**SOLUTIONS**

**Improved Tool Chain**

**Requirements Management and Traceability**

Key elements of a successful project are requirements and, their proper management and traceability. The goal is to ensure that the needs and expectations of the project stakeholders are correctly captured, documented, implemented, verified and validated. Indeed, Wiegers [1] wrote that successful projects depend on a good understanding of the requirements and the implementation of a collaborative partnership between the stakeholders for requirements development and management. Moreover, Kumar [1] stated that ineffective requirement management is one of the main causes of project failure and that requirements issues can lead to design issues that “are more difficult and expensive to resolve” after the project development is well advanced.

**Complete Solution View**

Standard development is a long process that can take many years. This process is constantly evolving and challenged with the emergence of new technologies and the needs of the different actors working on it. Moreover, in the standard development process, requirements come from different sources: each stakeholder has needs to meet using this standard. During the development process, requirements can change according to the evolution of the stakeholders’ needs and new requirements can also be created from feedback on the implemented features for example. Consequently, requirements traceability should be integrated into this process to document the full lifecycle of each requirement, from its origin to its implementation. Thereby, each stakeholder can track the source of each requirement, the changes made to these requirements and link them to the features through which they are satisfied. Tracking requirements allows the stakeholders to know whether a requirement has been successfully implemented or if it needs to be reworked. Moreover, requirements management makes it easier to identify the person (or group of people) who issued a requirement, to get more information about it, but also offers a real-time overview of all the requirements to prioritize them.

The development of STEP began several decades ago and since that time, the stakeholders’ requirements have evolved because of the change of the business needs and the evolution of the information technologies available. In the STEP development process, requirements can be listed in ISO documents, and it happens sometimes that there is no information about the requirement issuer or the objective behind each of them. Thus, in some cases, once the features are implemented, it is almost impossible to get back to the concerned stakeholders to validate their requirements because of the lack of traceability. Besides, in STEP, there are two different types of requirements: technical requirements, which are the requirements about the implementation of the standard, and domain requirements, which are the requirements about the environment in which the standard will be operated, for example, Product Manufacturing Information (PMI), Mechanical and Electrical Wire Harness (EWH).

Additionally, the development of international standards includes many actors, from different countries and organizations. This diversity of stakeholders necessitates efficient tools to make it possible for all of the different actors to work together. Indeed, the stakeholders need to be able to understand the role and the activities of everyone on the project for a good collaboration. In the same way, it can be useful for all members of the WG to know who is working on what and what tasks still need to be done.

Requirements traceability is a roadmap that defines where in the standard development process each requirement was implemented. Traceability can also be used to assess the impact of requirements change and expose dependencies between the requirements. Indeed, on complex projects with multiple parts and different teams working on it like standard development, it can be pretty long and difficult to manually determine what part and who is affected by the change.

**Current Tool availability**

Requirements were traditionally captured in spreadsheets, but the growing importance of requirements management led to the development of dedicated requirements management and traceability tools.

Jira is very popular software in Agile projects. Jira is a tool specialized in bug tracking, issue tracking, and project management, including requirements management. However, tracking requirements will be really difficult with Jira, once they are completed. Indeed, Jira is a task management tool, it is not originally designed to manage requirements. When requirements are completed, they are taken off the backlog, so tracking the completed requirements can easily become a full-time job.

Modern Requirements is a solution that provides a collaborative requirements management platform. This software also offers requirements traceability and impact analysis. Besides, it can be easily integrated with bug issues tools like JIRA and backlog tools like Microsoft TFS.

ReqView is a requirements management tool that allows to capture structured requirements and trace these requirements between requirements elicitation, design, and tests.

**Future Research Needed**

As previously mentioned, SAFe provides methods to help teams in implementing Agile in their projects, including Backlog management and Agile Release Trains. SAFe also offers methods and processes for requirements management such as the SAFe Requirements Model and, Continuously Verify and Validate processes. The SAFe Requirements Model “provides a scalable model that demonstrates a way to express systems behaviors” [3], like features (*user account, notifications, keywords search)*, stories (*As a user, I want to be able to run the software on Windows and on Mac.*), and non-functional requirements (*The software should be reliable in order to be able to resist attacks and handle system errors.*). The Continuously Verify and Validate processes ensure “that the system works as designed and it meets the needs of the user” [4] and these processes are supported by the Requirements Model. However, SAFe Requirements Model is only a conceptual model, which means that you need tools to implement it.

Moreover, while SAFe provides guidelines to implement Agile principles and requirements management, there are still some practises that are missing and need to be integrated such as meetings’ minutes.  By definition, meeting minutes record relevant, important, and critical topics and decisions discussed and agreed upon during meetings (online and face-to-face). These notes, archived and available to the community, helps to ensure that every member of the development process knows what was discussed, decided, and agreed upon. In international standard development, the different actors are generally geographical dispersed, in different timezones, and  working in different teams in parallel, making it challenging for the different actors to keep track of all ongoing activities and decisions made.In this context, these minutes are a key communication, reporting and traceability tool, in order to keep people informed and up to date with the current state of the development process. The STEP development team(s) hosts several international meetings such as the ISO TC184/SC4 or PDES workshops during which the different stakeholders meet face-to-face to discuss past, current, and future developments.  These meetings are held twice a year and STEP experts cannot always participate to all the international meetings. Meetings minutes are taken during both the ISO and PDES meetings, and they are shared with the participants, often by emails. These minutes are not necessarily very detailed and easily accessible by all the STEP community. Moreover, the meeting minutes are not written according to a formal template. Therefore, implementing a formal model for taking minutes would make it possible to link the decisions and the actions taken during the meetings to the tasks or bugs in Jira. This formal model should also facilitate the understanding of the conduct of the meeting for the people unable to attend.

Furthermore, integrating Agile principles with requirements and minutes management into the standard development process requires the use of multiple tools on top of the many different tools used to develop, implement, and maintain an information standard. Working with all of these different tools and technologies means that the development team needs to ensure that there is a proper integration model in place. Indeed, there is often no formal integration model to ensure perfect interoperability and integration between all of these technologies and tools. In the STEP environment, the tools integration situation is even more complex due to STEP complexity, lifespan, and the use of bespoke tools and technologies. STEP development began decades ago, and its range has expanded a lot over the past few years. With the continuous emergence of new technologies, the tools used for STEP development have changed since its creation. There are two types of integration to implement for STEP: on the one hand, the integration between the old and the current technologies. Regarding the first integration, some legacy data need to be migrated in the technologies currently used. On the other hand, the integration between the tools used to implement STEP and the Agile management tools. The tools chosen to implement the Agile method in the STEP development should be able to easily collaborate with the tools currently used.

Finally, the standard development process is not the same as usual IT projects process. Indeed, the development of a standard relies on the voluntary contributions of the members of the WG. The people and resources available vary, which makes the development process more irregular than in standard Agile projects, in which the development team is dedicated to the project full-time. Besides, standard experts are geographically dispersed and with the time difference, everybody is working according to their time zones, which can make it difficult to adopt some of the Agile practices. Without a full-time development team, the Agile sprint can’t be as regular and intense as normal Agile projects sprints, which means that in the case of the standards development, there are challenges that we still need to work on to ensure that the Agile method can meet all their needs and constraints.

[1] Wiegers, K. (2000). Karl Wiegers Describes 10 Requirements Traps to Avoid. Software Testing & Quality Engineering Journal, January/February

[2] Kumar, V. S. (2006). Effective requirements management. Paper presented at PMI Global Congress 2006—EMEA, Madrid, Spain.   
[3] <https://www.scaledagileframework.com/safe-requirements-model>

[4] [https://www.scaledagileframework.com/compliance](https://www.scaledagileframework.com/compliance/)