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Combining patient journey modelling and visual multi-agent computer simulation: A framework to improving knowledge translation in a healthcare environment

Joanne CURRY [a], Anneke FITZGERALD [b], Ante PRODAN [a], Ann DADICH [a] and Terry SLOAN [a]
[a] *University of Western Sydney, New South Wales, Australia*
[b] *Griffith University, Queensland, Australia*

Abstract. This article focuses on a framework that will investigate the integration of two disparate methodologies: patient journey modelling and visual multi-agent simulation, and its impact on the speed and quality of knowledge translation to healthcare stakeholders. Literature describes patient journey modelling and visual simulation as discrete activities. This paper suggests that their combination and their impact on translating knowledge to practitioners are greater than the sum of the two technologies. The test-bed is ambulatory care and the goal is to determine if this approach can improve health services delivery, workflow, and patient outcomes and satisfaction. The multidisciplinary research team is comprised of expertise in patient journey modelling, simulation, and knowledge translation.

Keywords. Patient journey modelling, computer simulation, knowledge translation, healthcare management, healthcare quality

1. Background

Most Australians have contact with the public health system – improving healthcare services and access to these services, is therefore important. Despite many attempts to solve the persistent problem of increasing patient wait-times, no firm solution has emerged. This presents an opportunity to trial an innovative approach to an intractable problem. One such approach is the combination of two disparate methodologies – patient journey modelling and visual multi-agent computer simulation. This paper suggests that this combination has the potential to facilitate knowledge translation – this encompasses practitioner buy-in, problem-ownership, and the use of viable strategies to improve processes, and ultimately, patient experience. This approach is based on the premise that clinicians, managers and administrators require a comprehensive and deep understanding of the context, to generate and sustain change. This is exemplified in an ambulatory care department.

Ambulatory care departments, also known as outpatients department or specialist clinics, provide medical care, allied health and diagnostic services to people who are able to reside in the community. In Australia, 'the number of non-admitted patient occasions of service provided by Public acute hospitals increased by 3.5% per annum between 2004-05 and 2008-09' (1). However, Australian public hospitals have limited capacity to meet this demand. The limited capacity is evidenced by ambulatory care wait-times. Although data are limited, a survey of major health services in Victoria indicates that the median times to first appointment in these departments are 5-9 days for urgent patients (range: 0-41 days), 14-34 days for semi-urgent patients (range: 0-182 days), and 15-165 days for non-urgent (or routine) patients (range: 0-912 days) (2). Such demand on heavily burdened health services has contributed to the 'current crisis in the… public hospital system' (3).

Delayed access to ambulatory care services represents a significant issue. This is because of the pivotal role they hold in the community. Given their broad role, ambulatory care departments are well-utilised. Of the 42 million non-admitted services provided in 2008-09 (excluding emergency services), 16.5 million were delivered in specialist ambulatory care clinics – notably, medical / surgical / obstetric, allied health, and dental services (1). The community need for ambulatory care departments is further demonstrated in NSW. In 2008-09, public acute hospitals in this state provided over 6.5 million outpatient occasions of service, an increase from approximately 6.4 million in the previous 12-month period (4). These reports indicate that patient wait-time is a nationwide ongoing issue.

To improve the delivery of health services and, as such, patient experience, this paper proposes an innovative approach that integrates three disparate fields – patient journey modelling, visual multi-agent simulation and knowledge translation. This requires a multidisciplinary team comprised of representation from management, computing, and medicine. This approach has the potential to increase the speed and quality of knowledge translation to hospital personnel by increasing buy-in to, support for, and use of changed processes. As a deviation from conventional practices, this represents a radical approach to address a systemic issue. To demonstrate its potential value, this conceptual paper describes the application of the approach to an ambulatory care department. Prior to this, the three key concepts are reviewed for clarity.

1.1. Patient Journey Modelling

Originating from the field of process modeling within the business process reengineering domain, patient journey modeling is being used in a growing number of healthcare improvement projects with encouraging results (5-9). Typically patient journey modeling (PJM) depicts patient movement within and across healthcare providers by graphically displaying interactions between patients and healthcare providers. Each time a patient interacts with healthcare staff or is moved, the interaction is tracked and described. The goal is to collect required information only once, reduce the number of times the patient is moved, increase compliance to evidence-based best practice, eliminate excessive activities, remove duplicate communication and provide clear and concise information to the patient.

This framework uses an emerging patient journey modeling tool developed specifically for the health sector which encompasses additional dimensions other approaches, such as Lean and Six Sigma have ignored (6, 10). These include patient needs, evidence-based clinical practice, complex multiple-path process flows, discontinuities of care and care handovers along with comprehensive metric collection.

Adding to its appeal, particularly to healthcare stakeholders, the tool known as Essomenic (used under the name PaJMa in Canada) is highly graphical and colour coded, making it easy to comprehend by both clinical and non-clinical staff alike.

Essomenic has been incorporated into a number of successful healthcare improvement projects in the areas of midwifery, chronic kidney disease, mental health, oncology, ambulatory care, lymphoma and osteoarthritis (11-13).

Outputs from the Essomenic models provide the current state process flow inputs and associated data points for the development of the visual multi-agent computer simulation models.

1.2. Visual Multi-Agent Computer Simulation

Given the ethical, financial, and practical challenges of testing alternative service delivery strategies in hospital departments, visual modeling and simulation have become an increasingly attractive option (14). Computer simulation is used to represent the flow of patients and their associated information through a system to identify and test alternative processes that are viable, effective and/or efficient, leading to models that are tractable and useful. This has specific relevance to hospitals as trialing alternative approaches in real-time can be risky – it can risk patient wellbeing, the effective use of limited hospital resources, and the efficient allocation of public funds.

This framework employs visual discrete-event simulation. Discrete-event or event-driven simulation is a process-oriented, middle-out approach. The models consist of passive entities that pass through a sequence of events. Characteristics of systems that are candidates to be modeled using this approach include: activities, queues, delays, and process, seize and release of resources. Australian researchers have applied visual event-based computer simulation to represent and modify departmental processes in a hospital sonography department within a virtual environment. Resultant patient throughput increased by 25%. (9). This study also affirmed the importance of the engagement of clinical staff who are closest to the patients. Their participation at every stage of the process can increase their support for, and adoption of change. Literature describes patient journey modelling and visual simulation as discrete activities (5, 6, 15-18). This paper argues that their combination and resultant synergy can facilitate enhanced knowledge translation. Furthermore, we propose to use the Essomenic patient journey models as the template to assign properties to agents (entities) and define actions they undertake. In this way setup and alterations of the behaviour of the simulated entities can be done in a more intuitive, visual way. This in turn can increase participant engagement, facilitate and promote stakeholder "buy-in" as well as accelerate and enhance knowledge translation outcomes.

1.3. Knowledge Translation

Knowledge translation holds a pivotal role in the health sector (19) – it aims to improve public health by bridging the 'chasm' between research and practice. Knowledge translation involves close collaboration between those who generate knowledge and those who use it. More specifically, it involves 'the exchange, synthesis and ethically-sound application of knowledge – within a complex system of interactions among researchers and users – to accelerate the capture of the benefits of research… through improved health, more effective services and products, and a strengthened healthcare system' (20).

There are several frameworks that can be used to assist with the translation of new knowledge into practice. Most models follow a similar conceptual approach:

a) problem identification;

b) source and validate evidence relevant to the problem;

c) determine and implement agreed intervention; d) evaluate modified practices.

The combination of patient journey modelling, visual multi-agent simulation and knowledge translation has the capacity to:

1. build models of both current and future processes;
2. allow alternative processes to be pilot-tested under different conditions before implementation; and
3. facilitate and sustain systemic change.

However, these propositions are yet to be empirically tested. Despite several attempts to improve patient access to hospital services, these have not combined the disparate methodologies of patient journey modelling and visual multi-agent computer simulation, nor investigated the potential impact this approach could have on knowledge translation. This paper addresses this void and exemplifies the approach within an ambulatory care department.

2. Methodology

An approach that amalgamates patient journey modelling, visual multi-agent computer simulation and knowledge translation involves eight interrelated phases with stakeholders – for the purpose of this example, stakeholders here include clinicians, managers, administrators, and researchers. Although unlikely to be linear, the phases are presented as such for clarity.

To ensure a *bona fide* representation, *Phase One* would involve stakeholder workshops for the purposes of developing an Essomenic patient journey model. This phase would culminate with the production of a set of validated visual representations of the current state patient journey.

Phase Two involves identifying relevant measurement criteria (data points) for input to the simulation tool and simulating the current-state of the patient journey. The current-state is required for comparative purposes, following the simulation of changed processes.

Phase Three involves identifying and prioritising opportunities to improve the patient journey into, through and out of the ambulatory care department. Representation of the patient journey in its entirety would enable stakeholders to identify duplicated and/or excessive activities, service bottlenecks, superfluous administration, discontinuities of care, inefficient care handovers, poor guideline adherence, excessive levels of care variability, as well as opportunities to develop evidence-informed policy. This phase would culminate with a comprehensive collection of improvement opportunities, all of which have been prioritised and agreed to by affected stakeholders.

Phase Four involves developing innovative strategies that lead to the realisation of the opportunities for improvement from Phase 3. In workshops with stakeholders we would use the current state patient journey models and prioritised opportunities for improvement as a springboard to brainstorm ways to improve the patient journey. This phase would culminate with an extensive compilation of agreed potential solutions.

Phase Five involves simulating the identified solutions. This would be achieved by identifying the agents and parameters required to simulate each solution from Phase 4. Following each simulation, outcomes data would be captured and analysed. This phase would culminate with a suite of completed simulations with accompanying outcomes data.

Phase Six involves developing of a fully-justified compendium of recommendations. This would require a systematic review of the simulation results including a SWOT analysis (strengths, weaknesses, opportunities and threats), and the development an action plan for each recommended implementation activity. This phase would culminate with a detailed report to management and involved stakeholders.

Phase Seven involves management and stakeholder review of the Phase Six recommendations and receipt of approval to move forward to implementation.

Phase Eight would involve developing future state patient journey models. Following approval, a visual representation of the improved patient journey inclusive of all improvements is developed. Due to the rigour of the preceding phases, each visual model would be based on evidenced-informed processes. This phase would culminate with a complete compilation of graphical future state patient journey models, all of which would also be textually described. These models can be used to disseminate project results; to communicate to, and sustain a streamlined approach among stakeholders; to facilitate continuous improvement within the department when used within regular in-service sessions; and to familiarise new personnel with accepted practices.

3. Proposed Results

This theoretical framework improves the patient journey in a public hospital system by integrating research on patient journey modelling, visual multi-agent simulation and knowledge translation. Patient journey modelling would visually portray patient movement from the patient perspective. The benefits of patient journey modelling include (but are not limited to) reduced variability within the care process, thus increasing patient safety; the improved timeliness of service delivery; improvement in the quality of patient outcomes and experiences; and the incorporation of the multiple dimensions involved in high quality service delivery, including (but not limited to) patient needs and evidence-based clinical practice. Simulation would be used to trial innovative strategies to improve the patient journey – the use of a virtual environment to experiment with these approaches will incur no risk to patients, hospital personnel, or limited hospital resources. Knowledge translation would be used to maximise the immediate and long-term value of this project by:

a) working with hospital personnel to understand and improve the patient journey;
b) representing information in a manner that is visual, interactive and comprehensible; and
c) developing future-state models to translate novel processes to the hospital setting.

4. Conclusion

The methodology presented in this paper has the capacity to provide hospital managers with evidence-based strategies that can improve both work processes and the patient journey in a core part of the acute health system.

The suggested approach would provide stakeholders with a proven and repeatable methodology that can be adapted to other hospital departments, as well as auxiliary healthcare services. Improving work processes and the patient journey within and between hospital departments and additional healthcare services is associated with additional direct benefits. These include improved planning of individual departments and the hospital as a whole; improved allocation of limited resources including wards, beds, personnel, and medical equipment; reduced waste and reduced cost of healthcare services; reduced patient-waiting periods; and improved patient and carer experience with the healthcare system.

In addition, the proposed methodology would improve communication between hospital team members and may help to build consensus particularly when roles, responsibilities and disciplines are diverse. By enabling personnel to observe, identify and learn more about inefficient practices, visual modelling and simulation can facilitate professional development within a safe, risk-free environment.

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