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Kaizen & Healthcare: A Bibliometric Analysis

Sandro Alberto Vianna Lordelo¹[0000-0002-3046-395X], Sara Monaliza Sousa Nogueira¹[0000-0003-4310-8655], José Rodrigues de Farias Filho¹[0000-0003-1843-8695], Helder Gomes Costa¹[0000-0001-9945-0367], Christiane Lima Barbosa²[0000-0002-8303-9263], and Robisom Damasceno Calado³[0000-0003-3349-0344]

¹ Universidade Federal Fluminense, Niterói, Brasil
sandrolordelo@id.uff.br, {saramsnogueira, fariasfilho,
helder.hgc}@gmail.com

² Universidade Federal do Pará, Belém, Brasil
cllima@ufpa.br

³ Universidade Federal Fluminense, Rio das Ostras, Brasil
robisomcalado@id.uff.br

Abstract. The objective of this article was to map the state of the art, by means of bibliometric research, of how the scientific evolution of Kaizen has been occurring in theory, in practice and, especially, in the health area around the world, in order to guide future research in the same, as, for example, kaizen has been contributing to humanization within health centers. A broad structured search was performed using keywords and Boolean logic, in the PubMed, ISI and Scopus data bases. The identified publications were cataloged in EndNote and NVIVO 10 software for bibliometric analysis. Through these, 1,467 publications were identified, in the three databases, excluding the repeated publications and those without relevant information. The main key terms identified and in common in all publications were: “management”, “lean”, “quality” and “kaizen”; and the authors who publish the most were Van Aken, E.M., Farris, J. A., Suárez-Barraza, M.F. and Glover, W. J; and when kaizen applied to healthcare was evaluated, the most cited article among the 1,467 selected was the “Lean in healthcare: The unfilled promise?”, by Radnor, ZJ, Holweg, M. and Waring, J., which has 316 citations in Scopus. It was evidenced that kaizen applied to health still has much potential to expand.

Keywords: Continuous Improvement · Lean · Healthcare

1 Introduction

Lean is a management philosophy based on concepts from the Toyota Production System [25]. The Lean process evaluates operations step by step in order to identify waste and inefficiencies, create solutions and improve operations, adding value and continuous quality improvement [7, 10, 1].

As a lean tool, Kaizen is used to achieve continuous improvement [3, 6], reducing waste and improving the quality and efficiency [16]. Kaizen seeks incremental

improvements, small or large, to eliminate non-value-added actions, determining who are the customer and the current status, developing the vision of the future and implementing, measuring and evaluating performance [13], being already used in several areas [16], including health [7, 24].

The general objective of this research was to map the state of the art, by means of bibliometric research, of how the scientific evolution of Kaizen has been occurring in theory, in practice and, especially, in the health area around the world.

2 Theoretical framework

Kaizen is part of Lean philosophy and therefore embodies this lean thinking. Kaizen is a Japanese word formed by two terms, 'zen' meaning 'good', and 'kai', 'change'; that is, a term that constitutes "good change" or "improvement" [11].

At first, this lean thinking was focused on manufacturing companies, hence comes the denominations lean manufacturing or lean production. However, this philosophy quickly shifted to new areas, such as healthcare [16]. Hence the concept of "Lean Healthcare" emerged with a focus on adding value to the patient, eliminating wasteful activities from healthcare processes, and respecting all people [17].

The Kaizen philosophy has been successfully applied to quality improvement and safety in the medical field [12]. Physicians and healthcare managers work together to study and apply the principles of continuous improvement to achieve better efficiency, greater effectiveness, lower costs, and more satisfied patients [2].

Nowadays Kaizen is used in many different areas of medicine: radiology [12]; ophthalmology [20]; surgical units [24]; telemedicine [5]; exams [21]; among others.

And in the scientific literature there are already documents about Lean and Kaizen approaches in healthcare. Some, for example, in review formats, such as those presented by D'Andreamatteo et al. [8], Daultani et al. [4] and Mazzocato et al. [15], which bring dozens of other articles, with theories and practical cases, in general, about such applications.

3 Methodology

This research is based on the literature review of the state of the art of continuous improvement, especially kaizen and its use in healthcare. The first steps of this are the definition of the research keywords, the search for data in bibliographic information bases, and the construction of the library [22, 23].

The keywords were organized according to the focus of the research, into three axes: a) theoretical axis; b) application axis; c) health axis. The main terms selected were kaizen, lean, improvement, concept, case, application, practice, implementation and health; all in English, to obtain international publications.

Then, these terms were entered using the Boolean logic with the connecting terms "AND" and "OR" in the PubMed, Web of Science and Scopus. As reported

by Rodriguez et al. [19] the choice of such bases reduces the probability of using predatory sources or even no blinded reviewed ones.

In PubMed, the search was performed by selecting the option “Title/Abstract” option, so the search for the desired words was performed over the title and abstract of the papers. In Web of Science, the option “TOPIC” was selected, which searches the title, abstract, author’s keywords and Keywords Plus® (words or phrases that often appear in the titles of article’s references, but do not appear in the title of the article). And in Scopus, the “TITLE-ABS-KEY”, which searches the title, abstract and keywords of the documents in this database.

All research in the databases were performed on July 1, 2020, and these considered the documents already published in the first half of 2020. These results were exported to the EndNote X7 software for library construction and management. In such software, articles repeated (“duplicates”) in the databases or with incomplete relevant information, such as title, authors, abstract and keywords, were excluded.

The remaining records were then exported to the NVivo 10 and VantagePoint software to perform the bibliometric analysis: year of publications; authors with the most published scientific articles and with the most citations; and journals with the most publications in the study areas.

4 Results and discussions

After building the keyword tree and the definition of the Boolean logic for each axis, the queries were inserted in the three search bases and 1,795 documents were reached in axis 1 (kaizen in theory); 1,395 documents in axis 2 (kaizen in practice); 187 documents in axis 3 (kaizen in health). After assembling these 3,377 documents in EndNote software and deleting 1,753 duplicate documents, 1,624 documents remained. The Boolean sequences with the key terms and these results can be seen better in Table 1.

It is interesting to point out that about 90% of the documents raised in the third axis, had already been raised in the other two axes. And, about 2/3 of the documents in the second axis, had also already been lifted in the first axis. Also the repetition of documents between the bases; about 90% of them were in Scopus. Thus, relating the third axis with the second and the first axis, respectively, one notices that only 12.6% of the articles with Kaizen practices in healthcare, and 9.5% of theoretical documents about Kaizen and healthcare. This reveals the large field still to be explored.

Latter, the data from the documents were viewed one by one by the authors of this research in order to exclude files with excessive missing information (no title, abstract and authors’ name) or even duplicate documents that passed the first software filter, leaving a total of 1,467 diverse documents in the library, among articles (53.3%), conference papers (34, 3%), reviews (5.4%), book chapters (3.1%), books (1.3%), and others (2.6%).

Table 1. Number of selected articles per axis of interest

AXIS	Base	No. of articles	No. of articles (excluding repeats)
1. THEORETICAL ((kaizen) AND (improvement)) OR ((kaizen) AND (concept)) OR ((kaizen) AND (lean))	Pub Med	81	1.314
	Web of Science	546	
	Scopus	1.168	
	Sub-Total	1.795	
2. PRACTICAL ((kaizen) AND (application)) OR ((kaizen) AND (case)) OR ((kaizen) AND (practice)) OR ((kaizen) AND (implementation))	Pub Med	57	998
	Web of Science	464	
	Scopus	874	
	Sub-Total	1.395	
3. HEALTH (((kaizen) AND (application)) OR ((kaizen) AND (case)) OR ((kaizen) AND (practice)) OR ((kaizen) AND (implementation))) AND (health*)	Pub Med	26	126
	Web of Science	48	
	Scopus	113	
	Sub-Total	187	
	Total	3.377	1.624

The main areas of study for these papers identified were: Engineering (31.2%); Business, Management and Accounting (23.3%); Decision Sciences (9.4%); Computer Science (9.3%); and Medicine and Health (9.1%).

Next, this data was exported from EndNote to the NVivo and VantagePoint software for bibliometric analysis. At this step, it was possible to obtain an overview of Kaizen in the three contexts: theoretical, practical and in healthcare. That is, from the 1,467 documents. The first result generated by VantagePoint was the historical line with the number of publications per year. The oldest document found is from 1948. But the recurrence of publications on these themes occurred since the late 1980s.

The highest peak of publications occurred in 2018, with a total of 125 articles. It is worth noting that this research was conducted considering only the 1st half of 2020, and therefore indicates a 'drop' in publications this year, which cannot yet be stated as true.

Next, all authors with at least one publication on the themes addressed here were identified. In all, 3112 different authors were surveyed, who published alone or in co-authorship with other researchers. The list of authors with the largest number of publications and the respective total number of articles published by them are Van Aken, E.M. (28), Farris, J.A. (26), Suarez-Barraza, M.F. (22), Glover, W.J. (19), Doolen, T.L. (18), Aleu, F.G. (11), Katayama, H. (11), Wor,ey, J.M. (11), Murata, K. (10) and Nahmens, K. (10). In this list one can highlight the work done by the first three researchers who published more than two dozen materials on the themes explored here, often as co-authorship.

In order to evaluate whether there is a relationship between quantity and quality, Table 2 was prepared, with the first 10 names of authors who have accumulated more citations received for their scientific articles that were selected in this research. And to this, the h-index that these authors have in the Scopus database was added.

Table 2. Ranking of authors with the highest number of citations received

Rank	Author	Number of Citations	H index
1	Bessant, Jonh	625	38
2	Van Aken, E. M.	478	17
3	Farris, Jennifer A.	440	15
4	Doolen, T. L.	358	14
5	Caffyn, Sarah	331	8
6	Radnor, Zoe Jane	318	28
7	Holweg, Matthias	316	28
8	Waring, Justin	316	28
9	Samson, Danny	286	23
10	Emiliani, M. L.	270	23

Remembering that this index quantifies the productivity and impact of a scientist, evaluating their most cited articles [9]. And here, it will consider the citations and publications that the author has in the entire Scopus database, and not only the articles selected here.

These results were surprising because the most cited author, among the more than three thousand researchers, was J. Bessant who was not even on the previous list because he only had three articles selected in this research; but, who received 246, 193 and 186 citations in them, totaling 625 and an average of 208 citations per article.

The second most cited author was Van Aken, E. M., with 475 total citations and an average of 17 citations per article only. A relatively low value because of the large number of publications that this researcher has. And because only two of them have more than 100 citations and 20 have less than 10 citations, some with none. The same occurs with Farris J. A. and Doolen, T. L.

These results of Bessant, J., Van Aken, EM, Farris JA and Doolen, TL could already indicate that there is not necessarily a relationship between quantity and quality in publications, since the author who has the highest number of citations does not have as many papers of his authorship in the areas of this research. And the authors who have many publications in the areas of interest here did not received numerous citations per article. Therefore, it is also interesting to evaluate an author's h-index.

Other authors who were noteworthy were Radnor, Z. J., Holweg, M. and Wa-ring, J. Together they wrote the most cited article among the 1467 selected, "Lean in healthcare: The unfilled promise?" [18], which has 316 citations in Scopus as of the date of this research (07/2020), as can be seen in Table 3.

Table 3. Articles with highest citations and respective authors, journal and year of publication.

Document title	Authors	Journal	Year	Citations
<i>Lean in healthcare: The unfilled promise?</i>	Radnor, Z.J., Holweg, M., Waring, J.	Social Science and Medicine	2012	316
<i>Evolutionary model of continuous improvement behaviour</i>	Bessant, J., Caffyn, S., Gallagher, M.	Technovation	2001	245
<i>Implementation of total productive maintenance: A case study</i>	Chan, F.T.S., Lau, H.C.W., Ip, R.W.L., Chan, H.K., Kong, S.	International Journal of Production Economics	2005	215
<i>An international study of quality improvement approach and firm performance</i>	Adam, E.E., Corbett, L.M., Flores, B.E., (...), Samson, D., Westbrook, R.	International Journal of Operations and Production Management	1997	213
<i>A review of data mining applications for quality improvement in manufacturing industry</i>	Köksal, G., Batmaz, I., Testik, M.C.	Expert Systems with Applications	2011	212

It is interesting to note in Table 3 that the most cited article addresses Lean in healthcare (axis 3), which apparently quite aligned with the interests of this research, the others are from industry and engineering (axes 1 and 2).

It is also curious to note that all the authors surveyed in Table 3 are also in Table 2 and that most of them reached such a position in this one with only a single article. This reinforces that there is not necessarily a relationship between quantity and quality, since a single article may contain enormous quality; and vice versa, many articles may not. Thus, it is important to read these and evaluate whether they are aligned with the research objectives.

Another interesting example is that of Suárez-Barraza, M. F. with 23 articles, 262 citations and an h index of only 9 at Scopus, where there are several other works by him and in partnership with other authors. Thus, if only the h-index were considered as a selection criterion for further reading of the selected articles, it is likely that this author would not be selected. Therefore, several criteria are used when selecting the articles that will be read [22, 23].

Lima et al. [14] in their literature review listed 19 areas of healthcare where kaizen can be applied. If at least one article per year were published in a specially index journal in each of these areas, there would be an exponential increase in this margin 10%.

Another important analysis to be mentioned is the co-occurrence of keywords that appear in the articles. Figure 1 was created using the VOSviewer software.

The word kaizen was the most common, followed by continuous improvement and lean manufacturing. It is also observed that the most recent terms (after 2012) are works related to health care and lean production. The health care part is focused on managing people and organizations, such as hospitals, while the lean production part, for process improvements, using VSM, Six Sigma and agile manufacturing systems.

4. Daultani, Y., Chaudhuri, A., Kumar, S.: A decade of lean in healthcare: current state and future directions. *Global Business Review* **16**(6), 1082–1099 (2015)
5. van Dellen, J.R.: The philosophy of kaizen and telemedicine. *World neurosurgery* **91**, 600–602 (2016)
6. Deming, W.E.: *Out of the Crisis*. MIT press (2018)
7. Dickson, E.W., Singh, S., Cheung, D.S., Wyatt, C.C., Nugent, A.S.: Application of lean manufacturing techniques in the emergency department. *The Journal of emergency medicine* **37**(2), 177–182 (2009)
8. D’Andreamatteo, A., Ianni, L., Lega, F., Sargiacomo, M.: Lean in healthcare: A comprehensive review. *Health policy* **119**(9), 1197–1209 (2015)
9. Elsevier: Scopus: Access and use support center. Available at: https://service.elsevier.com/app/answers/detail/a_id/14194/supporthub/scopus/ (2020), accessed at: 07/20/2020
10. Farris, J.A., Van Aken, E.M., Doolen, T.L., Worley, J.: Critical success factors for human resource outcomes in kaizen events: An empirical study. *International Journal of Production Economics* **117**(1), 42–65 (2009)
11. Goyal, S., Law, E.: An introduction to kaizen in health care. *British journal of hospital medicine* **80**(3), 168–169 (2019)
12. Knechtges, P., Decker, M.C.: Application of kaizen methodology to foster departmental engagement in quality improvement. *Journal of the American College of Radiology* **11**(12), 1126–1130 (2014)
13. Liker, J.K., Meier, D.: *Toyota way fieldbook*. McGraw-Hill Education (2006)
14. Lima, R.M., Dinis-Carvalho, J., Souza, T.A., Vieira, E., Gonçalves, B.: Implementation of lean in health care environments: An update of systematic reviews. *International Journal of Lean Six Sigma* (2020)
15. Mazzocato, P., Savage, C., Brommels, M., Aronsson, H., Thor, J.: Lean thinking in healthcare: a realist review of the literature. *BMJ Quality & Safety* **19**(5), 376–382 (2010)
16. Mazzocato, P., Stenfors-Hayes, T., von Thiele Schwarz, U., Hasson, H., Nyström, M.E.: Kaizen practice in healthcare: a qualitative analysis of hospital employees’ suggestions for improvement. *BMJ open* **6**(7), e012256 (2016)
17. Naidoo, L., Mahomed, O.H.: Impact of lean on patient cycle and waiting times at a rural district hospital in kwazulu-natal. *African Journal of Primary Health Care and Family Medicine* **8**(1), 1–9 (2016)
18. Radnor, Z.J., Holweg, M., Waring, J.: Lean in healthcare: the unfilled promise? *Social science & medicine* **74**(3), 364–371 (2012)
19. Rodriguez, D.S.S., Costa, H.G., Carmo, L.F.R.R.S.d.: Multicriteria decision aid methods applied to ppc problems: a mapping of papers published in brazilian journals. *Gestão & Produção* **20**(1), 134–146 (2013)
20. Sommer, A.C., Blumenthal, E.Z.: Implementation of lean and six sigma principles in ophthalmology for improving quality of care and patient flow. *Survey of ophthalmology* **64**(5), 720–728 (2019)
21. Sugianto, J.Z., Stewart, B., Ambruzs, J.M., Arista, A., Park, J.Y., Cope-Yokoyama, S., Luu, H.S.: Applying the principles of lean production to gastrointestinal biopsy handling: From the factory floor to the anatomic pathology laboratory. *Laboratory medicine* **46**(3), 259–264 (2015)
22. de Toledo, R.F., Junior, H.M., Farias Filho, J., Costa, H.G.: A scientometric review of global research on sustainability and project management dataset. *Data in brief* **25**, 104312 (2019)

23. Treinta, F.T., Farias Filho, J.R., Sant'Anna, A.P., Rabelo, L.M.: Metodologia de pesquisa bibliográfica com a utilização de método multicritério de apoio à decisão. *Production* **24**, 508–520 (2014)
24. Ullah, M.F., Fleming, C., Fox, C., Tewary, T., Tormey, S.: Patient experience in a surgical assessment unit following a closed-loop audit using a kaizen lean system. *Irish Journal of Medical Science (1971-)* **189**(2), 641–647 (2020)
25. Womack, J.P., Jones, D.T., Roos, D.: *The machine that changed the world: The story of lean production—Toyota's secret weapon in the global car wars that is now revolutionizing world industry*. Simon and Schuster (2007)