ABSTRACT
Driven by the urge to be more flexible, quicker and still have high quality, large-scale companies managing safety-critical systems are transitioning to agile development methodologies in their day-to-day software and systems development practices. Due to the standards and regulations requirements of the safety-critical systems development, full adoption of agile methods is not viable. Also the requirements engineering process, which is critical for successful development of safety-critical systems, is seen as anti-agile due to heavy upfront analysis. Thus, the use of hybrid approaches is the common practice. However, the overall picture of safety-critical systems development (especially in terms in communication and documentation) within such hybrid, agile, or other continuous software development environments is missing. This work describes a research agenda to address this challenge. The work proposes a series of empirical studies to discover the information needs and related knowledge, pertinent to product development. We expect to make a contribution by establishing guidelines and frameworks that can be used to make requirements engineering a foundation for agile systems development, while providing empirical evidence of the use of agile methods in safety-critical development.

CCS Concepts
• Software and its engineering → Software development process management; Agile software development; Software post-development issues; • Hardware → Safety critical systems;

Keywords
safety-critical Systems; requirements engineering; agile development

1. INTRODUCTION
Due to increasing competition, evolving requirements and changing market demands [5], large-scale systems development companies, with stage-gate processes, are adopting agile methods [11, 4], which were meant for small-scale companies [7]. Safety concerns are managed well in such stage-gate processes, but it is unclear, how they can be dealt with in more agile approaches.

A system is considered “safety-critical” if it can either cause harm or is responsible for preventing harm [1]. These systems range from automotive braking, nuclear power plant control, medical devices to avionic flight management systems. A substantial amount of papers [2, 1, 5, 6, 10] have reported that agile methods are beneficial for the development of safety-critical systems. These systems are subject to regulations and standards which provide objectives to be met by the software development process used depending on the domain of application.

We started this research with an exploratory study [8], conducted in large-scale companies using agile development methods, to discover the requirements related challenges faced. This study identified many challenges that could impede the successful adoption of agile methods; dealing with safety-critical systems development is one of the challenges. Considering the research done on requirements engineering in regards to the identified challenges, the application of agile development to safety-critical systems development is still challenging practitioners [2]. There is however, few works on safety-critical development in the agile context or hybrid environment addressing especially the communication and knowledge management challenge [8, 9]. This study aims to cover that gap by providing empirical evidence on the implementation challenges and solutions.

This study aims to identify the information needs and related knowledge through the use of workshops, focus groups and interviews with practitioners. We aim to answer the following research questions:

RQ1: How can the RE process be defined to support the proper development of safety-critical systems in an agile development environment?

RQ1.a: What practices can be used to manage the requirements communication without compromising the agile...
structure?

RQ1.b: What processes ensure that all stakeholders get the same understanding of the requirements in order to deliver value?

2. METHODOLOGY

This study is inspired by design science research methodology and the regulative cycle [12], which proposes the following phases: Problem identification, design proposal and validation, implementation and evaluation. For the problem identification phase, we did a multi-case exploratory study with four cases: two automotive companies, one technology company and one telecommunications company, all of which are considered large-scale companies and based in Sweden. We collected data using focus groups, interviews and workshops [8]. The current research is in the design proposal and validation phase where we are using workshops, focus groups and an extended literature search to confirm the challenges identified and also verify if there have been any proposed solutions for them. This is being done as we also explore the challenges particular to safety-critical systems development in an agile environment. Depending on the results received, we shall present a draft topic map to companies in workshops, discuss their experience and see whether the map is useful and then uncover frameworks or methods that can be used for redefining the RE process to support the proper development of safety-critical systems in an agile development environment. A software development team would then have to be obtained to implement the proposed framework so that we can then evaluate and see if the problems have been addressed and which ones new problems could be there.

3. CONCLUSIONS

Our exploratory research so far is part of a research agenda with the aim to better support agile development of safety critical systems based on new approaches to requirements engineering. Findings so far raise important questions with respect to engineering complex systems, including:

- How do the product owners ascertain that the developed product still meets the desired standards even with quickly evolving requirements?
- How is shared understanding of safety-critical concepts (value) achieved in a large-scale agile development environment (from a requirements engineering context)?

My aim is to explore and understand these concepts so that I can devise guidelines or a framework to support safety-critical systems development in an agile environment. The fact that my research studies involve large-scale organisations with complex systems in which large teams develop software and data is exchanged in the process, knowledge from the course will enable me to understand how data is handled in such complex organisations and how this impacts on software engineering. I have read some works on data-driven decision making e.g. [3] that caught my attention and I believe that at this doctoral school on Engineering Complex Systems and IT, I can gain more knowledge to accomplish my goal as I explore some other domains like data science and big-data for handling or managing requirements. Its multi-disciplinary nature will help me find a way to use the knowledge obtained to draft an easier way forward.

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5. REFERENCES