Institution: University of Nottingham

Unit of Assessment: 11

Title of case study: Improving Homecare Quality in the UK Through Optimised Workforce Planning

Period when the underpinning research was undertaken: February 2014 to present

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:
Dario Landa-Silva	Professor	2004 to present
Rong Qu	Associate Professor Research Associate	2005 to present
Rodrigo Pinheiro		Feb 2014 to Feb 2016

Period when the claimed impact occurred: October 2017 to present

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

In collaboration with Webroster Ltd, a UK based software design company, researchers at the University of Nottingham developed Optimiser – a commercial software product using world-class artificial intelligence algorithms to schedule homecare workers. The software became a key component of Webroster.net's offering contributing to its growth and in March 2020 Webroster Ltd was acquired by Access Group. At the same time, a new company, NDG Artificial Intelligence Ltd. (NDGAI), was established to focus on commercialisation of the optimiser – renamed OptifAI. OptifAI (formerly Optimiser), has been used by 56 of Webroster and NDGAI's clients – private and government homecare providers across the UK - to solve the complex task of scheduling homecare workers. The software affords key benefits to clients, carers and patients through: i) increased operational efficiency, ii) time and cost savings (in the field and the office), iii) delivery of a better quality of care, and iv) increased job satisfaction among homecare workers. OptifAI enables NDGAI's clients to adapt to changing circumstances whilst still providing high-quality care. In April 2020, with the emergence of the COVID-19 pandemic, users of OptifAI were able to adapt schedules quickly and easily to account for staff absences arising through illness and self-isolation, offering societal benefit.

2. Underpinning research

In the UK, the social care system is under increasing pressure to deliver, owing to an ageing population and an increase in the number of people with long-term care requirements. Demand for domiciliary care (homecare) is rising, exacerbating existing pressures and creating new challenges for those delivering the service. The public service union, Unison, highlighted time pressures faced by homecare workers as a key challenge in a 2017 report. Planning, scheduling and mobilising skilled healthcare workers in the community is a highly complex task and, if not managed correctly, can lead to poor working conditions and hinder patient care.

For over ten years, Landa Silva has conducted research on methodologies to tackle optimisation problems with multiple criteria which arise in many logistic scenarios **[7]**. In 2012, Landa Silva began research into optimisation models and algorithms for 'scheduling the mobile workforce'. A PhD project, supervised by Landa Silva and Qu (completed in 2015), attracted the attention of Webroster Ltd, a workforce scheduling software company based in Peterborough. In February 2014, a two-year KTP (Knowledge Transfer Partnership) project between UoN and Webroster Ltd commenced, to develop an optimisation engine for home care scheduling **[6]**.

Supported by this collaboration, three more PhD projects investigated a wide range of models and algorithms to tackle mobile workforce scheduling and in particular scheduling of homecare field-

based workforce. One of the PhD students, Rodrigo Pinheiro, was also employed in the KTP in collaboration with Webroster Ltd and became the Chief Optimisation Engineer in charge of the optimiser module within Webroster.net.

During this intense period of research on optimisation methodologies for Workforce Scheduling and Routing Problems (WSRP), Landa Silva and his team have developed optimisation models and intelligent algorithms to automatically generate schedules for a 'mobile workforce', i.e., workers that travel between locations to perform tasks. Homecare is an example of this type of scenario, where nurses, social workers, carers etc. visit patients in their own homes to provide them with health and/or care services. Research revealed the computational difficulty of this type of problem and laid the foundation for the models and algorithms that followed **[3]**. Several advanced optimisation algorithms have been developed for tackling homecare scheduling under different conditions, for example whether workers carried out tasks in teams, and whether workers are limited to working within specific geographical areas. The algorithms developed include tailored heuristics **[1]**, variable neighbourhood search **[2]**, heuristic decomposition **[4]**, and evolutionary algorithms **[5]**. All these algorithms exploit the structure of homecare scheduling problems producing high-quality schedules in minutes. This research conducted over a period of over six years since 2012, and through four PhD projects and a KTP project, has been fundamental for the development of the Optimiser module being so successfully commercialised by Webroster and NDGAI, the new company created to further develop and commercialise OptifAI.

OptifAI uses the mathematical models and intelligent optimisation techniques developed by Landa Silva and his team. Our research on scheduling homecare workforce and collaboration with NDGAI continues with the company about to embark on another KTP project with the University of Nottingham to further develop OptifAI.

2. References to the research

Research papers

[1] A Greedy Heuristic for Workforce Scheduling and Routing With Time-dependent Activities Constraints. **J. Arturo Castillo-Salazar, Dario Landa-Silva, Rong Qu**. 4th International Conference on Operations Research and Enterprise Systems (ICORES 2015), pp. 367-375, Scitepress, Lisbon, Portugal, January 2015. DOI: 10.5220/0005223203670375

[2] A Variable Neighbourhood Search for the Workforce Scheduling and Routing Problem. **Rodrigo Lankaites Pinheiro, Dario Landa-Silva, Jason Atkin**. Advances in Nature and Biologically Inspired Computing, Series Advances in Intelligent Systems and Computing, Vol. 419, 7th World Congress on Nature and Biologically Inspired Computing (NaBIC 2015), pp. 247-259, Springer, Pietermaritzburg, South Africa, December 2015. DOI: 10.1007/978-3-319-27400-3_22

[3] Workforce Scheduling and Routing Problems Literature Survey and Computational Study. **J. Arturo Castillo-Salazar, Dario Landa-Silva, Rong Qu**. Annals of Operations Research, Vol. 239, No. 1, pp. 39-67, 2016. DOI: 10.1007/s10479-014-1687-2

[4] Decomposition Techniques with Mixed Integer Programming and Heuristics for Home Healthcare Planning. Wasakorn Laesanklang, **Dario Landa-Silva**. Annals of Operations Research, Vol. 256, No. 1, pp. 93-127, 2017. DOI: 10.1007/s10479-016-2352-8

[5] Adaptive Multiple Crossover Genetic Algorithm to Solve Workforce Scheduling and Routing Problem. Haneen Algethami, Anna Martinez-Gavara, **Dario Landa-Silva**. Journal of Heuristics, Vol 25, No. 4-5, pp. 753-792, 2019. DOI: 10.1007/s10732-018-9385-x

Grants

[6] Project KTP9240: Improve Homecare Workforce Utilisation by Developing an Adaptable Software Optimisation Engine that Solves Any Workforce Management Scenario that Includes

both Rostering and Routing. Academic Team: **D. Landa Silva, R. Qu**. Industrial Partner: Webroster Net. February 2014 - February 2016, GBP87207

[7] **Dario Landa Silva**, Towards More Effective Multi-objective Meta-Heuristics to Solve Complex Combinatorial Problems, June 2007 – May 2010, EPSRC, EP/E019781/1, GBP204876

4. Details of the impact

Intelligent scheduling of field-based workforce is essential to achieve improvements in efficiency for homecare in the UK. This is not only beneficial to society, and to the organisation providing the homecare service, but also to its employees. "By enabling providers to provide more home healthcare (up to 20% more) with their current resources, public funding can care for more people, including the disadvantaged. Intelligent scheduling of field-based workforce is essential to achieve this improvement in efficiency" **[A]**.

The University of Nottingham began a collaboration with Webroster Ltd in February 2014 and has completed several research projects to develop a solution to the industry wide challenge known as the Workforce Scheduling and Routing Problem (WRSP). This refers to the complex task of assigning care workers to visit those that require at-home care. As a direct result of this collaboration, Webroster launched the *Optimiser* software in 2017. This provided customers with superior rostering solutions affording the following key benefits; i) increased operational efficiency, ii) time and cost savings (in the field and the office), iii) delivery of a better quality of care, and iv) increased job satisfaction among homecare workers. "*The success of The Optimiser contributed to substantial growth in the company's client base and by March 2020, Webroster Ltd had over 330 UK clients*" **[A]**.

"*The growth and success of Webroster Ltd attracted the attention of Access Group, one of the UK's leading providers of software to mid-market business, and Webroster was acquired by Access Group in March 2020*" **[A]**. [redacted text] Access Group stated that the acquisition of Webroster into their Access Health and Social Care division had a number of benefits, "*deepening our expertise and expanding our ability to offer providers the freedom to deliver outstanding care*" and provided competitive advantage as, "*the combination of Access and Webroster will cement Access as the clear leader in the UK's Health & Social Care software market*" **[B]**.

In 2019-20, Webroster's CEO established a new company, NDG Artificial Intelligence Ltd (NDGAI). NDGAI focused on the development and promotion of the *Optimiser* software, repackaged as *Optif*AI, and delivered as software as a service (SaaS). NDGAI established a reseller agreement with Access Group for it to become the first reseller of *OptifAI* **[A]**. The Managing Director for Access Health and Social Care Division stated "*we are passionate about making our customers' lives easier. With the OptifAI reseller agreement, we look forward to offering our customers the ability to determine and deliver the highest standard of care to their clients anywhere in the world"* **[C]**. NDGAI now employs 9 full time staff and in September 2020 achieved a UK registered trademark for *OptifAI,* meaning it is legally distinguishable from other products **[D].**

Webroster and subsequently NDGAI have benefitted from the expertise afforded by collaborating with the University of Nottingham researchers in developing state-of-the-art models and algorithms for homecare scheduling. *OptifAI* is "*a tool that helps organisations become more efficient and profitable in field-based workforce scheduling*" **[E]**. Developing the *Optimiser* software, and incorporating state-of-the-art artificial intelligence algorithms, has strengthened the company's credibility and confidence among clients. The collaboration is celebrated on their website and used within their marketing materials **[E,M]**. NDGAI confirms that "*OptifAI is easy to use and saves hours of manual labour creating and maintaining schedules to meet service user's requirements. It is fast, efficient, flexible and most importantly it is responsive towards business needs*" **[E]**. Clients can rely on *OptifAI* to deliver the following benefits:

- Significant service delivery cost savings: More efficient schedules reduce labour and travel costs in the field, enabling you to take on more business without the expense of additional staff
- Enhanced service levels: Ensuring the right skills and characteristics are in the right place at the right time ensuring organisations deliver the highest level of service
- Increased productivity: Boost efficiency and staff utilisation levels
- Administrative efficiency: Save hours of manual scheduling freeing up staff to fulfil other administrative tasks such as reviewing and creating service plans, delivering a better return on investment on their wages.
- Improved wellbeing and employee satisfaction: Design schedules that support employees' health, safety, and work-life balance **[E]**.

"*OptifAI is a unique optimisation engine in the market for scheduling field-based workforce in home healthcare*" and "*OptifAi improves performance and profitability while helping provide a better quality of service*" **[A]**. The *OptifAI* software adds significant value to workforce scheduling for users. Case studies from the company website, as well as client focus groups carried out in collaboration with researchers in the School of Pharmacy, University of Nottingham, have established the impact for clients, as detailed below **[F-J]**.

Client satisfaction improvements

NDGAI clients report increased operational efficiency, larger profit margins and actual cost savings because of optimised planning of workforce scheduling. Rest Assured Homecare Ltd (UK), has saved GBP4,500 since deploying *OptifAI* in October 2019. In turn this has enabled the company to expand their client base without additional spend **[F]**. Cheshire West and Chester Council switched to *OptifAI* in 2019 following the evolution of their reablement service which required improvements to efficiency and time savings. The Senior Manager of Adult Services states, "*The scheduling solutions produced by the software (OptifAI) have allowed us to effectively and efficiently utilise staff within our newly agreed working day, meaning we can provide more care in fewer hours"* **[G, M]**. In 2018, Bradford Metropolitan District Council were faced with the introduction of new enablement services meaning they had to schedule 2,500 hours of care in a 6-week period to 300 service users. Webroster software was able to streamline their processes and make the operation feasible **[H]**. *OptifAI* users benefit from efficiencies in the task of staff rostering, freeing up time to focus on other administrative tasks, including business expansion. Apex Prime Care, providers of homecare services in the South of England, and Webroster clients since 2017, stated, "*The flexibility of the (Webroster) rostering system has been pivotal in helping Apex Prime Care reduce manual, time consuming processes*" **[I]**.

Carer satisfaction

OptifAI minimises travel time and distance between client visits, that, as well as reducing travel costs, also increases the time that carers can spend with patients **[M]**. The improved communication and advanced rostering afforded by *OptifAI* enabled the carers in one organisation to receive their rotas two weeks in advance. Other carers noted that having a more detailed plan of each day, including travel times, improved their work-life balance and enabled them to maximise their earnings (participant 1 and 2) **[J]**. KITE Manager, Department of Adult Social Services and Public Health Richmond and Wandsworth Councils explains how OptifAI enables them to meet other carer requirements, "*We use OptifAI to best match our carers to our service-users. This doesn't just mean ensuring our service-users have the right carers but making sure we protect our carers too. For example, OptifAI won't send a carer with asthma to a smoker's house*" **[M]**.

Quality of care

Service users really value building a positive, trusting relationship, with a regular carer, and achieving continuity of care is a key challenge in the industry, one that *OptifAI* helps to address **[J]**. The managing director of Rest Assured Homecare Ltd (UK) states, "*OptifAI has equipped us to offer greater continuity of care. This is important to my business, as it encourages personal relationships between carers and clients.*

This has helped us develop an excellent reputation as a leading homecare provider in our area, and we benefit from this good reputation from a business perspective" **[K, M]**.

Benefits in COVID-19

Another key benefit highlighted by clients in the case studies and focus groups is the flexibility afforded in OptifAI, enabling clients to adapt to changing circumstances whilst still providing high levels of care. In April 2020, with the emergence of the Covid-19 pandemic, service providers were able to amend schedules easily and quickly to account for absences arising through illness and self-isolation, *OptifAI* offering societal benefit. One client stated "*OptifAI was instrumental in the management of services in the first six to eight weeks of the Covid-19 pandemic…. I'm not sure how we would have coped without it*" **[K].** KITE Manager, Department of Adult Social Services and Public Health Richmond and Wandsworth Councils states "*OptifAI has been an excellent tool during the Covid-19 pandemic. It made scheduling rotas quick and simple and was easy to manage remotely by our homeworkers*" **[M]**.

The all-round impact of OptifAI is summarised by the former owner of Webroster Ltd and now CEO of NDGAI. "*The research expertise provided by the University of Nottingham team led by Prof Landa Silva was instrumental in the development of OptifAI (formerly The Optimiser) which contributed to the growth of Webroster. Working with the University of Nottingham, our team pushed the boundaries of technology to enable our users to provide the highest levels of quality and efficiency. The success of The Optimiser was a major factor in the company acquisition and was essential to the establishment of the new company NDGAI*" and "*OptifAI helps organisations become more efficient and profitable in field-based workforce scheduling*" **[A]**.

5. Sources to corroborate the impact

[A] Testimonial from CEO at NDGAI, February 2021 [PDF]
[B] Access Group Announcement of Webroster Acquisition, March 2020 [PDF]
[C] Access Group Reseller Agreement OptifAI [PDF]
[D] OptifAI Trademark from Intellectual Property Office, August 2020 [PDF]
[E] NDGAI Webpage Describing OptifAI Capabilities and Benefits [PDF]
[F] Case Study OptifAI: Rest Assured Homehealthcare Ltd December 2020 [PDF]
[G] Case Study OptifAI: Cheshire West Council December 2020 [PDF]
[H] Case Study Webroster: Bradford Council May 2018 [PDF]
[I] Case Study Webroster: Apex Prime Care January 2018 [PDF]
[J] Focus Groups, Impact Report for OptifAI Users WP1 (Exploring the impact of workforce planning software on the quality of homecare services) August 2019, School of Pharmacy in collaboration with NDGAI and the School of Computer Science [PDF]
[K] Focus Groups Impact Report for OptifAI Users WP2 (Exploring the impact of workforce planning software on the quality of homecare services) October 2020 – School of Pharmacy in collaboration with NDGAI and the School of Computer Science [PDF]
[L] [redacted text]
[M] Business Objectives and Challenges, NDGAI website: https://www.ndgai.com/business-objectives-challenges/ [accessed 9 February 2021 and PDF].