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NITTE MEENAKSHI INSTITUTE OF TECHNOLOGY

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SOFTWARE ENGINEERING

Report on,

Software Engineering in Health Care

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1.ABSTRACT

Over the last several years, software engineering (SE) has given birth to several communities and venues related to research on SE in the context of health care systems. By and large, the interest in this topic has been spurred by alarming failures of software-intensive systems that have been deployed to address some of the challenges faced in current health care environments.

Today, the software engineering in health care (SEHC) community faces several challenges. It needs to justify the significance of its existence towards the general SE community and towards the medical / health informatics community. The purpose of this paper is to explore some of the fundamental challenges pertaining to SEHC, to consider whether these challenges require a dedicated community-based effort and to generate recommendations on how to strengthen its impact. We argue that the community should adopt a conceptual model of knowledge translation (KT) analogous those used in the medical domain to position its research and maximize its impact.

2. INTRODUCTION

Software is playing an increasingly important role in health care, taking over evermore-critical functions with the goal of increasing quality of care to patients/populations at reduced cost. Health care has long been recognized as an information and knowledge intense industry; the use of information and communication technologies (ICT) has given birth to a distinct area of studies, health information science (or health informatics).

Today, health informatics is an established discipline with educational programs, professional associations as well as recognized research venues. Still, there are a growing number of concerns about the quality of the software systems developed for health care.

Medical informatics is commonly understood as a science, not an engineering discipline. Stakeholders are demanding dependable ("engineering-based") approaches to the design, construction and maintenance of health care software, beyond information science.

3.MOTIVATION

- Finding ways to provide sustainable access to quality healthcare in the light of aging populations and increasing treatment costs is one of the most significant challenges for countries around the world.

- Software engineering for healthcare systems is an emerging field for software developers and IT specialists.

- Software engineering methodologies are being used in healthcare the same way used in other industries.

- The nature of systems and industry such as healthcare systems should be considered in thesoftware-development methodology.

- A healthcare system has properties and features that need to be addressed, as they are different from other systems.

4.UNMET NEEDS FROM A HEALTHCARE/POLICY PERSPECTIVE

A. Subjectivity of Patients and Care Providers

Patients do not tend to read medical textbooks. Their symptoms are subjective and often described differently. For example, angina in women is not uncommonly described without the classic symptom of chest pain. There is an art in translating symptom descriptions and teasing out relevant historical details. Diagnosis is often as much craft as science. There are few signs and symptoms in an encounter that are pathognomonic for a condition. Even laboratory, imaging, and other diagnostic tests have room for interpretation. Despite a growing knowledge base of medical evidence, interpretation of complex subjective data is unavoidable. Simple rule-based tools have the ability to support decision-making, but these are often limited in their application.

B. Localized Practices

Healthcare is still in many ways a cottage industry , a very large, complex web of interconnecting, relatively autonomous, skilled crafts-people. Physicians, in particular, are experts with considerable autonomy in diagnosing, treating, documenting, and defining the processes of care. While practice standards and guidelines exist, they are applied or upheld very differently. Autonomy occurs on multiple levels: jurisdictions, regions, hospitals, clinics, and (care) providers all often have unique procedures and processes.

5. SOFTWARE ENGINEERINGIN HEALTH CARE NEEDS "KNOWLEDGE TRANSLATION"

Knowledge translation (KT) is an established term in the medical sciences. It refers to the iterative process of selecting and contextualizing (adapting) basic research results, synthesizing and deploying solutions leveraging these results and evaluating their effectiveness in order to inform the next iteration of the KT research cycle .

The term KT is less established in SE, but similar notions have started to emerge from groups focusing on empirical SE. KT is research. There is general consensus about this fact in the medical domain, and significant funding programs are dedicated specifically to it. In contrast, KT is less established in SE; it lacks comparable recognition in the research arena and by funding organizations.

We suggest that research in SEHC must be seen as KT, translating results from general SE research to the application context of health care – and in turn stimulating basic SE research based on observations made in the health care domain. Of course, it is arguable that KT may be required for other industry sectors. However, we assert that the need for SEHC KT is significantly higher than for other, more traditional application domains. Section II has already provided some arguments for this claim. The rest of this section adds further reasons (from a SE perspective) why current SE knowledge cannot readily be applied, but instead requires "translation".

6. HOW TO INCREASE IMPACT

We have argued that there is a genuine need for research on software engineering in health care; but how can we focus our efforts to have impact? We argue that SEHC requires a significant amount of KT research in order to be effective.

A. Adopt a KT Model

If SEHC research is a form of KT, it must respond to at least one of the following objectives: (1) it should contribute to translating general software engineering research results to health care (following a KT process), or; (2) it should generate research on how to conduct KT processes in the SEHC context. Adopting a KT model in SEHC research will focus the community on aspects of contextualization and adaptation of software engineering methods, tools and techniques rather than on their mere application. The adoption and research-driven refinement of a KT model for SEHC will also increase recognition within the research and funding communities. We propose such a model in Figure 1. Its cycle involves activities related to the identification of problems (in the medical domain), the adaptation of (software engineering) knowledge to the local (medical) context, the assessment of barriers to using this knowledge, the selection and implementation of interventions to overcome these barriers, the monitoring of the usage of that knowledge and evaluation of outcomes, and any actions fostering the sustained use of that knowledge.

B. Benchmark Case Studies

The SEHC community is interdisciplinary, involving members from healthcare (the "problem domain") as well as members from engineering (the "solution domain"). Effective KT requires close collaboration between these groups. Due to the sensitive and critical nature of health care,both camps find it difficult to "try out" new ideas. Even if SE concepts are evaluated in context of a real health care problem, it is often difficult to compare the results against alternative approaches. Benchmark case studies can provide an effective vehicle for facilitating this interdisciplinary collaboration.

They provide health care researchers a means of "lifting" real world problems to a level that makes them accessible to the SE community. Engineers can use these benchmarks to contextualize, evaluate, compare and adapt their approaches. The construction of realistic benchmarks for SEHC research is difficult and must be considered SEHC research itself (following objective 2 in the previous subsection).

The SEHC community should actively solicit, curate and refine benchmarks in order to facilitate KT and measure progress.

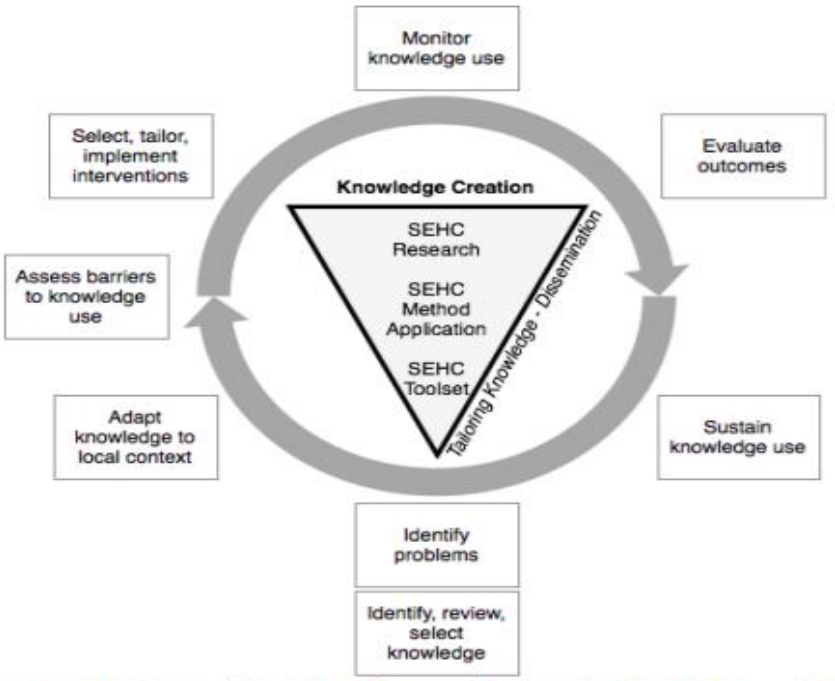

Figure 1: SEHC Knowledge Translation model, based on CIHR's *Knowledge To Action* model.

One example for a benchmark case study is the Pacemaker Formal Methods Challenge developed at McMaster University with support of Boston Scientific and other collaborators.

7. CONCLUSION

Finding ways to provide sustainable access to quality healthcare in the light of aging populations and increasing treatment costs is one of the most significant challenges for countries around the world.

Software systems have the strong potential to be a key enabling technology in addressing this challenge. However, they also have much potential for harm on an individual as well as systemic level.

The current and ongoing quality problems with health care software have led to calls to a more “engineering-based” approach to the construction and maintenance of healthcare software.

However, many of the software engineering processes, methods and tools developed for other domains cannot be readily transferred to health care due to the unique characteristics of that domain. We argue that in order to focus its efforts and increase its impact, the SEHC domain should explicitly orient is research along a KT model, analogous to the medical sciences.

Benchmark case studies provide an effective means for facilitating collaboration between domain experts and software engineering researchers.

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