The market of software systems is highly volatile and competitive. Software organizations are faced with changes from different sources, such as, customers, suppliers, technology, regulators, and competitors. To maintain their competitive advantage, software organizations need to be able to react to changes in their environment. The ability to change or react to environmental changes with little time, cost, and effort is known as flexibility (DeToni and Tonchia, 1998).

There are known approaches with respect to flexibility in software organizations, such as Agile and Lean methodologies. Agile methodologies advocate welcoming changes at any stage of the development. In the similar vein, Lean methods encourage to decide as late as possible, where decisions are made until more facts are available. However, there are contexts where Agile and Lean methods are not applicable (Vogel, 2006). For instance, in the domain of medical devices in the United States, it is impossible to adopt incremental deliveries. The Food and Drug Administration or FDA regulation forbids testing intermediate versions of the software with the potential users. Also, Agile and Lean methods are currently implemented at project level. Their applicability to achieve flexibility at organizational level is not yet implemented and evaluated.

There is a need to understand the challenges that a software organization faces pertaining to flexibility. Better understanding of the challenges can lead to better formulation of solutions that fit the needs of the software organization.

The aim of this research is to understand the challenges that a software organization faces with respect to flexibility and how flexibility is achieved, and to explore the potential of Agile and Lean practices to build software organization flexibility.

To achieve the aim of the research, a grounded theory study\(^1\) and a tertiary literature review\(^2\) were performed. A grounded theory study was performed to get a better understanding of challenges that were faced pertaining to flexibility, and courses of action that were taken to address such challenges. In the

\(^1\) An inductive research approach for collecting and analyzing qualitative data to construct theories from the data (Charmaz, 2014)

\(^2\) A systematic review of systematic reviews (Kitchenham and Charters, 2007)
grounded theory, the data were collected through interviews with managers of an IT Department that services a financial institution. Apart from interviews, project documentations and lessons learned were also collected. A tertiary literature review was performed to identify the impacts of Agile and Lean practices, and examine the extent of empirical support.

The grounded theory study revealed that a software organization faces not only changes in customers’ requests, but also changes in regulations and development budget. The grounded theory study also revealed that flexibility for a software organization is not about being able to constantly change the organization constituents in the face of uncertainty. However, flexibility is about being able to change the organization constituents into a state that allows the software organization to withstand uncertainty. Furthermore, the data shows that there are three main transitional stages as a software organization build its flexibility, as shown in Figure 1.

The tertiary literature review identified 13 Agile and Lean practices and their impacts on project constraints, such as, quality, budget, schedule, scope, risk, and communication. The impacts (positive, negative, or no impact) of each Agile and Lean practice on project constraints and the empirical support were examined.
The tertiary literature review shows that many secondary studies\(^3\) reported the impacts of Test Driven Development (TDD). The secondary studies reported that TDD showed positive impact on external quality. However, TDD showed negative impact on productivity. This shows that there are trade-offs that are associated with implementing a particular Agile and Lean practice. The tertiary literature review also revealed that secondary studies with clear synthesis methods can yield results that are different from secondary studies with unclear synthesis method.

Based on the findings of this research, we can conclude:

- Flexibility is not about quickly making changes to the organization constituents, but it is about structuring the organization constituents to withstand uncertainty.
- The main challenge in building flexibility is to predict the trade-offs associated with the flexibility building action.
- Key events that take place as a software organization build its flexibility:
  - Emerging uncertainty and need for flexibility.
  - Build flexibility.
  - Achieved flexibility and trade-offs.
- Each Agile and Lean practice has its benefits as well as associated trade-offs.
- There are a large number of empirical studies that studied the impact of TDD on quality. For the remaining practices, there were fewer empirical studies reported by the secondary studies.

**References**


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\(^3\) A study that reviews all the primary studies relating to a specific research question with the aim of integrating/synthesizing evidence related to a specific research question (Kitchenham and Charters, 2007).