Chapter 19
Application of Unified Modelling Language (UML) to the Modelling of Health Care Systems:
An Introduction and Literature Survey

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ABSTRACT

The unified modelling language (UML) comprises a set of tools for documenting the analysis of a system. Although UML is generally used to describe and evaluate the functioning of complex systems, the extent of its application to the health care domain is unknown. The purpose of this article is to survey the literature on the application of UML tools to the analysis and modelling of health care systems. We first introduce four of the most common UML diagrammatic tools, namely use case, activity, state, and class diagrams. We use a simplified surgical care service as an example to illustrate the concepts and notation of each diagrammatic tool. We then present the results of the literature survey on the application of UML tools in health care. The survey revealed that although UML tools have been employed in modelling different aspects of health care systems, there is little systematic evidence of the benefits.

INTRODUCTION

Health care systems are known to be complex and, as a result, difficult to analyse and re-engineer (Berwick, 2005). Health system engineers often rely on computer modelling and simulation to assist with the analysis of existing systems and the pretesting of suggested changes. To this extend, a variety of software engineering techniques and tools have been employed (Jun, 2007). Examples include data flow diagram (Pohjonen et al., 1994), state transition diagram (Mehta, Haluck, Frecker, & Snyder, 2002), entity relationship diagram (Kalli et al., 1992), integrated definition or IDEF (Hoffman, 1997), and more recently, Unified Modelling Language, commonly known as UML (Object Management Group, 2005).

UML provides a comprehensive set of tools that can be used for documenting the analysis of a system and for developing model requirements. UML diagrams are graphical depictions that demonstrate the flow of events within the system (Object Management Group, 2005). Depending on the perspective chosen for the study (e.g., actor oriented, activity oriented), different tools are available to the analyst. Due to its versatility and the ability to analyse systems from different perspectives, UML is said to be effective in describing and evaluating the functioning of complex systems such as health care (Kumarapeli, De Lusignan, Ellis, & Jones, 2007). However, there seems to be very little systematic evidence on its benefits.

The focus of the article is to review the literature on the application of UML tools to the analysis and modelling of health care systems. To this end, we first briefly introduce four of the most common UML diagrammatic tools, namely use case, activity, state, and class diagrams. We use a simplified surgical care service as an example to illustrate the notation and concepts of each diagrammatic tool. Next, we present the results of the literature survey on the application of UML in health. The survey revealed that studies of the benefits of UML to health evaluation are an exception and most studies have used UML without an evaluative component. We conclude with a brief discussion of the results.

UML DIAGRAMMATIC TOOLS

UML 2.0 has 13 types of diagrams, which can be categorised hierarchically as follows (Object Management Group, 2005):

- Structure diagrams used to represent the elements of the system being modelled. They include class, component, composite structure, deployment, object, and package diagrams.
- Behaviour diagrams that allow the representation of what happens in the modelled system in the activity, state, and use case diagrams.
- Interaction diagrams, a subset of behaviour diagrams, that allow the representation of the control and data flow among the elements of the system being modelled. These are communication, interaction overview, sequence, and timing diagrams.

We briefly introduce here the four UML diagrammatic tools that appear in the surveyed literature, namely, use cases and use case diagram, activity, state, and class diagram. A full description of the concepts and syntax of UML diagrams is beyond the scope of this article. A plethora of user guides and technical notes are available on the subject, with the monograph by Ambler (2004) a particularly useful introduction.

We illustrate the basic concepts and notation of each diagrammatic tool by presenting simple models of a simplified care process of surgical consultation with a patient in an outpatient clinic. In general, physicians refer patients for surgical consultation if they believe the underlying health problem is amenable to surgical intervention. Following the referral, the outpatient clinic books