Institution: The University of Warwick

Unit of Assessment: Warwick Business School

Title of case study: SimLean: Using Rapid Simulation Techniques to Facilitate Improvement in Healthcare

1. Summary of the impact (indicative maximum 100 words)

Research conducted at Warwick Business School (WBS), in collaboration with Warwick Medical School and Warwick Manufacturing Group, has provided new models and techniques for understanding and improving hospital processes and has been adopted by four NHS Trusts in England, informing their services and professional practice as well as enabling more efficient decision making. Research findings have been used to develop the SimLean concept, a simulation approach for use in hospitals. SimLean was developed in order to educate healthcare staff about lean principles and has been adopted commercially by the global company Simul8 as a platform for further development. Significantly, this research has also informed the national strategy for service improvement in the NHS.

2. Underpinning research (indicative maximum 500 words)

Simulation refers to the creation of a simplified imitation of a hospital process using hospital data to animate the movement of patients and resources through a system. 'Lean' is best described as a philosophy for continuous improvement, which aims to improve the smoothness of work by steadily eliminating activities that do not add value from the customers' perspective. The Strategic Lean Implementation Methodology (SLIM) project (2008-2011) was developed to consider if and how simulation could work alongside lean methodology to facilitate process improvement in healthcare organisations. Professors Ruth Davies (WBS, 2003-2010) (PI), Zoe Radnor (WBS, 2003-2011), Matthew Cooke (Warwick Medical School) and Dr Neil Davis (Warwick Manufacturing Group) successfully secured an award from the Warwick Innovative Manufacturing Research Centre. Two WBS research fellows were employed to lead the fieldwork: Dr Nicola Burgess and Dr Claire Worthington. In September 2009, Zoe Radnor replaced Ruth Davies as PI and Professor Stewart Robinson (WBS, 1998-2011) joined the project team. The following hospital trusts participated in the project: University Hospitals Coventry and Warwickshire (UHCW), East Lancashire Hospitals NHS Trust (ELHT), Royal Bolton Hospital NHS Foundation Trust (RBH) and St Helens and Knowsley NHS Foundation Trust (SHK).

The initial phase of the research, led by Zoe Radnor and supported by Nicola Burgess, explored whether simulation could provide a way of engaging senior doctors and managers in service improvements that applied lean principles. The distinctiveness of the approach was to involve influential users in the design process by using computer based simulation and deploying real data to map processes in order to facilitate rapid development and modification of the model for immediate effect. The study found that healthcare staff across all levels were attracted to the use of simulation to model a process accurately. Nurses liked the dynamic visualisation of the process using simulation and this gave them a platform to discuss service improvement with senior doctors and managers. Senior doctors were enthused by the potential to modify/redesign the process and rapidly observe the impact of the modification in a computer simulated environment, giving them increased confidence to implement changes. This last finding highlighted the importance of designing models that could be adapted easily and quickly by the practitioner without the need for an expert modeller, representing a radical departure from traditional simulation modelling (Robinson et al, 2012).

The second research phase, led by Stewart Robinson and supported by Nicola Burgess and Claire Worthington, engaged three of the participating hospital trusts in trialling different simulation approaches to support change through 'rapid improvement events' (RIEs). RIEs are part of the lean toolkit and provide a mechanism for making radical changes to current processes and activities within very short timescales. These events emphasise the patient's perspective on the value of processes and engage frontline staff in service redesign. In all the organisations involved in the project RIEs became the main tool for improvement activity. The research team designed a model to 'facilitate' the RIE, allowing participants to input their own data and simulate a process change.

A major output of this project was the creation of 'SimLean', a suite of resources for use by healthcare organizations to support process improvement (see Burgess et al, 2011; Robinson et al,

2012; 2013). The resources, which can be accessed at http://www.simlean.org, include a handbook for practitioners, videos, case studies, and the Simul8 models.

3. References to the research (indicative maximum of six references)

1. Robinson, S. Radnor, Z. Burgess, N. and Worthington, C. (2013), 'Facilitated Modelling with Discrete-Event Simulation: Reality or Myth?', *European Journal Of Operational Research*, Volume 219, Issue 1, Pages 188–197. Peer reviewed journal article.
2. Robinson, S., Radnor, Z., Burgess, N., and Worthington, C. (2012), 'Utilising Simulation in the Implementation of Lean in Healthcare', *European Journal of Operational Research*, Volume 219, Issue 1, Pages 188–197. (ABS: 3) Peer reviewed journal article.
3. Worthington, C., Robinson, S., Burgess, N. and Radnor, Z. (2010), 'Rapid Modelling of Patient Flow in a Health Care Setting: Integrating Simulation with Lean' in *Rapid Modelling and Quick Response: Intersection of Theory and Practice* , Reiner, G.(ed.). Springer, London, Pages 131-142. [Paper accepted into book volume and contributes to a chapter].
4. Burgess, N., Worthington C., Davis, N., Radnor, Z., Robinson, S. and Cooke, M. (2011), *SimLean Healthcare: Handbook*. Available from www.simlean.org ISBN: 978-0-9570823-0-4, published by SimLean Publishing
5. The 4 executive reports can be made available by WBS to the REF panel:
   a) Case Study Report: University Hospitals Coventry & Warwickshire NHS Trust, by Radnor, Z. and Burgess, N. (Dec, 2009)
   b) Case Study Report: East Lancashire Hospitals NHS Trust, by Radnor, Z. and Burgess, N. (Dec, 2009)
   c) Case Study report: Royal Bolton Hospitals Foundation Trust, by Radnor, Z. and Burgess, N. (June, 2010)
   d) Case Study report: St Helens & Knowsley Foundation Trust, by Radnor, Z. and Burgess, N. (Jan, 2011)

Associated grants:

1. Davies, R. (PI at Warwick Business School from April 2008 – August 2009), and Radnor, Z. (PI at Warwick Business School from September 2009 – December 2010); Robinson, S. (CI at Warwick Business School), Cooke, M. (CI at Warwick Medical School) and Davis, N. (CI at Warwick Manufacturing Group). Strategic Lean Implementation Methodology (SLIM), £314,343, R.IBOP.9229 IMRC 60: SLIM

4. Details of the impact (indicative maximum 750 words)

Combining aspects of the Lean toolkit with real-time and credible simulation in a model which is easy to modify and allows lengthy periods of time to be simulated in a few minutes helps clinicians to embrace change. In engaging with frontline nursing staff, service improvement facilitators, senior clinicians, and executive managers at the participating hospital trusts, this research has made four key impacts upon professional practice and healthcare policy:

1. Provided evidence to support the adoption of lean-based resources and new practices in NHS trusts and by health practitioners internationally.
2. Facilitated process improvement and organisational change through real data simulation.
3. Led to development of IT resources to inform and support professional practice.
4. Informed NHS policy debate within the Department of Health.

During January 2009-November 2010, simulation models were developed to facilitate improvement work in three of the hospital trusts with the intention of improving the quality of care in A&E, theatres, radiology, and ophthalmology. The models proved to be a successful method for conveying lean concepts and initiating discussions that led to improvements to established processes which senior staff were often initially reluctant to change. For example, at the start of a RIE at one hospital senior doctors hotly refuted a proposed change to the scheduling of theatre appointments, but by the end of the session they had agreed the change.

Lean implementation was evaluated following exploratory analysis in each of the participating hospital trusts and the analysis was presented to executive members of each hospital trust board. The presentation and accompanying reports were well received and influential.

The research has also helped to influence the professional standards of nurses and improve their

attitude towards process improvement. In one case study at St Helens and Knowsley Hospitals (SHK) ophthalmology clinic (undertaken in November 2010), nursing morale was low owing to workload issues and a lack of engagement in the improvement process. Most patients waited around two hours past their appointment times to be seen by a doctor. Following a computer based simulation modelling of the ophthalmology process by the research team, the nurses identified possible process improvements, which immediately lifted their morale. The improvement facilitator at SHK Hospitals, leading the improvement event where SimLean was trialled, remarked "the simulation was the turning point in the discussion". The suggested changes were modelled over lunch with the resultant process immediately fed back to staff. The model was then used to communicate the changes to middle managers and senior doctors and the changes began to take shape the following day. Three months after the trial of SimLean, the improvement facilitator emailed to confirm that process efficiencies were evidenced by a 10% reduction in patient waiting times. Nursing morale was also improved, and following the intervention the Trust began to implement changes identified by the use of the model, and invested in the training of improvement champions to use simulation alongside lean.

The concept of SimLean was developed as a direct result of the project's exploratory and experimental phases, in collaboration with the four hospital trusts, and launched as an official product in July 2011, via a series of practitioner events titled: 'Lean Healthcare Dissemination Event' held at University Hospitals Coventry and Warwickshire, attracting delegates from across the NHS. Since June 2011 a suite of simulation models and a facilitator handbook has been available for free download from our research web pages (http://www2.warwick.ac.uk/fac/cross_fac/slim). To date, two hundred copies of the handbook have been distributed to practitioners and academics via workshops and conferences. The research still attracts interest from practitioners around the world, most recently (May 2013) from health centres in Canada and Sweden, where recent literature suggests lean healthcare is currently gaining momentum. SimLean was also adopted commercially by the software company Simul8 in 2012 as an addition to their suite of products. As a vehicle for educating practitioners of all levels, the suite of simulation models provides a novel and tested approach to communicating lean principles in relation to organising work (and patients) that may at first appear counter-intuitive to traditional methods, such as the popular practice of 'batching' patients around appointment times.

The project also attracted the attention of the Department of Health, where the project findings have helped the NHS establish a robust approach to service improvements. Professor Matthew Cooke, an official from the Department of Health, states that "The Department of Health [DH] reviewed the NHS's approach to service improvement and the findings of the SLIM project informed this debate (via the National Clinical Director for Urgent and Emergency Care and Jim Easton, then Director of Transformation at the DH) that determined the way forward for service improvement in the new NHS".

5. Sources to corroborate the impact (indicative maximum of 10 references)

Evidence of impact supporting the adoption of lean techniques within NHS Trusts/ organisational practice in UK NHS Hospital Trusts

1. **Head of Improvement, University Hospital Coventry and Warwickshire**. Head of Improvement can testify that the research has had an impact on the organisation in terms of influencing debate amongst professionals regarding process improvement for patient flow in theatres and in A&E.
2. **Director of Strategy and Improvement, Royal Bolton Hospital**. The Director can testify that the research has had an impact on the organisation in terms of influencing debate amongst professionals regarding process improvement for patient flow in the Assessment and Observation unit for children's A&E and along the Radiology pathway, and influencing the redesign of processes in the assessment and observation unit and in Radiology.

Evidence of research facilitating process improvement and organisational change

3. **Resource Planning Manager, St Helens and Knowsley NHS.** The manager can testify that the research has had an impact on the organisation in terms of influencing debate amongst professionals regarding process improvement in SHK Ophthalmology and influenced the redesign of processes to improve patient flow and nursing morale. He can also confirm the adoption of simulation software (and training) to support the use of simulation modelling for service improvement activity.

Evidence of SimLean concept and IT toolkit engaging with practitioners internationally

4. **Lean Facilitator** (email correspondence): email from lean facilitator in a primary care network in Calgary, Alberta, Canada. (Email available from WBS.)
5. **Simul8**: evidence of SimLean model developed by SLIM research team being adopted commercially by software company Simul8 as a basis for development of other products in their suite. Available online: http://www.yousimul8.com/watch.php?x=4cd7c185309f1

Evidence of impact upon national policy and the Department

6. **Associate Medical Director & Head of Clinical Systems Design, Heart of England NHS Foundation Trust**. The Associate Director can corroborate impact on informing policy debate on the NHS within the Department of Health.