Evaluation of the application of continuous improvement based on the *Kaizen* concept in Emergency Healthcare Units

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Abstract
The Brazilian Ministry of Health and the Fluminense Federal University promoted *Kaizen* in lean thinking implementation projects in 24-hour Emergency Care Units. This research aimed to evaluate the application of *Kaizen* in both projects looking for patterns, providing valuable information for the design and improvement of future projects. Both projects focused their *Kaizen* efforts on improving the environment and standardization, with a focus on the use of 5S. The literature shows a more comprehensive approach, making use of *Kaizen* also to solve recurring problems using methods of analysis and problem solving. For future projects, there should be considered to use 5S within the initial steps for the entire units and to start promoting problem solving *Kaizen*.
Keywords: *Kaizen*; Rapid process improvement; Rapid improvement event; Lean healthcare; Emergency Care Unit.

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Avaliação da aplicação da melhoria contínua a partir do conceito de *Kaizen* nas Unidades de Emergência em Saúde

Resumo

O Ministério da Saúde brasileiro e a Universidade Federal Fluminense promoveram o *Kaizen* em projetos de implementação do pensamento *lean* em Unidades de Pronto Atendimento 24 horas. Esta pesquisa teve como objetivo avaliar a aplicação do *Kaizen* em ambos os projetos buscando padrões, fornecendo informações valiosas para a concepção e melhoria de futuros projetos. Ambos os projetos focaram seus esforços *Kaizen* na melhoria do ambiente e padronização, com foco na utilização do 5S. A literatura mostra uma abordagem mais abrangente, fazendo uso do *Kaizen* também para resolver problemas recorrentes usando métodos de análise e resolução de problemas. Para projetos futuros, deve-se considerar a utilização do 5S nas etapas iniciais para todas as unidades e começar a promover o *Kaizen* de solução de problemas.

Palavras-chave: *Kaizen*; Melhoria rápida de processo; Evento rápido de melhoria; *Lean* na saúde; Unidade de Pronto Atendimento.

Evaluación de la aplicación de la mejora continua basada en el concepto *Kaizen* en unidades de emergencia sanitaria

Resumen

El Ministerio de Salud de Brasil y la Universidad Federal Fluminense impulsaron proyectos de implementación de *Kaizen* in *lean thinking* en Unidades de Atención de Emergencia 24 horas. Esta investigación tuvo como objetivo evaluar la aplicación de *Kaizen* en ambos proyectos buscando patrones, brindando información valiosa para el diseño y mejora de futuros proyectos. Ambos proyectos centraron sus esfuerzos *Kaizen* en la mejora del entorno y la estandarización, con un enfoque en el uso de 5S. La literatura muestra un enfoque más completo, haciendo uso de *Kaizen* también para resolver problemas recurrentes utilizando métodos de análisis y resolución de problemas. Para proyectos futuros, se debe considerar usar 5S dentro de los pasos iniciales para todas las unidades y comenzar a promover la resolución de problemas *Kaizen*.

Palabras clave: *Kaizen*; Mejora rápida de processos; Evento de mejora rápida; Asistencia sanitaria ajustada; Unidad de Cuidados de Emergencia.

Introduction

Healthcare systems around the world face similar difficulties, such as an aging population, culminating in increased demand for health services, new technologies and expensive services while experiencing increasing financial constraints. In this context, providing high quality services meeting patient expectations with minimal resources is a major challenge, which has led some healthcare organizations to explore lean methodology - which focuses primarily on improving processes, reducing and eliminating the waste (KELENDAR; FAISAL; MCINTOSH; MOHAMMED, 2020).

The adoption of lean practices has been studied and reported as successful stories of strategic changes in healthcare organizations. Lean practices have been applied also within Six Sigma methodology. Kelendar, Faisal, Mcintosh and Mohammed (2020) report in their literature review the cases of Bolton Improving Care System – BICS and Virginia Mason Medical Center as international references. Lean experts, since its discovery as a working philosophy, Womack and Jones (1997), introduced in their work the application of lean thinking in healthcare systems. Other authors as Fillingham (2007), Kollberg, Dahlgaard and Brehmer (2006), Lodge and Bamford (2008), Manos, Sattler and Alukal (2006) also advocate the use of lean practices to eliminate delays, waiting times, reduce on-call time, repeated encounters, errors and wrong procedures in healthcare environments.

In Brazil, the lean philosophy has been applied in healthcare environments in private capital institutions, such as in the hospitals of Sociedade Israelita Albert Einstein (ALBERT…, 2012) and in publicly funded institutions. The use of lean has been encouraged by the Brazilian Ministry of Health through the Lean in Hospital Emergencies program (LEAN NAS EMERGÊNCIAS, 2018) which, according to information available on the program website, would be expanded to the 24-hour emergency care units (24h ECU, as a translation for the Brazilian UPA 24h). In Reis, Abreu, Braga Neto, Viera, Torres and Calado (2022), the authors present a review on challenges and enablers of a lean culture in healthcare organizations. Reis, Abreu, Braga Neto, Viera, Torres and Calado (2022) discuss lean in Brazilian 24h ECU and the replication of the implementation model.

In the public sector, challenges stem from inadequate planning and management. Cross-cutting themes often seem to influence decisions more than the public's real needs. As highlighted by Santos, Calado, Orlando Filho and Bourguignon in (2021), this emphasizes the urgent need for reforms.

One of the practices of the lean mindset is *Kaizen*. *Kaizen* was initially explained by Imai (1986) as "continuous improvement involving all employees", "an umbrella concept that covers most of the typically Japanese practices that have gained fame around the world". By typically Japanese practice, Imai (1986) refers to the concept of TQC (Total Quality Control), quality circles, suggestion systems, TPM (total productive maintenance), *kanban*, JIT (just in time), *etc*.

According to Pinto, Coelho, Calado and Silva (2013), understanding how to balance the process is crucial: excess patients, workers' free time, and the ability to match expected demand with hourly capacity allowed these variables to combine to achieve an optimal flow.

After Imai (1986), many authors studied and published about the same concept. For Ferreira and Saurin (2019), *Kaizen*, or continuous improvement, is a fundamental principle of lean production, which implies that work systems must continually evolve towards better performance, addressing the weaknesses of previous projects. According to Spear and Bowen (1999), *Kaizen* initiatives are characterized by small improvements carried out as part of daily work, preferably by those who work on the front line and form the lowest hierarchical echelons. However, what counts as "small" is not precisely defined, and the scope of *Kaizen* varies substantially, from individual operations to entire value streams. Suarez-Barraza and Miguel-Davila (2020) discuss that a broader initiative is referred to as a '*Kaizen* project', which usually takes place over weeks or months, aimed at improving performance using lean production principles.

Although known as a concept and practice, as discussed in the aforementioned publications and by its broad definition, – continuous improvement involving everyone – the implementation of Kaizen within healthcare organizations varies in its use and format.

The Brazilian Ministry of Health funded lean implementation projects with the purpose of reducing overcrowding in 24h ECU. Within the project deliveries, the units were demanded to implement *Kaizen*. The purpose of this article is to evaluate the application of *Kaizen* implemented during the two lean implementation projects in Brazilian 24h ECU, aiming to provide valuable information for the design and improvement of future projects of the same scope.

Literature review

In the bibliometric analysis published by Lordelo, Nogueira, Farias Filho, Costa, Barbosa and Calado (2021), its authors identified that only in 12.6% of the publications until July 2020 referred to *Kaizen* practices in healthcare and only 9.5% were theoretical material on *Kaizen* and healthcare. These results evidenced a lack of specific literature existent to guide and support the use of *Kaizen* in such environments as healthcare.

Conducting a more specific research for the applications in hospitals and emergency care units, Mazzocato, Stenfors-Hayes, Thiele Schwarz, Hasson and Nystrom (2016) focused on the use of *Kaizen* in a Swiss hospital based on an improvement suggestion program and comment that the hospital uses "*Kaizen* Blitz", which they describe as long-term initiatives for which those involved regularly meet.

Borges, Santos, Torres, Silva, Santos and Calado (2021) highlight the ability to promote continuous improvements in health systems, emphasizing the importance of establishing consistent behavioral routines. Such an approach, according to the authors, can enhance health management, and additional studies can enrich the understanding of its practical application and benefits.

According to the analyzed literature, the lean approach, together with the *Kaizen* principles of continuous improvement, is effective in mitigating the risks associated with Hospital Acquired Infections (HAI) (DE AMARAL; CALADO; VIEIRA; CHAVES, 2021).

Beattie, Hookway, Perera, Calder, Hunter-Howe and Woerden (2018) present the use of *Kaizen* at Osprey House – an English institution for the recovery of drug and alcohol addicts – in the RPIW format (rapid process improvement workshop), described as an event divided in three phases: planning (12 weeks before the workshop), one-week workshop and follow-up of results at 30, 60, 90 and 180 days.

Knechtges and Decker (2014) present results from the application of *Kaizen* in a radiology department using 5-day events, although they do not restrict the use of *Kaizen* to just this format.

Elsheikh, Emam and AlShareef (2017) present the case of a project to revitalize the documentation of a hospital in Saudi Arabia, with lean practices and cite *Kaizen* as the improvements identified for the points discussed, using a model of suggestions for improvements and support for the initiatives of the employees.

Blouin-Delisle, Drolet, Hains, Tailleur, Allaire, Coulombe and Vézo (2020) present the case of two geriatric units in which *Kaizen* was used to improve the patient's journey. In the *Kaizen* project format, following the DMAIC methodology (acronym in English for the phases define, measure, analyze, improve and control), in which planning is done 45 days before a 3-day event is held, which, in turn, is followed by a 12-week implementation and control period.

Lamm, Eckel and Amerine (2015) present the use of lean principles, including *Kaizen*, in a chemotherapy clinic. In this article, the improvement model used begins with data preparation and collection, followed by a 5-day *Kaizen* event, using the Lean Six Sigma method, using A3 thinking.

The emergency department is one of the most important parts of a hospital. Its proper functioning has a great impact on the quality of care and patient satisfaction, as well as on the volume of service demands to other auxiliary departments, such as the laboratory and pharmacy. Furthermore, the emergency department is where patients often have their first hospital experience. In recent years, due to the increase and aging of the population, epidemiological and social-economic factors that imply a sick population, the demand for emergency services has been growing. Due to their relevance and the sensitivity of the services provided, emergency departments must be structurally and organizationally well-organized and defined in order to provide a high-quality service (MOUSAVI ISFAHANI; TOURANI; SEYEDIN, 2019).

For a more specific understanding of the *Kaizen* approach on ECU, a review was conducted following the PRISMA recommendations. The terms "*Kaizen*" and "hospital" and "*Kaizen*" and "healthcare" were used as search criteria. Searches were also performed with "*Kaizen*" and "emergency", resulting in a small number of documents, all of which were contained in the search "*Kaizen*" and "hospital". These search terms were connected using the boolean operator 'AND'.

For this review, all scientific articles and congress documents published between the years 2011 and 2021, until May 27, 2021, in English, were selected. The search in the databases of PubMed, Scopus and Web of Science returned 370 documents for the defined search criteria. For this search, 370 records were found.

Among the 370 records, 95 were duplicates, 228 were excluded after reading the title and abstract and 36 were excluded because they did not meet the eligibility criteria, book or book chapter documents and documents that were not in English in their entirety. In the end, 11 documents remained, which were fully read. Of these,

only seven had the work model used regarding the use of *Kaizen*. Reading the articles brought us, as expected, a variety of forms in how health institutions are applying the concept of *Kaizen* in emergency departments around the world.

Among the selected studies, the article published by Carney, Crespin, Woerly, Brethouwer, Baucum and DiStefano (2020) presents the application of *Kaizen* at Children's Hospital Colorado, Colorado, USA. The authors describe an initiative lasting more than one year, with the objective of improving emergency department indicators, namely, door-to-office time, abandonment rate, percentage of visits in less than 30 minutes and patient satisfaction. It is, therefore, a systemic approach. The use of *Kaizen* presented begins with the interest of the top leadership, who hires an external expert (consultant) to assist in the implementation. In the first year, a committee was established, and employees were trained. The group did a VSM after this initial approach. After surveying opportunities, *Kaizen* was carried out in a 5-day event format with pilot implementation and sustainability monitoring for a period of two months. The article deals with this event and does not discuss the application of *Kaizen* at other times.

The article published by Hitti, El-Eid, Tamin, Saleh, Saliba and Naffa (2017) presents the application of *Kaizen* in the radiology department of the emergency department of the American University of Beirut Medical Center (AUBMC), Lebanon. The authors describe the use of *Kaizen* from a multidisciplinary team existing in the hospital's emergency department. This team was motivated by patient complaint records and aimed to reduce the radiology department's response time. This initiative also takes place over a period of more than one year, with six months of preparation, one month of interventions in which the VSM and chrono analyzes were carried out (the *Kaizen* event) and six months of monitoring the results. This article also does not discuss the application of *Kaizen* at other times and how the institution forms and maintains the *Kaizen* spirit.

The article published by Medina-León, Medina-Palomera, Gonzalez-Angeles, Rogers, Gil-Samaniego-Ramos, Ceballos-Corral and Nuno-Moreno (2014) presents the application of *Kaizen* in the gynecology and obstetrics department of the emergency department of a public hospital in Mexico City, Mexico. The authors present a framework for defining when *Kaizen* should be used. In the structure presented, the study of the process is carried out to identify bottlenecks and, if the opportunity to address the bottleneck refers to the implementation of 5S, use of the SMED technique,

implementation of *kanban*, standardization of the process, use of visual management frameworks, elimination of unnecessary processes, they move on to the use of *Kaizen*. For the problem discussed in the article, no needs were identified to justify the use of *Kaizen*.

The article published by Phillips, Hebish, Mann, Ching and Blackmore (2016) presents the application of *Kaizen* in the emergency department of the Virginia Mason Institute Hospital in Seattle, USA. Unlike the approaches presented by Carney, Crespin, Woerly, Brethouwer, Baucum and DiStefano (2020); Hitti, El-Eid, Tamin, Saleh, Saliba and Naffa (2017); Medina-León, Medina-Palomera, Gonzalez-Angeles, Rogers, Gil-Samaniego-Ramos, Ceballos-Corral and Nuno-Moreno (2014); Phillips, Hebish, Mann, Ching and Blackmore (2016) use the concept of daily *Kaizen* (everyday lean idea). The authors present *Kaizen* in line with the concept originally proposed by Imai (1986), of continuous improvement practiced by everyone as a routine and not as a project.

In this article, the authors comment that *Kaizen* is done with the support of its leaders who use huddles, rounds and visual management boards to train and recognize teams when proposing and executing improvements. This article is not, therefore, about a project focused on business results, but about the leader's standard work as a developer of a culture of continuous improvement.

The article published by Suarez-Barraza and Miguel-Davila (2020) presents the application of *Kaizen* in the admission of patients to the emergency department of a large hospital in Mexico. The article presents a method proposed and applied by the authors, whose structure follows the steps: 1) carrying out a diagnosis of the current situation; 2) practical training and guidance of key people; lasting 20 hours; 3) training and formation of *Kaizen* teams; 4) three months of measuring the current state; 5) prioritization of problems with Pareto chart; 6) survey of root causes with Ishikawa diagram; 7) construction of the improvement action plan; and 8) implementation of the proposed actions (three to five months depending on available resources). The article does not present the application and results of a *Kaizen* initiative.

The article published on *Kaizen* at Summer Regional Medical Center, Lake Cumberland Regional Hospital, and LifePoint Hospital, all in Tennessee, USA, without author (LEAN-DRIVEN…, 2012), introduces the use of *Kaizen* in a framework in which *Kaizen* takes place in a 3-day event. On day 1, the current patient flow is sketched and the search for waste is carried out, on day 2 there is a discussion to redesign the

flow and on day 3, the pilot implementation plan is detailed and approved by the administration.

Finally, the article published by Kovacevic, Jovicic, Djapan and Zivanoviz-Makuzic (2016) presents the application of *Kaizen* in the emergency department laboratory of Vidant Health Centers, Greenville, North Carolina, USA. The article presents *Kaizen* as part of a Six-*Sigma* project, after defining the project team to ensure understanding of the topic.

Objective

The objective of this article is to evaluate the application of *Kaizen* implemented during the two lean implementation projects in Brazilian 24h ECU, aiming to provide valuable information for the design and improvement of future projects of the same scope.

Method

This study consists of a summative evaluation of the Lean Implementation Project funded by the Brazilian Ministry of Health during its first and second projects that have been named in this work as Project 1 and Project 2.

The Federal Fluminense University coordinated both projects. The scope of each project was to implement lean thinking, methods and tools in 50 selected units pursuing the reduction of queues and overcrowding.

The 24h ECU selected were distributed along the five main regions of Brazil. In Project 1, 40% of the units were located at Southeast, 28% at Northeast, 21% at Midwest, 6% at South and 4% at North Region. In Project 2, 36% of the units were located at Southeast, 26% at Northeast, 19% at South, 15% at Midwest and 4% at North Region. It means the projects contemplated all regions with its geographical and cultural differences.

As explained by Fitzpatrick, Sanders and Worthen (2011), evaluation methods consist of the identification, clarification and application of defensible criteria to determine an evaluation objective's value in relation to the established criteria. For this study, the author followed the steps described in sequence:

First Step: define the purpose of the evaluation

The purpose for this study is to compare the actual implementation with literature reported application models and to evaluate Project 1 and Project 2 *Kaizen* implementation approach. The partnership between the Brazilian Ministry of Health and the Federal Fluminense University imposes a demand for project evaluation, with ways to understand and direct its continuity.

Second Step: define the evaluation criteria

Chaves *et al.* (2022) analyzed using datamining the good practices (*Kaizen*) implemented on Project 1. The analyses presented showed a pattern with clusters related to Environment, Work Processes, Communication, Pandemic, Monitoring and Follow up and Provision of resources. Reis, Viera, Amaral, Farias Filho, Teixeira and Calado (2021) 15 motivators for lean implementation that can be grouped in improving satisfaction (patient employee), improving quality of care, reducing risks (including safety), increasing capacity, reducing times and increasing productivity and reducing costs.

Based on Chaves *et al*. (2022) and Reis, Viera, Amaral, Farias Filho, Teixeira and Calado (2021), the authors defined, as criteria for evaluation: the type of waste identified and treated, the theme of the improvement implemented, and the type of resources utilized to implement the *Kaizen* proposed. And, to complement the evaluation, a comparison between literature findings and Project 1 and Project 2 *Kaizen* approach was conducted.

Criteria 1: type of waste

- **Defects:** refers to the observation of non-conformities, situations in which an established standard is not followed, when an established standard is not adequate (by being obsolete, incomplete or unclear). It can also be identified when a legal standard or rule is not being obeyed.
- **Wait:** refers to the observation of people or processes waiting for materials (like medicines), equipment, information (like exams results or patient information) or people (patient or care team).
- **Excess movement:** refers to the observation of people, material, equipment or information moves from one place to another following a non-optimized route or moving through a route different from the one planned.

- **Excess transportation:** refers to the observation of people, material, equipment or information being transported from one place to another following a non-optimized route or through a route different from the one planned.
- **Excess inventory:** refers to the observation of people, material, equipment or information in quantities different from the ones necessary to deal with the demand (considering its variation). Any amount greater than the one necessary for answering the demand is considered excess.
- **Waste of talent:** refers to the observation of specialized people performing activities that could be performed by a less specialized person. It can also be observed in not integrated actions taken by each member in the team, not considering the experience and expertise of all involved.
- **Overprocessing:** refers to the observation of an activity being performed with more steps than the necessary to get to its results, or being performed using an equipment more accurate than the accuracy needed for the results pursued.
- **Overproduction:** refers to the observation of an activity being performed before the actual demand is in place.

Criteria 2: theme of the improvement

- **Communication:** when the description demonstrates that the improvement is applied to solve a communication problem between patient and care team, between team members, between departments.
- **Standardization:** when the description demonstrates that an improvement is applied to solve the problem/or its outdatedness, either by the existence of fields that work and are outdated.
- **Maintenance:** when the description demonstrates that the improvement is applied to solve a problem related to the maintenance of infrastructure and equipment.
- **People:** when the description demonstrates that the improvement is applied to solve a problem related to people, regarding the number of people, organization of human resources and competence/training of human beings. When for the development of a management a work system for human resources must be adjusted as planned.
- **Environment:** when the description demonstrates that the improvement is applied to solve problems related to the work environment, such as reorganizations

and that do not fit the maintenance item. Items related to a work environment should be found here. Items that refer to workflow guidance, which should be designed as protection protocols and procedures.

Criteria 3: type of resources utilized

- **Working hours:** when carrying out the activity resolved only with the time of the unit's team.
- **Administrative expenses:** when carrying out the activity was resolved only with resources as results. Financial expenses made available in the institutions' budgets and do not include investments in new equipment and infrastructure works.
- **Investment:** when carrying out the activity was resolved only with resources classified as investment. Investments are financial resources made available for the purchase of new equipment and works.

Third step: define the data necessary for the evaluation

The *Kaizen* implemented on Project 1 and Project 2 were registered at the Best Practices Application of the project. The information available in the databases of *Kaizen* is: time and date, name of the ECU, title, waste identified, keywords, description of the problem, description of the actual situation, description of the improved situation, objectives of the improvement, sector where the improvement have been implemented and names of the team. Considering the information available on *Kaizen* database of the projects, there was a need to categorize the information to evaluate the "theme of the improvement" and the "type of resources utilized".

Fourth step: elaborate data collection strategy

The authors defined to use the *Kaizen* database for the projects and to make samples of each project database to categorize the information for evaluation.

Fifth step: collect and analyze the data

The data was collected from the application and analyzed using Microsoft Excel®. A simple randomized sample for a finite population was calculated, using 90% confidence interval for each project database and data categorized with the information required for evaluation, by the authors, in consensus. The authors conducted a descriptive analysis of the events, for all the records in the application that included every ECU within the two projects, totalizing 100 units and 1.769 records.

Results

Analysis for criteria "Type of waste"

The identification of wastes is multifactorial because in one single observation, more than one waste can be identified. From the analysis of the complete database, the author found that in Project 1 the teams declared more than one waste for 20% of the recordings and in Project 2 they only registered a single waste *per* record. Therefore, the authors considered only the first waste declared for the analysis. Table 1 presents the distribution of records in each project stratified *per* waste declared. Full database was used. In both cycles, 'defects' are the prevalent waste identified and treated, followed by 'excess movement and 'waste of talent'.

Table 1 - Frequency distribution of *Kaizen* records from Project 1 and Project 2, stratified by type of waste and its representativeness

First waste declared	Project 1		Project 2		Total	
	Amount	%	Amount	%	Amount	%
Defects	191	**28%**	508	**47%**	699	**40%**
Excess movement	141	**21%**	194	**18%**	335	**19%**
Waste of talent	176	**26%**	133	**12%**	309	**17%**
Wait	83	12%	104	10%	187	11%
Inventory	55	8%	124	11%	179	10%
Overproduction	15	2%	7	1%	22	1%
Overprocessing	5	1%	17	2%	22	1%
Excess transport	11	2%	5	0%	16	1%
Total	**677**[1]		**1092**		**1769**	

[1]One record without waste declared had been omitted from the table.
Source: The authors (2023).

Analysis for criteria "Theme of the improvement"

To analyze the "Theme of the improvement", a categorization of the records was necessary, wherefore a sample for each project was calculated, for 90% confidence interval. For Project 1, consisting of 678 records, the simple random sample calculation provided a sample size of 195 records. And, for Project 2, consisting of 1.092 records, the simple random sample calculation provided a sample size of 219 records. The categorization was made with consensus after discussion between the authors.

In both projects, the *Kaizen* implemented directed efforts mostly on issues related to the 'environment' and 'standardization'. The authors' findings are presented in Table 2.

Table 2 - Frequency distribution of *Kaizen* records from Project 1 and Project 2, stratified by theme of the improvement and its representativeness

Theme of the improvement	Sample: Project 1		Sample: Project 2		Total	
	Amount	%	Amount	%	Amount	%
Environment	93	**48%**	107	**49%**	200	**48%**
Standardization	59	**30**%	67	**31%**	126	**30%**
Communication	18	9%	25	11%	43	10%
People	20	10%	3	1%	23	6%
Maintenance	5	3%	17	8%	22	5%
Total	**195**		**219**		**414**	

Source: The authors (2023).

When analyzing the tools explicitly mentioned in the records, three lean tools are mentioned: (1) 5S, (2) Huddle and (3) Fast track. The 5S tool appear in 36.9% of the records in Project 1 and in 37.4% records in Project 2. The Huddle appears in 1.5% of the records in Project 1 and in 3.2% records in Project 2. And the Fast track appears in 3.6% of the records in Project 1 and in 5.0% records in Project 2.

Another useful information to understand the theme is the keywords registered. To deepen the understanding of the theme of the improvement, the authors analyzed the keywords. A list of the top 10 words and its frequency is presented on Table 3.

Table 3 - Frequency distribution of *Kaizen* records keywords most frequent from Project 1 and Project 2 with its positions on the rank of each project

Keyword	Project 1	Position	Representativeness	Project 2	Position	Representativeness
Organization	264	1º	8.0%	161	1º	6.3%
Standardization	146	2º	4.4%	45	4º	1.8%
Safety	108	3º	3.3%			
Patient	95	4º	2.9%			
Time	86	5º	2.6%			
Wait	70	6º	2.1%	43	6º	1.7%
5S	65	7º	2.0%	125	2º	4.9%
Cleaning	62	8º	1.9%			
Service	61	9º	1.8%	28	10º	1.1%
Identification	54	10º	1.6%	54	3º	2.1%
Pharmacy				44	5º	1.7%
Stock				39	7º	1.5%
Maintenance				34	8º	1.3%
Flow				32	9º	1.3%
Total			30.6%			23.7%

Source: The authors (2023).

Adding up to this analysis, the authors crossed the "Type of Waste" and "Theme of the improvement" criteria, the authors observed that the prevailed category 'environment' is not concentrated in one specific waste. It accompanies the most frequent wastes (defects, excess movement and talent wasted). Table 4 and Table 5 present the results of the cross.

Table 4 - Frequency distribution of *Kaizen* records from Project 1 crossing "Type of waste" and "Theme of the improvement"

Project 1	**Environment**		**Standardization**		**Communication**		**People**		**Maintenance**		**Total**	
Wastes	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Defects	28	14.4%	18	9.2%	7	3.6%	4	2.1%	2	1.0%	59	30.3%
Wait	2	1.0%	15	7.7%	0	0.0%	1	0.5%	1	0.5%	19	9.7%
Excess_Movement	24	12.3%	12	6.2%	4	2.1%	2	1.0%	2	1.0%	44	22.6%
Talent_Wasted	25	12.8%	9	4.6%	6	3.1%	12	6.2%	0	0.0%	52	26.7%
Excess_Inventory	14	7.2%	1	0.5%	0	0.0%	0	0.0%	0	0.0%	15	7.7%
Overproduction	0	0.0%	2	1.0%	1	0.5%	1	0.5%	0	0.0%	4	2.1%
Overprocessing	0	0.0%	2	1.0%	0	0.0%	0	0.0%	0	0.0%	2	1.0%
Total	93	47.7%	59	30.3 %	18	9.2%	20	10.3 %	5	2.6%	195	100.0%

Source: The authors (2023).

Table 5 - Frequency distribution of *Kaizen* records from Project 2 crossing "Type of waste" and "Theme of the improvement"

Project 2	**Environment**		**Standardization**		**Communication**		**People**		**Maintenance**		**Total**	
Wastes	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Defects	31	14.2%	21	9.6%	7	3.2%	0	0.0%	15	6.9%	74	33.8%
Wait	7	3.2%	15	6.9%	3	1.4%	2	0.9%	0	0.0%	27	12.3%
Excess_Movement	27	12.3%	11	5.0%	1	0.5%	1	0.5%	0	0.0%	40	18.3%
Talent_Wasted	1	0.5%	7	3.2%	14	6.4%	0	0.0%	0	0.0%	22	10.1%
Excess_Inventory	39	17.8%	7	3.2%	0	0.0%	0	0.0%	0	0.0%	46	21.0%
Overproduction	0	0.0%	4	1.8%	0	0.0%	0	0.0%	1	0.5%	5	2.3%
Overprocessing	1	0.5%	2	0.9%	0	0.0%	0	0.0%	1	0.5%	4	1.8%
Excess_Transportation	1	0.5%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.5%
Total	107	48.9%	67	30.6%	25	11.4 %	3	1.4%	17	7.8%	219	100.0%

Source: The authors (2023).

Analysis for criteria "Type of resources utilized"

The type of resource could not be accurately defined. After discussing the records, the authors concluded that there were not enough and accurate information to categorize the resources used.

Kaizen's approach on the specialized literature

The specialized literature included information about the results and the approach (or method) used when implementing *Kaizen* as part of the Lean Thinking Strategy. Despite the different formats, there is a general pattern among all the approaches presented in the articles, which encompasses three phases: 1) preparation; 2) execution; and 3) sustainability. Table 6 resumes the information encountered in the literature about the approaches and provides useful benchmark information.

Table 6 - Kaizen work model for the publications related to ECU

Publication	Work Model
Carney, Crespin, Woerly, Brethouwer, Baucum, DiStefano (2020)	Department: pediatric emergency department at Children's Hospital Colorado, Colorado, USA Work model: 1) multidisciplinary team establishment; 2) training; 3) use VSM to make a diagnostic; 4) promote a week *Kaizen* event; 5) piloting the solutions; and 6) monitoring.
Hitti, El-Eid, Tamin, Saleh, Saliba, Naffa (2017)	Department: emergency department radiology at American University of Beirut Medical Center (AUBMC), Lebanon Work model: 1) structuring initiative (measurements, training, awareness); 2) multidisciplinary team establishment; 3) use VSM and time and motion studies; 4) execute actions; and 5) monitoring results.
Medina-León, Medina-Palomera, Gonzalez-Angeles, Rogers, Gil-Samaniego-Ramos, Ceballos-Corral, Nuno-Moreno (2014)	Department: emergency department obstetrics/gynecology at Public Hospital in Mexico City, Mexico Work model: 1) bottleneck identification; 2) classification of the problem (complex or non-complex); 3) *Kaizen* event preparation (agenda, scope and baseline); 4) actions proposal; and 5) execution.
Phillips, Hebish, Mann, Ching, Blackmore (2016)	Department: hospital emergency department at Virginia Mason Institute, Seattle, USA Work model: 1) leadership standard work implementation; 2) coaching of employees; 3) proposal of ideas; and 4) ideas implementation.
Suarez-Barraza, Miguel-Davila (2020)	Department: admission to the emergency department of a large public hospital at Mexico Work model: 1) diagnosis of the current situation; 2) training and coaching; 3) teams formation; 4) *Kaizen* project executed; and 5) actions implementation.
Kovacevic, Jovicic, Djapan, Zivanoviz-Makuzic (2016)	Department: Emergency Department Laboratory at Vidant Health Centers, Greenville, North Carolina, USA Work model: 1) project definition and 2) six-*sigma* project conduction.

Source: The authors (2023).

Final considerations

The result of the analysis indicates that the Brazilian 24h ECU *Kaizen* implementation focused efforts on organizing the environment and standardizing the processes. It corroborates with the keyword's "organization", "standardization" and "5S" among the top 10 position in both projects. As well as the mention of 5S method in more than 30% of the records in both projects. It points to a need to start the lean implementation by structuring the processes and the environment.

Considering the literature available and the records analyzed, there is still opportunities to promote *Kaizen* for problem solving of recurring problems, using problem-solving approaches (PDCA or DMAIC).

For a future project or for individual initiatives, there should be considered to conduct an institution wide 5S implementation, organizing and standardizing the processes in the initial steps of the implementation. And, to follow with problem solving *Kaizen* initiatives.

There is little literature regarding the *Kaizen* application on ECU. The results of a case study reveal important information on a pattern on Brazilian 24h ECU that can serve as a starting point for further discussions on *Kaizen* implementation on similar environments. Specifically for Brazil, the identified patterns can serve as useful information for the 24h ECU that decide to follow such implementation, considering the projects did not contemplate all Brazilian 24h ECU.

And information about the resources utilized to implement the *Kaizen* should be collected to provide information on how much does the *Kaizen* cost.

Limits of the study

This study is limited to the analysis of the records of the improvements of the lean implementation projects funded by the Brazilian Ministry of Health and a literature review on emergency care units.

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