Institution: University of Southampton

Unit of Assessment: 19 Business & Management Studies

Title of case study: 19-02 How many dentists does Sri Lanka need?

1. Summary of the impact

Management science research that has evolved over two decades at Southampton Management School has provided the Sri Lankan government with the means to revolutionise its dental care system, and to devise new strategies for the more effective recruitment of health care professionals. A computer simulation model, based on Southampton's research, underpinned a government decision to limit dental student intake, create 400 new posts in under-resourced rural areas and grant access to dental care to an additional 1.5 million people. This in turn led to better use of taxpayers' money and improved career prospects for Sri Lankan dentists.

2. Underpinning research

The use of computer simulation tools to optimise work processes is widespread across the manufacturing and defence sectors, yet their adoption in the healthcare industry has been slow. The £1.2m EPSRC-funded RIGHT project (2007-09), in which Southampton was a key partner, aimed to understand why simulation and modelling approaches are not routinely applied within the NHS. Political and cultural factors are at play. The majority of health professionals are trained to implement clinical, not organisational, interventions and the lack of continuity that regular restructuring of the NHS brings, renders it difficult to embed new processes despite rising pressure for cost-effectiveness.

Research into healthcare-related operational research (OR) modelling at Southampton has sought for many years to address this challenge by incorporating human factors into OR tools for healthcare applications. As far back as the late 1980's Ruth Davies (who moved to Warwick in 2003) designed a discrete-event simulation approach [3.1] for use in healthcare settings that allowed for the fact that patients are unique individuals and not homogenous groups. Further work led by Davies [3.2] applied this "patient-oriented" approach to reduce the risk of blindness in patients with diabetes, by simulating different screening policies for diabetic retinopathy.

In the following years Sally Brailsford and her colleagues Jonathan Klein and Con Connell (all at Southampton since the 1990s) have led numerous simulation modelling projects in healthcare, all involving the development of bespoke models requiring methodological or technological innovation. Brailsford, drawing on theories from health psychology, developed an approach that incorporated human behaviour in simulation models by taking into account physical, social and psychological factors. She applied this approach to model patient attendance for screening for diabetic retinopathy [3.3] and for breast cancer [3.4]; this improved method of modelling health-related behaviours enabled health planners to design more effective screening programmes.

Close collaboration with healthcare organisations and the need to identify clinical "modelling champions" within them runs through this body of research. Brailsford worked with the NHS in 2004 to create a system dynamics model [3.5] of the entire Nottingham healthcare system following a severe winter bed crisis. Based on interviews with a wide range of health practitioners (A&E and other hospital staff, the ambulance service, in-hours and out-of-hours GPs, community mental health and social services), Brailsford's team devised a computer model of the complex network of potential patient pathways through the system. The model showed that slightly reducing GP referrals of elderly patients to hospital emergency departments resulted in a substantial reduction in bed occupancy. In 2006 [3.6], Brailsford led a study into system dynamics modelling of chlamydia infection, in collaboration with St Mary's Hospital, Portsmouth. The model improved the targeting of high-risk populations for regular chlamydia screening at greater cost-effectiveness. Brailsford won the OR Society's Goodeve Medal for both these papers – awarded annually for the best paper published in the *Journal of the OR Society*. She is one of only two people ever to be

awarded this medal twice.

Brailsford, who is Chair of the European Working Group on OR Applied to Health Services and co-Editor-in-Chief of the OR Society journal *Health Systems,* is recognised internationally as an expert in the field. Having discovered Brailsford's research, Dileep de Silva, at the time a practising dentist (with no previous knowledge of OR) working for the Sri Lankan Ministry of Health, began a PhD at Southampton in 2007 under her supervision. De Silva applied several key approaches from Brailsford's research – the importance of capturing human behaviour in models and ways in which to facilitate and support the role played by a clinical champion to bridge the gap between model and client – to create a system dynamics model for the dental care workforce in Sri Lanka.

3. References to the research

3.1 R.M. Davies and H.T.O. Davies (1994). Modelling patient flows and resource provision in health systems. *Omega*, 22:123-31.

3.2 R.M. Davies, S.C. Brailsford, P.J. Roderick, C.R. Canning and D.N. Crabbe (2000), Using simulation modelling for evaluating screening services for diabetic retinopathy, *Journal of the Operational Research Society*, 51:476-84.

3.3 S.C. Brailsford and B. Schmidt (2003). Towards incorporating human behaviour in models of healthcare systems: an approach using discrete event simulation, *European Journal of Operational Research*, 150:19-31.

3.4 S.C. Brailsford, P.R. Harper and J. Sykes (2012). Incorporating human behaviour in simulation models of screening for breast cancer. *European Journal of Operational Research*, 219:491-507.

3.5 S.C. Brailsford, V.A. Lattimer, P. Tarnaras and J.A. Turnbull (2004). Emergency and On-Demand Health Care: Modelling a Large Complex System, *Journal of the Operational Research Society*, 55:34-42 [winner of 2004 Goodeve Medal]

3.6 D. Evenden, P.R. Harper, S.C. Brailsford and V. Harindra (2006). Improving the cost-effectiveness of Chlamydia screening with targeted screening strategies. *Journal of the Operational Research Society*: 57:1400-1412 [winner of 2006 Goodeve Medal]

Relevant grants: Southampton Management School staff in **bold**; shows total value of grant

2009-11	EPSRC	**Brailsford (PI), Bolt**	Use of simulation tools in healthcare	£250,000
2007-09	EPSRC	Young, Brunel (PI), **Brailsford, Connell, Klein, Bolt, Patel**	RIGHT (Research into Global Healthcare Techniques)	£1.09M

4. Details of the impact

Sri Lanka has suffered from a chronic oversupply of qualified dentists for the last 15 years. State employment is, in theory, guaranteed to all Sri Lankan-trained doctors and dental surgeons. However, from the early 1990s onwards the Sri Lankan government funded too many university places in dentistry and as a result has been unable to employ all its qualified dentists. By the start of 2010 there were more than 250 dental surgeons awaiting government employment, one quarter of the total number of dentistry graduates. Many either left to work overseas or establish private practices.

The problem showed no sign of abating. Lack of coordination between the trainer (the Ministry of Higher Education) and the main employer (the Ministry of Health) persisted and the University

Grant Commission, which decides the number of undergraduates to be trained, was under great political pressure to increase the intake of dental students. Dental training is the most expensive degree course, not only in Sri Lanka but also in most developed countries, including the UK. This was therefore a highly contentious political issue about the use of taxpayers' money, particularly given serious issues over access to dental care for the wider Sri Lankan population. In a country of 20m people, less than two million visited a state-funded dentist in 2007. Moreover, there was a disparity between the capital Colombo and rural districts, some of which had less than three dental clinics per 100,000 people, compared with 10 in Colombo, 46 in the UK and 58 in the USA.

De Silva's collaboration with Brailsford produced a new system dynamics simulation model of the supply and demand for dental healthcare in Sri Lanka in order to analyse the various policy options available to the Sri Lankan government between 2010 and 2025. The supply part of the model simulated the flow of dentists through the complex recruitment and career progression process through to retirement and captured the behavioural effects of employment prospects and government policy. The demand model combined empirical data on the time required to carry out various dental procedures and secondary clinical and demographic data used to project the future incidence of different dental conditions. Together, the supply-demand model enabled policymakers, civil servants and politicians to investigate a range of scenarios and trial various staffing, training and recruitment policies.

As a practicing dentist, De Silva was able to gather reliable data that was acceptable to the dental fraternity, a crucial part of gaining professional acceptance of the model. He presented the model at a Cabinet meeting of the Sri Lankan government and demonstrated the effect of different policy options. Based on the findings, in October 2010 the Sri Lankan Ministry of Higher Education finally agreed to fix the intake of dentistry students at its current level of 80 for another ten years [5.1]. Moreover, the Ministry of Health was convinced, based on the model results, of the long-term adverse consequences of widespread unemployment among dental surgeons and created 400 additional government-funded vacancies over three years from 2011 to 2014 [5.2] [5.3] [5.4]. All these posts were created in rural areas to narrow the urban-rural divide.

The beneficiaries are numerous. The Sri Lankan government has a tool to aid decision-making that takes a 'whole system' view and reduces the effects of political lobbying and game playing by different government ministries with competing objectives. The use of taxpayers' money has been improved and Sri Lankan dental surgeons have improved career prospects. However the main beneficiaries are the Sri Lankan people. By the end of 2012, when only 250 of the planned 400 new posts had been created, more than one million people who previously had no access to care now visit a state dentist at least once a year, and will benefit from improved dental health in future [5.5]. Moreover, many of these 250 new dentists also work in the private sector after hours, which have resulted in 500,000 additional patient visits per year in the private sector.

De Silva is now Head of Dental Human Resources Planning at the Sri Lankan Ministry of Health. The Sri Lankan Secretary for Health has recently asked him to develop a similar model for midwives. He is now a keen advocate of system dynamics modelling for workforce planning and is Sri Lanka's acknowledged expert in this field. He was shortlisted for the Development Prize of the International Federation of Operational Research Societies and presented his research at the 2011 Triennial IFORS Conference in Melbourne, Australia [5.6].

5. Sources to corroborate the impact

5.1 Statement: from Dean of the Faculty of Dental Sciences, University of Peradeniya, Sri Lanka

5.2 Contact: Chief Dental Officer/ Deputy Director General of Health Services, Ministry of Health, Sri Lanka

5.3 Statement: Certified English translation of Cabinet Paper, Office of the Cabinet of Ministers, Sri Lankan Government

5.4 Contact: Secretary for Health, Ministry of Health, Sri Lanka

5.5 Contact: Head of Dental Workforce Planning, Ministry of Health, Sri Lanka

5.6 IFORS Newsletter March 2011 p.18 http://issuu.com/ifors/docs/march2011_web/19?e=0