

Requirements Engineering Challenges in Large Research Projects

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Abstract— Public authorities fund large research projects with the goal to develop and advance innovative products, solutions as well as methodologies. Due to the large volume and the typical mixture of industrial and research partners in the consortia, these projects offer a strong basis for delivering highly innovative results that further the state of the art significantly. Nevertheless, these projects face execution challenges in addition to the technical ones that are the actual object of their research proposals. One of these execution challenges is having an effective and efficient requirements engineering phase that details the project vision and goals, and aligns the project partners to achieve optimal results. This paper presents (1) several requirements engineering challenges that were perceived in large research projects where the authors' affiliation was involved in defining and/or performing requirements engineering and (2) a discussion of the reasons for, potential implications from, and possible solutions for these challenges. This information is expected to help project members in anticipating and managing the requirements engineering challenges in large research projects and potentially avoiding problems during project planning.

Keywords—Requirements engineering challenges; large research projects; project characterization.

I. INTRODUCTION

Public authorities such as the national ministries (e.g., the German Federal Ministry of Education and Research) or the European Commission fund large research projects (LRP) with the goal to develop and advance innovative products, solutions as well as methodologies. Publicly funded research projects in Europe are mainly large projects i.e., numerous partners are involved, the projects last at least two years, and the funding is expressed in several million Euros. Due to the critical mass with regard to the number of project partners and effort provided in the project, the public authorities expect these projects to deliver highly innovative results that advance the state of the art significantly.

These kinds of projects largely address technical challenges, i.e., they want to innovate the next generation of products, or develop new technologies or methodologies to improve the development of products. The organization to which the authors belong typically is involved in LRP that have the goal to develop new software and system development tools and methodologies, or in projects that use IT to innovate next generation products.

However, these projects face not only technical challenges i.e., to provide new technologies, methodologies

or products, but also challenges in the execution of the project. One of these execution challenges is to have an effective and efficient requirements engineering (RE) phase in order to (a) detail the vision and the goals of these projects and (b) align the project partners in order to achieve optimal results. This alignment is especially difficult, as the project partners are spread over a country, or over Europe. Often, they include partners from industry as well as from research organizations. Additionally, there is no clear organizational hierarchy as many large industrial organizations cooperate. Furthermore, the project vision and goals tend to be detailed during the course of the projects.

Therefore, these projects use, as in industrial practice, either an implicit or explicit RE phase to build a solid basis for the development of the new methodologies or products. To support this, industrial partners typically state their requirements with the intent to help the research partners in clearly understanding the problems to be solved as well as to evaluate the proposed solutions.

In our participation in such LRP, we perceived several challenges related to the RE phase. This paper presents and reflects on the main challenges among them. The purpose of making the challenges explicit and sharing them with the RE community, in this paper, is twofold:

1. To help consortium members in LRP to anticipate and manage the challenges in the RE phase, so as to avoid their undesired impacts. Indeed, we believe that addressing these challenges demands significant effort, especially since their impacts can sometimes represent a threat to project success, e.g., when the potential impacts are schedule overrun, or misalignment between the requirements specification and the real requirements of stakeholders, or when the research product does not satisfy the needs of the industrial partners.
2. To promote a discussion of possible solutions in the RE community.

The rest of this paper is structured as follows: In section II, we propose the dimensions for characterizing LRP and present the characterization of the six projects on which we report. In section III, we provide the methodology that we used for identifying and analyzing challenges from the six LRP. In section IV, we describe the set of perceived challenges discussing the reasons for, potential implications from, and possible solutions for these challenges. In section V, we present related work in the literature, concerned with challenges in large and complex project settings, and conclude the paper in section VI.

II. PROJECT CHARACTERIZATION

We characterize large public research projects, along 8 dimensions, namely: *number of project partners*, *project duration* (years), *project volume* (Million €), *funding source* (European Union or nationally funded), *domains represented*, *expected product type* (product for end-users vs. software development tools and methods), *inclusion of end-users* and *inclusion of industrial partners* respectively in the project consortium.

We intentionally do not provide the exact numbers for each project, to make the projects anonymous. Drawing conclusions on the individual projects is not the purpose of this experience report. The six projects that serve as the analysis base for the perceived challenges comprise a mixture (almost 50%) of nationally funded and European Union funded projects where the number of project partners was larger than 10 organizations, the project duration lasted between 2 - 4 years, and the project volume was higher (sometimes significantly) than 3 Million €.

Additionally, industrial participation existed in all the projects that we considered in this study: in general, industrial participants in the projects represented a broad spectrum of application domains including (business) information systems, industrial automation systems, medical systems, assistance systems, the telecommunications sector, the automotive sector, aerospace and aeronautics sector, railway systems, and a variety of related service providers.

However, not always did the consortia for these projects contain the end-users of the related application domains e.g., although a project may have had an industrial partner from the aeronautics sector, it was not always the case that an airline was also part of the project consortium.

Furthermore, the type of end-product to be developed in the projects varied i.e., some projects focused on tool and method development, whereas others focused on actual consumer end-products.

All projects were organized such that each contained distinct work units, known as *work packages*, to be executed according to a project plan defined during the project proposal phase. Each work package had a defined run time culminating at a *milestone*, where the promised *deliverables* were to be supplied.

III. METHODOLOGY FOR CHALLENGES IDENTIFICATION AND ANALYSIS

We used the following methodology for identification and analysis of the RE challenges that we perceived in LRP. In our context, we define an RE challenge as an issue appearing during RE activities which is perceived by at least one RE participant as a problem that requires measures to address such that the project goals are not threatened.

1) *Identification of LRP*: We identified LRP in which Fraunhofer was involved in the RE work packages in the previous years. We picked six projects out of a larger set of projects in order to enable anonymity of the projects¹. We

identified people from the RE teams (henceforth called RE participants) of those projects who could provide information, and especially the challenges the team had to face due to the characteristics of LRP.

2) *Collection of RE challenges*: Each RE participant was asked to list the RE challenges his/her requirements engineering team had to face, which he/she believe to have arisen or become more relevant as a consequence of the project being a large research project.

3) *Shared understanding and refinement of challenges*: In a meeting, each RE participant presented his/her list of challenges, so that the other participants could have the opportunity to understand them and eventually realize whether their projects also had to face the same challenge. Some challenges were rewritten for clarity, others were decomposed into sub-challenges, or still others consolidated into higher-level challenges. The result of this step was a unified list of challenges. Each challenge was reviewed again as to whether it was a challenge specific for RE and also for LRP. Other challenges were eliminated from the list.

4) *Definition of a scale for rating challenges*: We defined a scale for rating the relevance of a challenge in a specific research project (TABLE I.)

TABLE I. SCALE FOR RATING CHALLENGES

Rank	Interpretation
0	The challenge was not perceived in this specific project.
1	The challenge was perceived in the project, but it was of minor severity, i.e., little effort was needed to deal with it and/or it did not represent a relevant risk for the project.
2	The challenge was perceived in the project and it was of medium severity i.e., the challenge had the potential to negatively impact project success and major effort was required to deal with it.
3	The challenge was perceived in the project and it was severe, i.e., it threatened project success and it required major effort to resolve.

5) *Rating of RE challenges*: For each LRP, the RE participants of this project rated together the relevance of each challenge listed in the unified list of challenges. For this rating, they used the scale defined in the previous step.

6) *Definition of selection criteria*: We defined the following criteria to select challenges for further analysis:

(a) The sum of the ratings, taking the six LRP into consideration should reflect *significant* challenges, i.e., the sum of the rating must be greater than or equal to 8. We chose a rank of 8 to represent a sufficient level of severity: if a project is ranked with 8, it was likely to be ranked in at least one project with rank 3 or in at least two projects with rank 2.

(b) The number of projects in which the challenge occurred should be greater than or equal to 3, i.e., representing at least 50% of the projects.

7) *Selection of the main RE challenges*: By applying the selection criteria to the unified and ranked list of RE challenges, we identified nine challenges for further analysis.

8) *Analysis of the main RE challenges*: For describing the challenges, we analyzed each selected RE challenge to derive the potential reason/ cause for its occurrence, the

¹ The authors of this paper were not necessarily participants in the project; rather they coordinated the information gathering for this paper.

observed impacts on certain projects and possible solutions. In doing so, we identified dependencies between challenges and impacts that were not immediately evident i.e., after analysis, some challenges were reasoned to be actually impacts of other challenges, while many challenges were reasoned as producing the same or similar impacts. In addition, we classified the challenges as *barriers to performing an RE activity* (e.g. see challenge C1), *barriers to achieving the expected outcome of an RE activity* (e.g., see challenge C2) and *deviations from expected outcome* (e.g., see challenge C9)

We visualized the dependencies using a directed graph, labeling each challenge and corresponding immediate impact with the identifiers (Cx) and (Iy), respectively. The idea was to reason about the causal relationships between challenges, immediate and inferred impacts, and design solutions to address the challenges.

IV. MAIN CHALLENGES IDENTIFIED

A. Description

In this section, we describe the main challenges that we perceived in publicly funded LRP. The challenges and impacts are intertwined, therefore we use unique identifiers to reference the various challenges and impacts:

(C1) Unclear RE process definition at project start:

Although LRP contain several project partners there is, largely, no clear definition on how RE is to be executed in the project. Particularly, an RE process tailored for the project is missing. This challenge was perceived in the early phases of project execution and it represents a *barrier to performing RE* in the project.

We hypothesize that neither the need for having such a process definition, nor a statement in the project proposal of who will provide it, is one of the main reasons for this challenge. A second reason is potentially that project partners have heterogeneity both in their internal RE processes (which, in turn, varied in their maturity levels), and in their methods and tools for RE.

The impacts of this challenge were broadly identified to be: (I₁) *Significant rework* required on the outcome of the RE work package, as the content to be documented, or the need to improve the document specification (template) itself, is discovered. Additionally (I₂) *Increased communication overhead and effort* resulted as the RE process was defined on-the-fly. This, in turn, resulted in (I₃) *Problematic process execution*, e.g., due to distinctly different project partners who are involved in defining the process versus executing it. In turn, this precipitated in (I₄) *Specifications not reflecting the correct or relevant requirements as per stakeholder expectations*, i.e., the requirements produced did not reflect the real requirements.

(C2) Ad-hoc requirements elicitation

Requirements elicitation is performed in an ad-hoc manner without a well defined set of activities or steps to systematically identify and query stakeholders, interpret needs, document and validate the requirements according to a commonly acceptable standard. This challenge was also

perceived in the early stages of project execution, and represents a *barrier to achieving the outcome of RE*.

This challenge represents a special case of (I₃) *Problematic process execution*. We hypothesize that it arose primarily due to (C1) *Unclear RE process definition* and (C4) *Misaligned project schedule*.

As a consequence, the resulting documents represented (I₆) *Vague documentation of needs statements rather than requirements*, i.e., requirements specifications contained vaguely stated stakeholder needs rather than accurate requirements statements that could be further refined or validated. In turn, this led to (I₁) *Significant rework* on the elicited requirements, i.e., restating the requirements such that they could be commonly interpreted by the development work packages while being able to be validated by the stakeholders. Eventually this precipitated in (I₅) *Schedule overrun*.

(C3) Unclear requirements terminology

We discovered that the reconciliation of common terminology dealing with requirements was universally a challenge in almost all projects considered for this study. In particular, different project partners had varying concepts of needs, requirements and specifications. Even when a standard such as the IEEE Std. 830-1998 was used, despite a general agreement on the definition provided by the standard, there were marked differences in interpretation, manifesting directly in the quality of the requirements documents. This challenge, a *barrier to performing RE*, was observed when RE process execution began.

We hypothesize that the variety of partners participating in LRP, together with heterogeneous internal RE processes of the partner organizations contributed to the challenge occurring in LRP.

Consequent to the challenge occurring, (I₂) *Increased communication overhead and effort* which, in part, also led to (I₇) *Hampered execution of planned process activities*, e.g., in a planned elicitation workshop, significant effort was spent in achieving consensus on requirements terminology rather than in eliciting requirements. An eventual impact of the challenge occurring was (I₆) *Vague documentation of needs statements rather than requirements*, precipitating in (I₄) *Specifications not reflecting the correct or relevant requirements as per stakeholder expectations*.

(C4) Misaligned project schedule

This challenge refers to suboptimal project set-up in terms of a project schedule created without sufficient consideration of the dependencies between different work-packages. For example, development work packages (which depend on project requirements) sometimes started well before the availability of acceptable and validated requirements. This challenge is a *barrier to performing RE* and was observed in the early phases of project execution.

We surmise that this challenge arises during project planning in a bid to get all the partners involved in the project as soon as possible. Furthermore, as partners in LRP tend to be distributed across different work-units, there may be greater focus given to planning the start and content of the work packages rather than to resolving interdependencies.

The impacts of this challenge manifested as requiring (*I₁*) *Significant rework*, e.g., to align the results of the work packages dependent on requirements. In one of the projects, this also impacted the requirements elicitation process resulting in (*C2*) *Ad-hoc requirements elicitation*, where picking a lightweight but unsystematic alternative was preferred to stalling the dependent work packages. In addition, (*I₇*) *Hampered execution of planned process activities* was observed, which eventually led to (*C9*) *Misalignment of the final product with the requirements*.

(*C5*) *Misaligned partner involvement and expectations*

The expectations of research partners and industrial partners about the extent of involvement in the RE phase of the project were not always aligned with each other. This was perceived, e.g., when requirements were not communicated in sufficient detail. This challenge is a *barrier to achieving the expected outcome of an RE activity* and was observed at the start of RE in some projects.

We hypothesize that the reasons for this challenge lie, in part, with incomplete awareness of all the responsibilities that a project partner has, and with incorrect estimations of the effort required to communicate real requirements.

Consequently, (*I₇*) *Hampered execution of planned process activities* resulted together with (*I₄*) *Specifications not reflecting the correct or relevant requirements as per stakeholder expectations*. In particular, we observed that some stakeholders did not formulate explicit requirements even if a defined process recommended such formulation, and needs about the expected solutions had been expressed. Eventually, (*I₁₁*) *the outcome of the project is not accepted*.

(*C6*) *Focus on known solutions instead of problem understanding*

One challenge that was also perceived was the bias towards adopting an existing solution or a part thereof, without a careful understanding of the problem itself. Although the adoption of an existing solution is not in and of itself detrimental, this is a *barrier to performing RE* and was observed both during RE in the early phases of the project and also later during project execution.

We hypothesize that this challenge arose, in part, due to (1) unawareness among research partners of the relevance of industrial requirements in the project, and (2) both industrial and research partners having their own culture and portfolio of solutions developed and/or applied in previous projects. Additionally, the reuse of work from previous projects is largely encouraged in LRP funded by the public authorities. We further surmise that the bias may also arise due the perception that legacy solutions can be introduced into existing industrial processes with greater ease.

One impact observed as a consequence was that (*I₈*) *the solution is not the best that could be provided by the project*. A more significant impact, however, is (*C9*) *Misalignment of the final product with the requirements*.

(*C7*) *Missing stakeholders or wrong stakeholders provide requirements*

Incorrect or insufficient stakeholder involvement e.g., in elicitation workshops, was also perceived as a challenge in

many of the LRP considered in this paper. Thus, although participants from the correct stakeholder organization were present, many were not always familiar with the subject matter of elicitation, while others did not always have sufficient domain experience to clarify the initially expressed stakeholder needs. Still others did not have the expected role in their organizations or in the context of product use.

We hypothesize that this challenge occurred, in part, due to the partners not being fully aware of the relevance of sending the right people to requirements elicitation workshops. Additionally, failure to clearly specify who the right participants are in such workshops, i.e., which expertise is expected from the participants, coupled with scheduling difficulties, is also likely to have contributed to the occurrence of this challenge.

The main impacts of this challenge manifested first as (*I₄*) *Specifications not reflecting the correct or relevant requirements as per stakeholder expectations*, i.e., either the wrong requirements were provided, or the requirements as specified did not reflect the real requirements of the stakeholders. Subsequently this led to (*I₁₁*) *the outcome of the project is not accepted* (by the industrial partners).

(*C8*) *Distributed requirements development*

This challenge was perceived when every project partner stated requirements for their needs inconsistently throughout requirements development and refinement, i.e., project partners work individually using their own processes for requirements specification. It represents a *barrier to achieving the expected outcome of an RE activity*, which was observed during the RE process.

This challenge is typical of distributed development in general, where work coordination is poorly supported.

The consequences of this challenge manifested as (*I₉*) *Specifications contain incompatible abstraction levels*, and also as (*I₁₀*) *Specifications are inconsistent*.

(*C9*) *Misalignment of the final product with requirements*

In essence, this challenge although not strictly confined to RE, was perceived when requirements were observed not to have been addressed in the eventual outcome of the project, i.e., products, solutions and/or methodologies. We have included this as an RE challenge for LRP, since it was strongly perceived as related to the RE phase.

This challenge was a *deviation from expected outcome* and was observed both during and towards the end of the project.

Several contributing factors exist for this challenge: in part, some of these reasons include lack of agreement in the project consortium on an implementation which imposes a problem for requirements prioritization, or the inability to enforce an implementation of the requirements as they were stated. Alternatively, it was infeasible to implement the specified requirements; the implication of this on RE is that scoping of requirements was likely to have been insufficient and inadequate, resulting in specifications that were not implementable. We further hypothesize that time pressure, inadequately specified requirements and potentially overlooking/ misinterpreting the requirements during the

subsequent development work packages also contributed to this challenge.

The primary impact of this challenge is (I_{11}) *the outcome of the project is not accepted*, i.e., the research products may not satisfy the needs of the industrial partners.

B. Dependencies between challenges and impacts

As mentioned in our methodology description (section III) we identified dependencies between challenges and impacts that were not immediately evident.

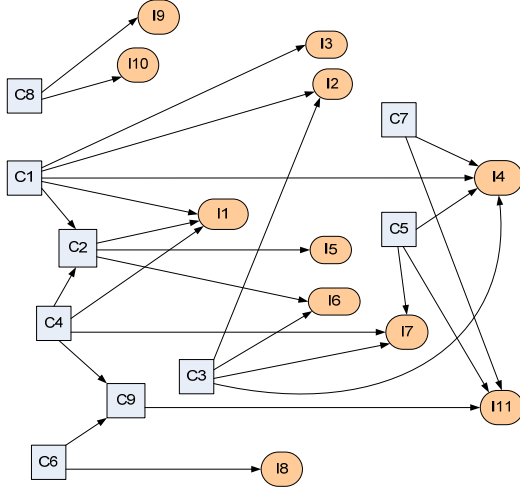


Figure 1. Dependencies between Challenges (C_x) and Impacts (I_x)

We visualized the dependencies as a directed acyclic graph (Fig. 1), where (1) each node in the graph corresponds to either a challenge (labeled as C_x) or an immediate impact (labeled as I_y), and (2) the directed edges represent causal relationships between challenges, and between challenges and the immediate impacts.

The graph can be interpreted as follows: When facing challenge (C_4) *Misaligned project schedule*, one of the observed impacts was requiring (I_1) *Significant rework*. Furthermore, we observed misalignment of the final product with requirements as an impact. This corresponds to an identified challenge, namely (C_9); we also observed *ad-hoc requirements elicitation* which again corresponds to an identified challenge, namely (C_2).

C. Possible Solutions for Identified Challenges

From an analysis of the challenges, we identified a preliminary set of potential solutions; these are intentionally independent from specific existing software or requirements engineering approaches, because specific approaches may not always be applicable to all contexts.

Visualizing and analyzing the dependencies (Fig. 1) helped us to identify solutions that are likely to address several challenges simultaneously. However, a detailed analysis of all dependencies is part of our future work. We note that the set of possible solutions presented here is not expected to be complete.

(S1) *Early and appropriate definition of an RE process*: Addresses challenges (C_1), (C_2), and (C_8); we recommend

clear and early designation of the partners responsible for defining the RE process to be used in the project, where process descriptions appropriately allocate responsibilities, and include explicit planning activities per work unit. The methods to be chosen for the various RE activities should be carefully chosen from the available set of methods in the state of the art and state of the practice. Furthermore, whenever possible, if the party responsible for defining methods to support activities would also be responsible for the execution of the activities, there is likely to be greater assurance of reliable implementation of the defined methods.

(S2) *Considering adequacy of project life cycle and project schedule*: Addresses challenges (C_4), (C_9); we recommend creating a project life cycle and schedule that takes the dependencies between project work packages, especially the dependencies to the RE related work packages into consideration.

(S3) *Focusing on the problem*: Addresses challenge (C_6); creating a shared awareness among the project partners that the project problems are better defined in the RE work package before investigating potential solutions or problem-solution combinations is likely to shift the solution bias to the problem space. We also recommend explicitly providing the rationale used for selecting a solution or a combination of solutions.

(S4) *Appropriate industry involvement in RE*: Addresses challenges (C_5) and (C_7); this refers to creating an early and shared awareness of the relevance of the industry partners for the success of the RE work package, and including statements of the profiles of the appropriate representatives, corresponding responsibilities, and expected effort. The early planning of the activities they are involved is also expected to be helpful.

(S5) *Alignment of RE and Project Management*: Addresses several challenges, especially (C_1) and (C_9); we recommend that Project Management is strongly involved in the definition and monitoring of the RE activities. There needs to be a clear commitment of the project management to the requirements activities.

(S6) *Creating a glossary of terms*: Early elaboration of a glossary of relevant requirements terms is likely to alleviate challenge (C_3).

(S7) *Synchronization and harmonization*: Addresses challenge (C_8). Inclusion of synchronization and harmonization activities within fixed and recurrent time intervals during the RE activities.

(S8) *Commitment with the requirement specification*: Addresses challenge (C_9). Agreement of all partners on the requirements to be implemented in the intermediate and final research product, and alignment of the requirements specification with the needs from the subsequent work packages).

V. RELATED WORK

Challenges in large and complex projects settings have been also reported by other sources: Konrad and Gall from Siemens Corporate Research present eight RE challenges faced in a large industrial project [1]. The analyzed project had more than 4,000 user requirements; several hundred

distributed components and an existing infrastructure, and needed integration of legacy systems. The eight challenges were: a large number of customer requirements, formal communication with the customer, management of customer expectations after presentation of early prototypes, changing technology, distributed teams, requirements of full bi-directional traceability, scope change and creep, and resource fluctuation. The authors also present lessons learned on how to deal with those challenges.

Bhat et al. [2] from Infosys Technologies present nine RE challenges in the context of offshore outsourcing: conflicting client-vendor goals, low client involvement, conflicting RE approaches, misalignment of client commitment with project goals, disagreements in tool selection, communication issues, disowning responsibility for delays, sign-off on RE documentation without thoroughly understanding the business requirements, and tools misaligned with expectations. Based on a root-cause analysis of those challenges, in [2], the authors derived strategic success factors, which should be achieved by using some proposed RE best practices.

Gorschek et al. [3] discuss RE challenges in three contexts: product lines for global markets, global distributed communication, and research on global RE. In *product lines for global markets* the challenges are: scalability of models, techniques, methods, processes and tools; availability of decision rationale associated with requirements; tool support for tailoring the presentation of the same data according to different views; selection of tool support taking into consideration the actual needs and available options. Concerning *global distributed communication* the challenges are: demand on formal processes and leadership definition; increase of resources needs; realistic use of modeling and formalization; distributed communication; and trust and communication channels between development and customers. Regarding *research on global RE*, the challenges are: shared understanding about distributed development, and need for empirical studies. The authors also mention two main challenges that were pointed out by previous industry experience reports [4], [5], [6]: heterogeneous understanding of requirements and substantial differences in domain understanding and interpretation. Some of these reported RE challenges are likely to also occur in LRP.

VI. SUMMARY AND CONCLUSION

This paper reflects on the RE challenges faced in six publicly funded large research projects where the authors' affiliation was involved in RE activities. For the most relevant RE challenges perceived in these projects, the reasons, potential implications, and possible solutions are discussed; the idea is to provide a sound basis for anticipating and managing challenges in future projects, before their undesired implications threaten project success.

In comparing the results of this paper with related work in the literature (section V), we identified some recurring challenges: challenges (C1) *Unclear RE process definition at the project start*, (C5) *Misaligned partner involvement and expectations*, and (C7) *Missing stakeholders or wrong stakeholders provide requirements* as we identified for LRP,

are similar to the challenges "Conflicting RE approaches", "Misalignment of client commitment with project goals" and "Low client involvement" respectively, as in [2]; whereas (C8) *Distributed development* is similar to the challenge "Distributed teams", as in [1]. We believe that these challenges are of special relevance for the RE community.

Note that we considered a set of eight practices as a first set of possible solutions for the different challenges that we identified; These are promising practices to consider in LRP, for example: (S1) *Early and appropriate definition of an RE process*, (S2) *Considering adequacy of project life cycle and project schedule*, (S4) *Appropriate industry involvement*, and (S8) *Commitment with the requirement specification*.

We believe that these solution proposals are a good starting point, but future work should focus on a systematic derivation of further possible solutions and their evaluation in LRP. We intend to perform more analysis of the dependencies between challenges and impacts, so that we can design solutions that may potentially address several challenges simultaneously. We also intend to provide some specific approaches based on the state of the art that may be used to implement the proposed solutions, when applicable.

With reporting challenges and proposing first solutions, we intend to promote the discussion in the RE community about RE challenges specific for LRP.

To conclude, we believe that it is essential for consortia in charge of executing LRP in the near future to understand that (1) RE challenges can detrimentally impact project success and (2) considering the challenges and proposed solutions identified in this paper are likely to help run projects more effectively and efficiently. We assert that addressing RE challenges in advance and monitoring RE in the project phases are essential activities in LRP, paying special attention to which will be beneficial to project consortia. This comprises agreeing upon and supporting a set of solutions to be adopted in their context so as to prevent the challenges from occurring.

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