitative risk analysis is performed for all project risks, quantitative risk analysis has a more limited use within the Safe4RAIL project, based on the type of project risks, and the limited availability of data to conduct a quantitative analysis.
Our quantitative analysis of risks is using a probability and severity matrix to prioritize the risks. The WP leaders are asked to indicate probability and severity of the stated risks, which have been identified in the previous step.

Probability describes the relative likelihood that a risk will eventuate. It can be defined, determined, measured objectively or subjectively and can be expressed either qualitatively or quantitatively [3]. The probability may be dependent on various factors like the project environment, consortium characteristics, external effects, technological breakthroughs etc. For the evaluation of the Safe4RAIL project risks the following classifications were defined:

- **High** – More than <*70%*> probability of occurrence
- **Medium** – Between <*30%*> and <*70%*> probability of occurrence
- **Low** – Below <*30%*> probability of occurrence

Of the 37 identified risks, 27 are classified as not likely to occur (“Low”), while 7 show a medium probability and 3 are identified as highly probable.

Severity defines the effects and consequences, a project may face in case of risk occurrence. The severity may be influenced by various risk triggers arising from the project environment, consortium characteristics, external effects, technological breakthroughs etc. and may affect the technological and financial performance as well as the schedule of the project [3].

- **High** – Risk has the potential to greatly impact the projects technological and financial performance as well as the schedule
- **Medium** – Risk has the potential to impact the projects technological and financial performance as well as the schedule
- **Low** – Risk has relatively little impact on the projects technological and financial performance as well as the schedule

While only 3 of 37 risks show a low severity, 8 risks are expected to have a “medium” impact, while 26 risks show a high impact on reaching the project objectives.
Classifying risks with the indicated scale, allows the appraisal if any action might be needed. The qualitative analysis further includes the assessment if a risk did materialise as well as an explanation for the current situation. This is needed as basis for the decision if any measures need to be taken in a further step. The description of the current risk status also supports the deeper understanding and specification of the risk. At this point quantitative elements step into. The detailed assessment of the risk may include explanations of further effort requests, additional expenses etc. needed to deal with the risk consequences, which makes it quantitatively measureable.
The practical implementation of the qualitative and quantitative analysis within the Safe4RAIL project is included in the project Periodic Report.

3.3 Risk Handling

The process of risk handling starts, once a risk is assessed as likely to occur (medium/high) and has impact (medium/high) on the project. At this point a WP leader correlates with the technical leader and the coordinator to define

- if countersteering measures need to be taken, and
- which project level (project bodies) will be appropriate to deal with the risk.

Within the first 12 months, 8 critical risks have been identified.

The WP leader correlates with the coordinator regarding the risk which occurred or is expected to occur. If it has no major impact on the project and appropriate actions can be taken by the WP leader, the risk will be handled at this level. Furthermore, the Joint Advisory Board (AB) will support the risk identification and handling. It is based on experts from different expertise areas spread across the technological topics that are addressed in Safe4RAIL, coming from 5 different countries. In case a risk is expected to create major impact on the project, the Executive Board (EB) or the General Assembly (GA) will be involved. In case of substantial risks, EB and GA also correlate with the Project Officer.

Therefore, the structure of the project bodies and the clear definition of responsibilities for each project body, defined during the proposal phase, have been proven and allow clear and swift communication of risks. In Figure 3 an overview of the defined project bodies and their field of responsibility can be found.

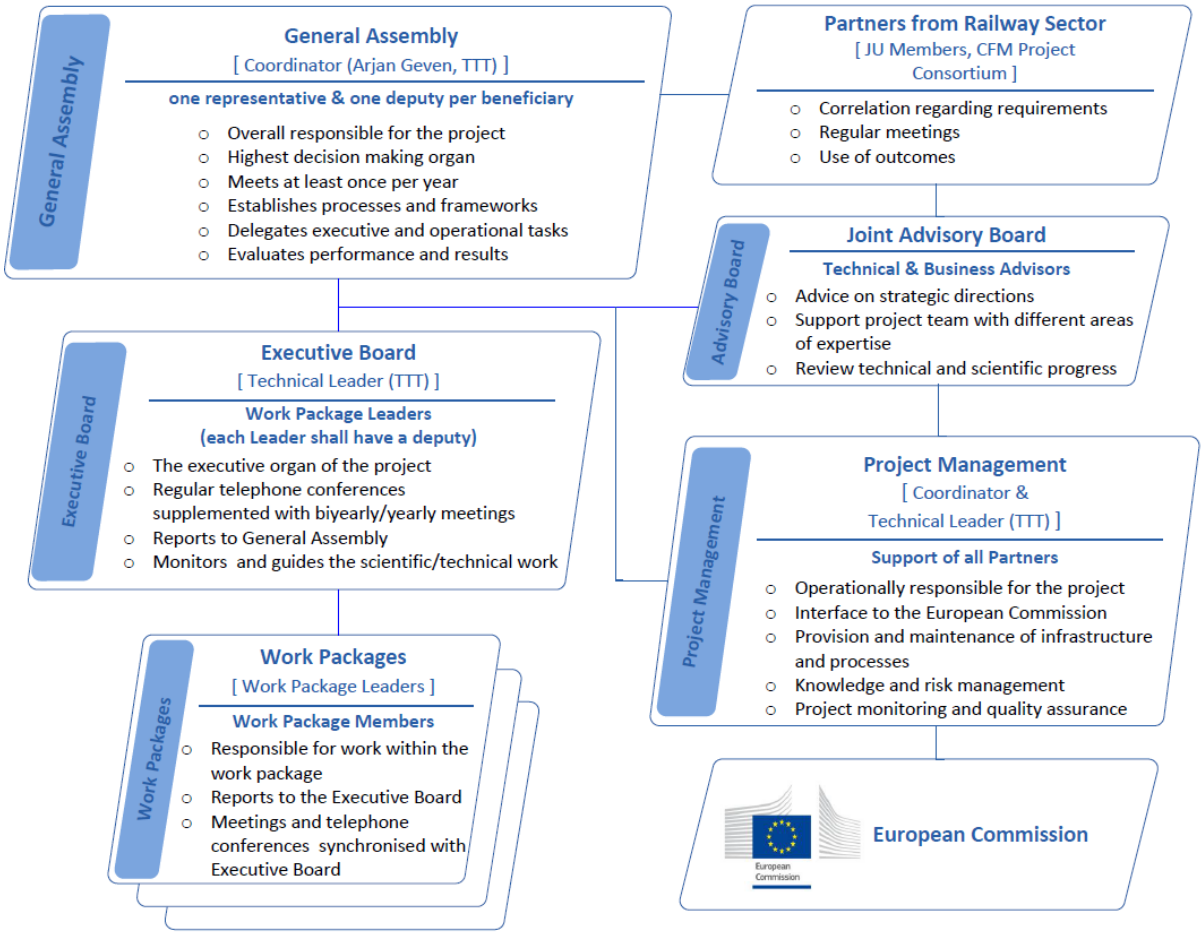

Figure 3: Project Bodies in Safe4RAIL

The governing culture of Safe4RAIL is based on democracy, co-determination and clear leadership. Each body operates on separate levels and has its own area of responsibility and decision-making power. Based on the expected impact of a risk, the coordinator assembles the EB or GA in a telephone conference to discuss countersteering measures. For risks affecting the overall strategy, which may threaten part of the project outcomes, the GA, as the highest decision-making body deals with this risk. Risks causing minor delays or minor changes in the work plan are handled by the EB.

The GA and EB members are experts in their fields and therefore, capable of estimating the effects of the risks as well as of countermeasures. The responsible body discusses if the already proposed mitigation plan is still suitable or if other actions need to be taken or are more suitable to the risk occurred. The decision regarding the countermeasures are taken according to the voting rules defined in the Consortium Agreement (based on MCARD model). Basically, the WP leaders are in charge of appropriate realization of the defined risk mitigation measures. All applied measures, arising challenges or chances will be documented in the risk table.

Beside the decision making bodies in the Safe4RAIL structure, an Advisory Board supports the consortium with external, unprejudiced view. This can also be seen as a risk minimizer as it makes sure that the project outcomes meet the market expectations and do not fail to meet substantial market-specific needs.

Chapter 4 Managing Safe4RAIL Risks

This chapter illustrates the implementation of the previously described risk tools into the Safe4RAIL project structure. It presents the defined risks, shows the development of the risks based on probability/severity estimations at several evaluations and tries to assess the current status of the risk. As the WP leaders are the main responsible persons for the risks of their WPs, this section is built up on WP level.

As described in detail in Section 3.2, a probability/severity matrix is used to qualitatively evaluate the risk status. The scale for these variables has been defined as low, medium or high and is described in Table 1 below.

	Low (L)	**Medium (M)**	**High (H)**
Probability	Less than <*30%*> probability of occurrence	Between <*30%*> and <*70%*> probability of occurrence	More than <*70%*> probability of occurrence
Severity	Risk has relatively little impact the projects technological and financial performance as well as the schedule	Risk has the potential to impact the projects technological and financial performance as well as the schedule	Risk has the potential to greatly impact the projects technological and financial performance as well as the schedule

Table 1: Probability/severity matrix

In the following sub-section a short update of the identified risks is given.

4.1 WP1 Networking for Drive-By-Data [M01-M24; TTT]

In WP1 there have been six pre-defined risks, which have been extended to seven during the continuous risk assessment, and then reduced by two. One risk materialised so far and was successfully mitigated. Except from the fourth risk, there have been no adaptations of probability or severity level and no additional risk has been identified. All risks, except the last, have high severity. In total, four out of five risks have a medium/high probability and medium/high severity, which makes them so-called critical risks.

4.2 WP2 Functional Distribution Architecture [M01-M24; IKL]

There have been five pre-defined risks for WP2. Two additional risks have been added after project start and during the risk assessment process. Since the beginning of the project, one critical risk (related to external dependencies) materialised and was mitigated successfully through efficient collaboration. There have been no adaptations of probability or severity level and no additional risk has been identified.

4.3 WP3 Virtual Placement in the Market [M01-M24; SIE]

There have been six pre-defined risks for WP3. Two additional risks have been added after project start and during the risk assessment process. There have been no adaptations of probability or severity level and no additional risk has been identified. The risk of high dependency on inputs from CONNECTA materialised, but the only impact is the postponement of one chapter in D3.3 to D3.5. However, D3.2 and D3.3 can be submitted in time. Two of the identified risks are classified as critical.

4.4 WP4 Brake-by-Wire [M01-M24; ELE]

There have been six pre-defined risks for WP4. Only one additional risk has been identified.. The second risk, about external dependencies has materialised and has resulted in the developing of plan B to reduce its impact on the WP4.. Three risks have a medium probability and high severity.

4.5 WP5 Dissemination, Communication and Exploitation [M01-M24, TEC]

There have been four pre-defined risks for WP5. Three additional risks have been added in the course of the risk assessment. None of the mentioned risks has taken place, except the third risk of this work package related to the correct following of dissemination procedures. The consortium discussed this issue and resolved it. The two added risks focus on the expected timeframe for standardization and a probably short exploitation timeframe. There have been no adaptations of probability or severity level and no additional risk has been identified. Only one of the risks is identified as likely to occur and has medium severity.

4.6 WP6 Project-, Risk-, and Cooperation Management [M01-M24; TTT]

There are two pre-defined risks and one additional risk in WP6. The WP leader TTT stated that none of these risks have yet materialized because of regular contacts between the partners, and standard legal agreements that have been put in force. There have been no adaptations of probability or severity level and no additional risk has been identified. None of the identified risks are classified as critical risk.

Chapter 5 Conclusion

The described risk management approach indicates how the Safe4RAIL consortium is and will avoid potential pitfalls and roadblocks on the road to success. Based on theoretical inputs, as described in Chapter 3, the Safe4RAIL risk management tends to professionally identify, analyse, monitor and handle highly innovative project risks. The consortium has been very effective when monitoring the project risks. As a result of continuous risk monitoring, partners identified five new risks, whereby several might negatively affect the project if not handled carefully. Overall, the current level of risks indicates appropriate mitigation measures as well as close attention of all partners.

Risk Assessment is a process, which will last throughout the lifetime of the Safe4RAIL project. Updates and assessments will be regularly performed by the consortium and reported within the Periodic Reports.

List of Abbreviations

AB	Advisory Board
DoA	Description of Action
EB	Executive Board
EC	European Commission
GA	General Assembly
IMR	Interim Management Report
MS	Milestone
PM	Person Month
RAP	Risk Assessment Plan
TCMS	Train Control Monitoring System
WP	Work Package

Table 2: List of Abbreviations

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