Requirements Engineering in Healthcare: Lessons Learned from Practice

Dr. Malak Baslyman

Information and Computer Science
King Fahd University of Petroleum & Minerals
Dhahran, Saudi Arabia
malak.baslyman@kfupm.edu.sa

About me

- **Work experience:**
  - Software Engineer, The Ottawa Hospital, Canada (2013 - 2015)
  - Requirements Analyst , Montfort Hospital, Canada (2016)
  - IT and Healthcare Transformation Consultant (2017 - present)
  - Assistant Professor, ICS, KFUPM (2019 - present)
- **Research work:** Requirements Engineering, Goal/Process alignment, User Experience Engineering, Emotional-lead modeling and analysis, and Healthcare Informatics.

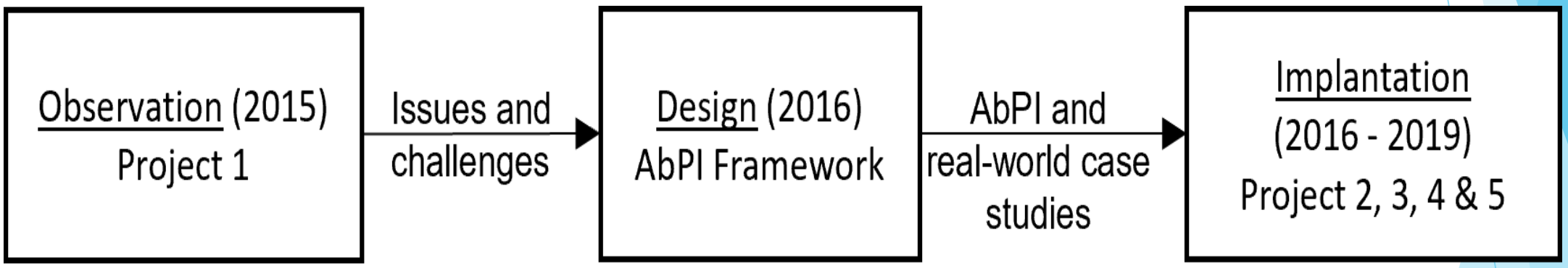
Introduction

- Healthcare systems are facing grand challenges in improving current processes and meeting the high demand on resources while maximizing the quality of delivered services.
- Although technology is a key enabler of improvement, it still fails, in healthcare, due to several reasons, such as poor acceptance by users/physicians, disturbance to existing practices, and lack of comprehensive analysis prior to the implementation of solutions.
- Hence, this study attempted to investigate the effectiveness of some Requirement Engineering (RE) methods, such as goal-oriented and process modeling, in capturing the context of a process under improvement, collecting requirements, and analyzing multiple views and conflicting opinions to support decision-making in healthcare.

Research contribution

- Report on lessons learned while practicing Requirements Engineering (RE), over five years, in five healthcare projects.
  - Started by exploring RE practices in real-world cases (in one project), then applying advanced RE-based methods to integrate technology effectively into current processes (in three projects).

Study plan


Observation (2015)
Project 1
Issues and challenges
Design (2016)
AbPI Framework
AbPI and real-world case studies
Implantation
(2016 - 2019)
Project 2, 3, 4 & 5

Background: User Requirement Notation (URN)

- URN is the first standardized modeling language that supports requirements engineering activities in a graphical representation way
- It provides two complementary sub-languages that are Goal-oriented Requirement Language (GRL) and Use Case Maps (UCM)
- GRL has the capabilities of capturing and modeling stakeholders and their intentional elements such as goals and tasks in addition to their relationships such as decomposition and contribution.
- UCM is a causal graphical representation of functional requirements and system behavior that consists of start and end points, responsibilities (activities), directions and conditions to guard the transition from one responsibility to another.

Background: Activity-based Process Integration (AbPI)

- The AbPI is a RE-based analysis framework that provides technology integration alternatives into current processes.
- It also provides a holistic and comprehensive analysis of the impact those alternatives have on stakeholder needs and practices, long-term values, and healthcare urgent needs.
- The AbPI takes the goal models and the process models of the context under improvement and the new technology to be integrated as inputs.
- Then, it applies to the main methods: the integration and the evaluation where the aim is to provide a flexible integration and the best integration alternatives.
- The AbPI profiled URN to model and analyze the integration context.

Project 1: Technology selection

- The project was about selecting the most appropriate technology for physicians to communicate through.
- It was led by the IT department.
- The tasks of the projects were to meet physicians, identify the communication issues, gather their requirements and needs, and map them to a set of off-the-shelf technologies.

Lessons Learned

- Requirement analysis:
  - collecting requirements started after preparing the business case
  - The functional requirements were collected from some physicians
  - little work was done to gather and analyze requirements
  - there was a paucity in considering non-functional requirements
- Premature solutions:
  - the main issue was the premature discussions of solutions before identifying current problems and user needs.
  - the lack of an achievable vision, long-term values, and convincing reasons for new changes
- Flexible integration: in a critical environment, such as healthcare, where lives are saved, it is not feasible to impose changes on physicians and obligate them to use certain technology as it may cause delay or deterioration of the quality of provided services.

Project 2, 3 & 4: Technology selection

- The AbPI framework was applied in three projects: two in Canadian hospitals and one in a Saudi hospital (2016-2018).
- The three projects were about emerging technologies to automate existing processes: patient information documentation, real-time tracking of lab samples, and real-time waiting estimation systems.
- Two projects were led by the Security and Privacy Office, and one by the Quality and Patient Safety Department.
- The tasks were to model goals and processes of different stakeholders, design integration alternatives, and recommend the best integration alternative.

Lessons Learned

- Tool support: it is challenging to use current RE tools in industry.
- Context-specific goals: current goal-modeling methods, such as GRL, cannot represent accurately healthcare-specific goals such as log-term values.
- Conflicting opinions of stakeholders: GRL does not give the flexibility to model the conflicting opinions of the same stakeholder (actor) in one model, which happens always in healthcare.
- Scalability and effort: URN models may not scale well at modeling, analyzing, and maintaining multiple large processes across the organization or across organizations. Also, a considerable amount of time was spent to collect data and build the models
- Usability: Healthcare providers described GRL to be a powerful analysis method; however, GRL also was considered complicated and difficult to use.

Project 5: Context Modeling and System Design

- In a Canadian hospital, a department that was responsible for managing research projects was facing issues of
  - monitoring the projects after the funding was granted,
  - unifying the process for receiving and approving those projects, and
  - dealing with a high workload for staff.
- We applied the AbPI framework partially to solve existing problems.
  - First, we attempted to analyze the problem
  - Then, we prepared the input of the AbPI that are the goal and the process models.
  - Following that, design thinking sessions were conducted, which resulted in the design and features of the system
  - The evaluation method of the AbPI was used to select the best system design alternative that achieves the indented outcomes

Lessons learned

- Visualization:
  - The UCM model helped in visualizing the main obstacles in the process that prevented them from achieving their goals.
  - It was to the base point to agree and disagree on the processes' definitions and roles. In addition, the UCM model became the first source in which the process was defined completely and formally.
- Goal model evaluation:
  - The team believes that GRL reflected how far they were from achieving their goals and how likely the new solution may satisfy the goals.
  - GRL helped them to focus on points of improvement rather than guessing what to be improved and why.
- Tool support: some comments were left also on jUCMNav; they found it effective and very useful throughout the project

Conclusion

- In this paper, it was shown that RE methods were used effectively in five healthcare-related projects and brought real and tangible positive results.
- The discussed lessons learned also showed that it is essential for both researchers and practitioners to continue investigating the applicability of requirements engineering practices in healthcare
- URN-GRL is perceived as powerful at analysis while URN-UCM is easy to understand and follow. However, they need to be customized to healthcare needs and to use healthcare vocabulary