Institution: University of Southampton		
Unit of Assessment: 17 Business and Management Studies		
Title of case study: 17-02 Healthcare workforce planning in Sri Lanka		
Period when the underpinning research was undertaken: 2000 – 2013		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Sally Brailsford	Professor of Management Science	October 1988 – present date
Period when the claimed impact occurred: August 2013 – July 2020		
Is this case study continued from a case study submitted in 2014? Y		

1. Summary of the impact

Computer simulation models based directly on University of Southampton research are now in routine use by the Sri Lankan Ministry of Health for planning the recruitment and training of health professionals. As a direct result of the first model, for dental surgeons, over 1.5 million people with no previous access to state-funded care are now able to visit a dentist once a year. There has been a significant improvement in population oral health and the number of unemployed qualified dentists has fallen from over 250 in 2010 to zero today. Following the success of this model, in 2016 the Ministry established a Human Resources Division to support its 125,000-strong workforce, and since 2018 simulation models are being used to plan postgraduate medical training in 56 specialties.

2. Underpinning research

Operational research (OR) modelling to improve decision-making in healthcare has been a research strength at Southampton since the 1980s. Professor Sally Brailsford has been involved in, and since 2000 has led, a number of research projects in this area, with a variety of funders including EPSRC, NIHR, various NHS organisations and The Health Foundation. Close collaboration with healthcare organisations and clinical stakeholders is a major feature of her research [**3.1**, **3.2**]. She has also developed methods [**3.3**, **3.4**] for including human behaviour in simulation models, using concepts from health psychology, for healthcare applications where it is important to recognise that the modelled "entities" are actually human beings, often in stressful situations, who do not always behave rationally.

Brailsford is recognised internationally as an expert in health OR. From 2010-19 she was Coordinator of the EURO Working Group in OR Applied to Health Services (ORAHS), and she was a founder Editor-in-Chief of the UK OR Society's journal *Health Systems* (2012-19). She is the only three-time winner of the UK OR Society's Goodeve Medal, awarded annually for the best paper published in the *Journal of the OR Society*. All three of these papers ([**3.1**], [**3.2**] and [**3.6**]) describe real-world applications of system dynamics modelling to improve decision-making in healthcare. Since 2010 her research interests have included investigating the factors that determine the take-up (or the lack of it) of OR modelling for routine decision support within the NHS. She has led two research projects in this area: one in 2010-11 funded by the NHS Institute for Innovation & Improvement [**3.5**], and one in 2018-19 funded by the Health Foundation. Key findings from the earlier research, summarised in [**3.5**], include the need for the model to address a business-critical problem, the importance of senior management engagement, the need for models to take account of human behaviour, and the need for a clinical "modelling champion" within the NHS organisation. Other challenges include data-related problems, political issues, and constant organisational change; clinical modelling champions rarely stay in the same role for long.

In 2007 Dileep De Silva, a qualified dentist working as an administrator in the Sri Lankan Ministry of Health, discovered Brailsford's research through an internet search and immediately saw its relevance for Sri Lanka. Like the UK, Sri Lanka has a publicly funded state health service which also includes dental care. As a low-middle income developing country, only a tiny number of people are able to afford private dental treatment and the vast majority of people are totally dependent on state-funded care. However, by 2007 nearly two decades of poor coordination

between the country's Ministries of Health and Higher Education had resulted in over 250 qualified dentists being unable to find employment due to a lack of government-funded posts, despite very low levels of population oral health and a desperate need for dental care, especially in rural areas. Since the early 1990s increasing numbers of new graduates – of whom De Silva was one – either worked in non-clinical roles, took up short-term locum posts, or travelled overseas for specialist dental training (at government expense). Instead of clinical training, De Silva decided to study for a PhD in OR at Southampton under Brailsford's supervision. They developed a simulation model that used several findings from her previous research: the need for clinician engagement, the importance of including human behaviour, and ways to facilitate and support the clinical champion role to engage with decision-makers. In 2010 he presented this model at a Sri Lankan Government Cabinet meeting and demonstrated the impact of different policy options. As a result, the Ministry of Higher Education agreed to fix the intake of dentistry students for ten years and the Ministry of Health created 400 additional government-funded posts over four years (2011-14). The journal article [**3.6**] describing the model and its early impact won Brailsford's third Goodeve Medal.

3. References to the research

3.1 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. https://doi.org/10.1057/palgrave.jors.2601667 [winner of 2004 Goodeve Medal]

3.2 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. https://doi.org/10.1057/palgrave.jors.2602134 [winner of 2006 Goodeve Medal]

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. https://doi.org/10.1016/S0377-2217(02)00778-6

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. https://doi.org/10.1016/j.ejor.2011.10.041

3.5 S.C. Brailsford, T. Bolt, G. Bucci et al. (2013) Overcoming the barriers: a qualitative study of simulation adoption in Primary Care Trusts in the NHS. *Journal of the Operational Research Society*, 64, 157-168. https://doi.org/10.1057/jors.2011.130

3.6 S.C. Brailsford and M.D. De Silva (2015) How many dentists does Sri Lanka need? Modelling to inform policy decisions. *Journal of the Operational Research Society* 66:1566-1577. https://doi.org/10.1057/jors.2014.136 [winner of 2015 Goodeve Medal]

4. Details of the impact

The most significant impact of this research since 2014 has been on the oral health of the Sri Lankan population. The Sri Lanka National Oral Health Survey is carried out every 10-12 years and provides a comprehensive evaluation of dental care provision and population oral health status. The most recent survey [**5.1**] was conducted in 2015-16 and published in 2018. Of course, many factors contributed to the improvements seen in this latest survey, but the benefits arising directly from an increase in dental service provision, especially in rural areas, were due to the model [**5.2** - **5.4**]. The Chief Dental Officer in the Ministry of Health stated: '*Having implemented the System Dynamics model findings; by 2014/2015, the entire waiting list for employment of dental surgeons was cleared. Moreover newly graduating dental surgeons' awaiting time for employment was brought down to 1-2 months. With the employment of new graduates, more than 2 million new patient*

Image source: [**5.1**], p14

visits were recorded from the entire country, mainly from the rural areas. Further it helped this ministry to launch new National programs in Dental Public Health, such as "Save molar program" and "Pregnant mothers program' [**5.3**]. The Past President of the Sri Lanka Dental Association stated: '*This has helped to improve the accessibility of dental services in the country, especially in the rural areas and hence the dental health status of the Sri Lankans, as shown by latest National Oral Health Survey*' [**5.4**].

The 2015-16 national survey [**5.1**] includes data from the previous survey, undertaken in 2002-03, which reported a significant lack of dental care, especially in rural regions. Nationally, in 2002-03 there were only 765 practising dental surgeons and 312 government clinics for a population of around 20 million; less than 10% of the population regularly visited a dentist; over 90% of adults had gum disease; and 51% of the 1.8 million dental visits per year were for extractions [**5.1**]. By 2015 service provision had increased substantially. The numbers of dental surgeons and government clinics had doubled since 2002-03, rising to 1,535 and 712 respectively. The 2015-16 report [**5.1**] states that "*When compared to the previous National Oral Health Surveys, there has been a reduction in the oral disease burden and an improvement in oral health habits of the Sri Lankan population, regardless of age, sex, ethnic and sector variations"* (p61) and "*.. there has been an improvement in dental service utilization patterns"* (p59). The increase in regular attendance, seen across all age groups, but particularly striking for 15-year-olds, is shown in Table 1.

Table 1. Percentage of people who visit a dentist at least once a year [source: 5.1]

Age	2002-03	2015-16
12	43.1	59.6
15	13.7	31.4
35-44	25.6	30.9
65-74	12.6	18.4

The 2015-16 survey found that around 40% of the population, approximately 8,000,000 people, now visit a state dentist annually and over 65% of people in both urban and rural areas live within 5km of a government dental clinic [**5.1**]. The overall percentage of visits for extractions, an indicator of poor general oral hygiene and lack of regular preventive dental care, had fallen from 51% to 33%. Table 2 summarises the improvements in population oral health, which were seen across all age groups. The greatest improvements are seen in the younger age groups; for people aged 65 and above, the effects of decades of poor dental care cannot be entirely reversed.

Table 2. Comparison in oral health indicators [source: 5.1]

Indicator	Age	2002-03	2015-16
Mean no. of teeth present	12	25.7	26.1
	15	27.8	27.9
	35-44	26.4	27.5
	65-74	12.2	15.3
% prevalence of dental caries	12	40.0	30.4
	15	52.2	41.5
	35-44	89.8	92.5*
	65-74	71.1	98.3*
% lacking all their natural teeth	35-44	0.1	0
	65-74	21.8	11.3
% with gum disease	12	72.8	44.7
	15	96.8	51.9
	35-44	89.9	77.9
	65-74	98.1	94.4

* increase over 2002-03 due to greater proportion of people retaining their natural teeth

A second, more general, impact has been on the Ministry of Health itself. The Sri Lankan Ministry of Health, Nutrition & Indigenous Medicine has been in existence for 120 years. In 2013 it catered for 54 million outpatient visits and 6 million inpatient stays per annum [**5.5**]. It employs over 125,000 staff whose salaries constitute over 50% of its total budget. Nevertheless, prior to 2017, the Ministry had no Human Resources Division. Sources [**5.5**-**5.8**] confirm that the creation of a new HR Division, headed by De Silva and with a staff of 10, was a direct consequence of the impact of the dentists model, and a recognition by the Sri Lankan Government that planning the future healthcare workforce is a complex task, requiring detailed analysis, often over very long timescales given the length of time it takes to train doctors and dentists. The Minister of Health stated: *"[We] recognize the importance and relevance of HR strategy objectives and basic principles of HR policy, planning and development*" [**5.5**].

Among the things De Silva was asked to do was to extend the dentist model to 2030 and to develop models for advanced medical training up to 2025 [**5.9**]. The Director General for Health Services at the Ministry of Health confirmed in November 2017 that the recommendations (increasing the intake of the pre-MD training programme for surgical specialties, but reducing it for medical and paediatric specialties) had been "…*discussed with all Professional Colleges and Associations"* and had then been accepted by the Post Graduate Institute of Medicine at the University of Colombo and would be implemented across all 56 specialties. He said "*This is the first time such a scientific and innovative methodology was developed in this Ministry, shifting Health Human Resources Planning of the country to an advance and scientific platform*" [**5.9**]. It is of course far too early to observe any direct impact on population health from this more recent modelling work, since the changes only came into force for the 2018-19 academic year. However, the creation of this new HR Division is evidence of the societal impact of Brailsford's research.

The third impact was on dentists themselves: their career prospects, their job satisfaction and their general wellbeing. This was evaluated in a survey [**5.10**], conducted by De Silva in summer 2019, of the 455 dentists (roughly one third of the total dental surgeon workforce at the time) who had graduated since the implementation in 2011 of the original model recommendations (response rate 51%). It takes at least six months to obtain Medical Council registration and complete all the necessary administrative processes, but nevertheless 87% of respondents had obtained government employment within a year of graduation, compared with the former average wait of over 40 months. 96% of respondents were happy or very happy that unlike their predecessors, they were able to start their clinical careers immediately, remain in Sri Lanka and do the job they had been trained to do. One respondent commented "*As an undergraduate at the Faculty of Dental Sciences University of Peradeniya, it was frustrating to see our seniors wasting around 3 years doing nothing but few locum work while awaiting for state sector jobs. Unemployment of dental surgeons was a big headache for us"* and another said "*I am so happy to receive Government employment within a short period from Graduation. This helped me to plan my professional career as well as family matters. I consider myself very lucky to receive government employment without waiting 2-3 years for permanent employment*" [**5.10**].

Image source: [**5.1**], p14

91% of respondents reported a job satisfaction score of at least 7 on a scale of 1-10, where 10 is high. The survey also found that 78% of respondents had been posted to rural areas, 17% to semi-urban and 5% to urban areas. This finding was particularly important given the low level of rural provision in the past. 29% of respondents regularly saw between 1-10 patients per day, 64% saw 11-25 patients per day and 7% saw 26-40 patients per day. Scaling these figures up to include all 455 newly qualified dentists, using the mid-point of each range, gives roughly additional 1,560,000 patient visits per annum, of which 1,250,000 are in rural areas [**5.10**]. Taken in combination with the findings reported in [**5.1**] and the Ministry's figure of 2 million new visits by 2014/15 [**5.3**], this yields a conservative estimate of 1.5 million people with no previous access to state-funded care who are now able to visit a dentist once a year.

5. Sources to corroborate the impact

5.1 National Oral Health Survey Sri Lanka 2015-16. Colombo: Ministry of Health, Nutrition and Indigenous Medicine (Sri Lanka), 2018. http://www.health.gov.lk/moh_final/english/public/elfinder/files/publications/2019/NOHS2015-2016.pdf

5.2 Transcript of Cabinet Proceedings, Sri Lanka Ministry of Health, Nutrition & Indigenous Medicine (June 2011).

5.3 Letter dated 12.11.15 from the Chief Dental Officer and Deputy Director General of Health Services, SL Ministry of Health, confirming the role of the simulation model in the decision to create the new posts

5.4 Letter dated 13.05.19 from the Past President, SL Dental Association, confirming continuing impact of increased dental care provision

5.5 Cabinet Memorandum dated July 2016 from the Minister of Health, confirming need for HR Division

5.6 Letter dated 23.06.17 to the Minister of Finance from the Secretary to Minister of Health

5.7 Letter dated 14.08.17 to the Minister of Health from the Director General of the Ministry of Finance

5.8 Letter dated 12.03.18 from the Secretary to the Minister of Health, appointing De Silva as Head of the new HR Division

5.9 Letter dated 01.11.17 from the Chief Dental Officer and Director General of Health Services in the Ministry of Health, confirming changes to medical specialty training

5.10 De Silva, MDK. (2019). Survey of Dentists who received Government employment as a result of Government funding additional cadre positions.