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Training Healthcare Professionals to Mitigate the Climate Challenge – Development of a Lean Six Sigma E-Learning

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Abstract. This paper presents the preliminary findings of developing and evaluating a Lean Six Sigma (LSS) e-learning aimed at empowering healthcare professionals in different roles to make healthcare more sustainable. The e-learning was developed with experienced trainers and LSS experts by combining traditional LSS and environmental practices. Participants found the training engaging and confirmed they felt motivated and prepared to start applying the acquired skills and knowledge. We are now following the 39 participants to further investigate the effectiveness of LSS for mitigating the climate challenge in healthcare.

Keywords. Lean Six Sigma, Sustainable Healthcare, E-learning

1. Introduction

Mitigating healthcare's impact on Earth's environment should be urgently accelerated. Healthcare is a major global industry and employer for which projections expect the sector to grow more than 25% in the next few years [1]. Recent studies on the significant negative effects of healthcare activities on Earth's environment show alarming results [2,3]. The environmental impact of healthcare, which includes a variety of water, air, and soil pollutants, frequently has a detrimental effect on health distant from the site of the healthcare delivery [3].

Solutions from the field of medical informatics can be applied for measuring, monitoring and mitigating the environmental impact of healthcare to realize the required acceleration of reducing healthcare's ecological impact. Examples include using telemedicine to reduce carbon emissions from travel, enhancing electronic information

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systems to realize paperless processes, and increasing exchange of data between care providers to prevent unnecessary activities such as diagnosing tests and prescription of medication [4-6]. Lean Six Sigma (LSS) is one of the solutions that is put forth by Godbole & Lamb to increase the sustainability of healthcare [6]. LSS is based on a structured approach in which multidisciplinary teams work together to optimize organizational performance. Its principles include waste reduction, supply chain optimization, systems thinking and continuous improvement.

Even though applying LSS for reducing the environmental impact of healthcare processes is new, using LSS to reduce the healthcare industries' environmental footprint seems promising. First of all, because this data-driven method has already been successfully applied for improving the environmental impact in other sectors [7,8]. Secondly, because LSS has been widely adopted as an effective method for quality improvement in healthcare [9]. Environmental impact is increasingly seen as a key component of quality of care, beside elements like health outcomes and costs [10]. Using LSS as a method for improving sustainability of healthcare is new, because no cases have been reported so far on how this method was applied for this purpose.

Promoting the use of LSS for making healthcare more sustainable, should start with training healthcare professionals in applying the method for this new purpose. Training is a key success factor for LSS performance [11]. Training increases knowledge and skills, which accordingly can realize change when applied in practice.

Our objective was to develop and evaluate an e-learning to empower healthcare employees to use LSS to drive environmental improvements in their organization.

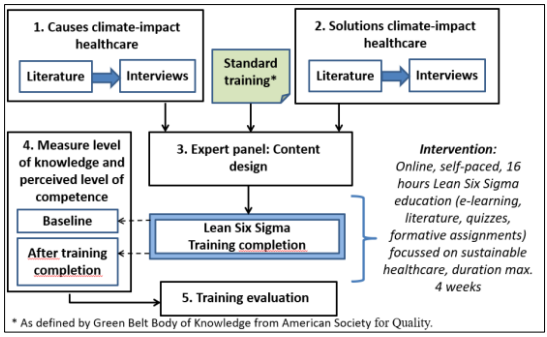

Figure 1. Overview of research design

2. Methods

Figure 1 presents the overall evidence-based approach used to design and evaluate the training program titled 'Green Lean Healthcare'. Literature review, interviews with experts from different domains within an academic hospital setting (procurement, logistics, food, medical informatics, waste management, patient care and environmental management), standard training content from a recognized certification body [12] and an expert panel with LSS (Master) Black Belts were used to design the e-learning.

To facilitate participation in parallel to busy working schedules, the training was developed for online, time- and location-independent learning.

Participants were recruited at a Dutch Green Healthcare seminar and completed the e-learning between March 2021 and April 2022.

Questionnaires based on training evaluation theory [13] were filled out pre- and post-training to gather participants' first reaction on the training, their learning curves and perceived behavior change related to the training program objectives.

3. Results

The review of literature with experts from different domains and the expert panel resulted in the course design based on five phases as presented in Figure 2. In this figure, the additions made to the generic training are presented in green and are underlined.

Thirty-nine participants of fourteen different Dutch healthcare institutions participated in the e-learning, including ten physicians, four physicians in training, two nurses, six project/program managers, fourteen professionals from healthcare logistics or supply chain and three other roles. The e-learning completion rate was 74%. Initial results show that participants found the e-learning engaging, acquired the intended skills and knowledge, and felt empowered and motivated to start improving their workplace's environmental impact after training completion.

Training part->	Introduction	Define phase LSS	Measure phase LSS	Analyze phase LSS	Improve phase LSS	Control phase LSS
Learning goals or topics -> (green underlined is added to general training after literature review, interviews and expert panel)	•Process management (incl.governance) •What is LSS •LSS principles and goals •Understand causal pathways climate change & health •Define impact healthcare on environment	•Define project purpose & scope •Collect process background info •Understand Customer needs and requirements •Define relevant stakeholders for sustainable healthcare*	•Evaluate measurement system. •Baseline current situation – examples environmental impact factors healthcare** •Refine focus of improvement	•Identify defect root causes •Confirm root causes with data •Example causes literature review •Perform waste analysis incl. circularity tool •Define Business Case sustainable healthcare	•Develop solutions to fix root causes •Test and prioritize solutions*** •Evaluate results of test with data. •Apply management of change to implementation	•Maintain the gains •Standardize work methods and process •Preserve lessons learned incl. role of communities for sustainable healthcare (e.g., Green Teams)

* Incl. procurement, building maintenance, waste management/facility services, logistics and care providers
** Incl. Lifecycle Assessment interpretation and Craddle to Grave concept
***Incl DPSIR model for modelling environmental impact

Figure 2. Design of LSS e-learning for sustainable healthcare used in this study

4. Discussion

Despite its exploratory nature, this study has found that knowledge and skills in LSS contribute to a greater feeling of preparedness in the particpants in this study to actively start implementing changes for making healthcare more sustainable.

An important fundament of the LSS methodology is to set measurable baselines and improvement goals and to use these to evaluate the effectiveness of implemented changes. The literature review conducted in this study to identify measurable factors to use for this purpose showed that the current body on knowledge in this area is incomplete and fragmented. Identifying which factors can be used for measuring the environmental impact of healthcare would be a fruitful area for further research.

Even though the e-learning was generic for the global healthcare industry, the scope of this study was limited to the Netherlands while the environmental impact and organization of healthcare differs between countries [2,3]. Additional research could

reveal the impact of these international settings on the effectiveness of applying LSS for sustainable healthcare.

Several participants mentioned the interaction with other participants from different roles in online discussion forums as a strength of the e-learning. Hence, exploring how sharing knowledge, tasks and ideas for reducing environmental impact in multidisciplinary teams might add useful insights that can further accelerate change.

To draw conclusions on the effectiveness of using LSS for making healthcare more sustainable, it is essential to evaluate the long-term effects of the e-learning besides the short-term effects that were reviewed in this study. This is why we continue this research in a longitudinal study to understand actual changes made by participants at their workplace and how the education contributed to these changes.

References

[1] Boniol M, Kunjumen T, Nair TS, Siyam A, Campbell J, Diallo K. The global health workforce stock and distribution in 2020 and 2030: a threat to equity and 'universal' health coverage?. *BMJ Glob Health*. 2022;7(6):e009316. Available from: https://gh.bmj.com/content/7/6/e009316

[2] Health care without harm [Internet]. Health Care Without Harm. [cited 2023Feb28]. Available from: https://noharm-europe.org/

[3] Lenzen M, Malik A, Li M, et al. The environmental footprint of health care: a global assessment. The *Lancet Planet Health*. 2020;4(7):e271–e279.

[4] Sijm-Eeken ME, Arkenaar W, Jaspers MW, Peute LW. Medical informatics and climate change: a framework for modeling green healthcare solutions. *J Am Med Inform Assoc*. 2022;29(12), p. 2083-2088. doi: 10.1093/jamia/ocac182

[5] Sittig DF, Sherman JD, Eckelman MJ, Draper A, Singh H. i-CLIMATE: a "clinical climate informatics" action framework to reduce environmental pollution from healthcare. *J Am Med Inform Assoc.* 2022, 29(12), p. 2153-2160. doi: 10.1093/jamia/ocac137

[6] Godbole NS, Lamb JP. *Making Healthcare Green: The Role of Cloud, Green IT, and Data Science to Reduce Healthcare Costs and Combat Climate Change*, Springer; 2018.

[7] Gholami H, Jamil N, Mat Saman MZ, Streimikiene D, Sharif S, Zakuan N. The application of Green Lean Six Sigma. *Bus Strategy Environ*. 2021; 30(4), p.1913–1931. doi: 10.1002/bse.2724

[8] Caiado R, Nascimento D, Quelhas O, Tortorella G, Range, L. Towards Sustainability through Green, Lean and Six Sigma Integration at Service Industry: Review and Framework. *Technological and Economic Development of Economy*. 2018;24(4), p. 1659–1678. doi: 10.3846/tede.2018.3119

[9] Henrique, D. B., & Godinho Filho, M. A systematic literature review of empirical research in Lean and Six Sigma in healthcare. *Total Quality Management & Business Excellence.* 2020;31(3-4), 429-449. doi: 10.1080/14783363.2018.1429259

[10] Mortimer F, Isherwood J, Wilkinson A, Vaux E. Sustainability in quality improvement: redefining value. *Future Healthc J*. 2018;5(2), 88. doi: 10.7861/futurehosp.5-2-88

[11] McDermott O, Antony J, Bhat S, et al. Lean Six Sigma in healthcare: a systematic literature review on challenges, organisational readiness and critical success factors. *Processes*. 2022;10(10),1945. doi: 10.3390/pr10101945

[12] American Society for Quality. *The ASQ certified CSSGB Six Sigma Green belt body of knowledge*; 2014. Retrieved January 17th 2021 from: https://asq.org/cert/six-sigma-green-belt#body-of-knowledge

[13] Kirkpatrick JD, Kirkpatrick WD. *Kirkpatrick's four levels of training evaluation*; Association for Talent Development, 2016.