Materials Today: Proceedings 46 (2021) 9610–9612

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Impact of lean implementation from the ergonomics view: A research article

H. Vinoth Kumar [a], Sivakumar Annamalai [b], N. Bagathsingh [c]

[a] Department of Mechanical Engineering, M. Kumarasamy College of Engineering, Karur, Tamilnadu, India
[b] Department of Mechanical Engineering, Kongu Engineering College, Erode, Tamilnadu, India
[c] Department of Mechanical Engineering, Chettinad College of Engineering and Technology, Karur, Tamilnadu, India

ARTICLE INFO

Article history:
Received 1 June 2020
Received in revised form 17 June 2020
Accepted 5 July 2020
Available online 9 August 2020

Keywords:
Lean manufacturing
Ergonomics
Implementation
Impact
Workforce

ABSTRACT

In the developed industries, it has been demonstrated that the efficient incorporation of Ergonomics in procedures and facilities reduces expenses associated with disability, additional or overtime hours, health care, premiums or incident fines. The Lean tools are complicated and beneficial but it can cause Ergonomics problems with promising modifications. Human wealth, the most significant component in an organisation, often feels the essence of the issues. The objective of this job was to evaluate current science understanding on the effect of implementing Lean manufacturing tools from the point of perspective of Ergonomics in manufacturing sectors. This study informs, based on the literature reviewed, how the incorporation of the ethics of both Lean tools and Ergonomics from the plan stage of the workplace can carry advantage to the safety of the employees and at the same time to increase the power of efficiency improvements. This article as well aims to precede trends and possibilities in this field for upcoming studies.

Selection and Peer-review under responsibility of the scientific committee of the International Mechanical Engineering Congress 2019: Materials Science.

1. Introduction

Lean manufacturing is a notion that is increasingly appearing in business that supports human requirements and their well-being. The well-being of human resources must be occasionally monitored and checked. The primary goal of the lean production is to reduce costs and increase productivity by eliminating waste. Employees need feedback and immediate participation in the industry, decrease of stress in lean manufacturing by exposure all misunderstandings, internal support between staff and executives. All this together, through Lean manufacturing, represents an Ergonomic viewpoint [1]. Work-related musculoskeletal disorders (WMSDs) are a significant sector problem that may also negotiate competitiveness owing to labour costs, labour income, absence, bad quality, and decreased output expenses. Most organisations presently only executes lean tools and do not consider the workers' security elements. Thus the firm could provide employees with safety and healthy surroundings and working conditions through undertaking the survey [2]. A key factor in empowering employees is the guarantee of safe working conditions. Although this factor is taken into consideration in the description of sustainable sector, in their sustainability plans, not many companies actually consider or create this approach [3]. During Lean manufacturing application, the incorporation of Ergonomics has the ability to achieve significant productivity gains and at the same time enhance working circumstances [4]. This document demonstrates Lean manufacturing's Ergonomics problems after a fast briefing and study.

2. Methodology

This research is based on a comprehensive literature review of the connection among Lean manufacturing and ergonomics and its effect on the working circumstances as well as the well-being of employees. The background is Lean execution in industrial settings and in the manufacturing industry, primarily at workplaces. A Systematic Literature [5] Review method was used to perform this research. I t defines present publications, chooses and evaluates contributions, analyzes and synthesizes data, provides proof to illustrate appropriate conclusions on what is previously recognized and consolidated and what is still understood [10–12]. Data

https://doi.org/10.1016/j.matpr.2020.07.113
2214-7853/
Selection and Peer-review under responsibility of the scientific committee of the International Mechanical Engineering Congress 2019: Materials Science.

from this technique have been gathered by databases that are the largest repositories in business research and are frequently used in studies projects such as Elsevier's Scopus. Our objective in identifying the search keywords was to discover as many documents as possible that looked at IT in the Lean manufacturing and Ergonomics context. All peer reviewed documents available in the past five years. The first stage was to eliminate the duplicates after acquiring the first set of papers from the distinct databases [15]. The first screening method then examined the titles and abstracts of the papers recognized and unconcerned articles; which were i) not in English ii) not related to Ergonomics and Lean Manufacturing iii) Lack of assessment. The complete research approach resulted in a sample of 294 articles. 81 duplicated papers, 4 non-English papers, 112 not fully assessed papers and 43 unrelated papers were found and quickly removed. In extra screening stage, 34 other papers were considered irrelevant for the purposes of this research, and therefore expelled. The original samples of 294 papers were reduced to 20 articles for literature analysis based on this methodology. The steps of the article selection process were shown in Fig. 1 and Table 1.

As a consequence, a total of 20 articles were integrated in the final sample over a period of previous five years, which were considered interrelated for further evaluation.

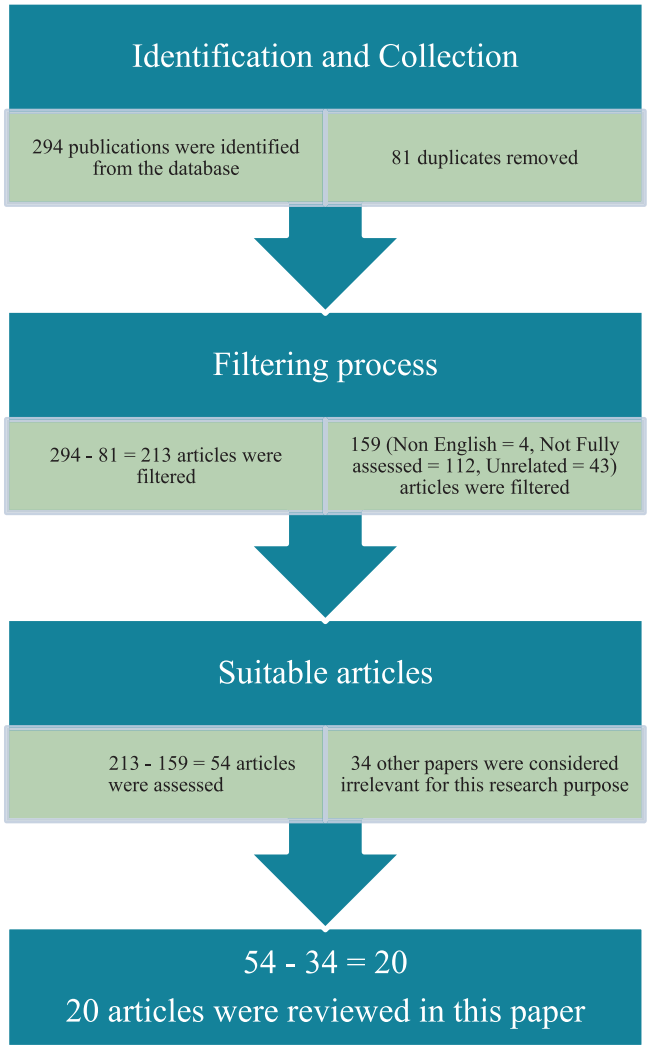

Fig. 1. Flow chart of systematic literature review.

Table 1
Search results.

Keywords	Implementation of lean manufacturing	Ergonomics	Lean and ergonomics
Number of articles	56	23	215
Total	294		

3. Lean Implementation from Ergonomic view

- What countless industries fail to understand is the potential to further increase productivity gains by integrating and implementing ergonomic principles simultaneously with lean systems [5].
- The findings of integration of Ergonomic with Lean manufacturing indicate a decrease in absenteeism due to changes produced and enforced in offices or workstations, is to have better working circumstances and thus improve the revenue of staff to conduct activities and improve quality [6,19].
- Lean Ergonomics results have shown a decrease in employee absenteeism as they are interested in working in better circumstances and increasing their revenue [7].
- Adapting the Ergo-Lean strategy decreases the adverse impacts of lean on the quality of life of employees and improves operational efficiency such as performance of operators, performance yield, complete lead time, value-added ratio, scrap and errors [8,20].
- Workstation design method plays a significant role in enhancing organizational performance and quality indicators. Nevertheless, it is not prevalent to discover user-oriented design and task demands in industrial workstations [9].
- When designing/ redeveloping a work station, ergonomic circumstances must be regarded in order to achieve efficient productivity improvements. In particular, ergonomic elements in business are still hard to enforce because some decision makers do not see ergonomics as an investment, but rather as a cost [13–14].

Lean Ergonomics can reduce lead time by eliminating waste from non-productive manual material handling movement such as stretching, bending, awkward postures and comprehensive reach, as well as increasing workers' effectiveness, safety, and health. To sum up, the significance of incorporating Ergonomic elements in Lean production is consensual [16–18].

The literature has many cases of the advantages of incorporating ergonomics elements into a Lean System in various industries. Some of the positive results are shown in Table 2.

4. Results and discussion

Survey analyses among industrial executives showed that they still regard ergonomics as a instrument for preventing health and disease rather than as a technique for saving costs and reducing waste. The current review discovered several studies during Lean execution reporting beneficial and negative impacts on the health of employees. This absence of agreement could lead to Lean instruments being misinterpreted and misused. Most writers of the analyzed research agreed that the integration of Ergonomics during Lean execution could lead to productivity gains and enhance working circumstances at the same time. Several instruments have recently emerged to assess and guide Lean execution while taking Ergonomic elements into consideration. In the view of the writers, they are general in scope despite the presence of several instru-

Table 2
Some of the results from literature on implement lean & ergonomics in various sectors.

Type of industries	Authors	Positive effects
Automobile Industry	Srinivasa Rao	The findings showed a decrease in worker absences as they are interested to work in the better working circumstances and increasing their revenue. They often make every effort to achieve the required production with the finest quality and quantity
Textile Industry	Thandapani Sakthi Nagaraj	Adapting the Ergo-Lean strategy decreases the adverse impacts of lean on the quality of life of employees and improves operational efficiency such as performance of workers, performance yield, complete lead time, value-added ratio, scrap and errors.
Meat Industry	Lucia Botti	Ergonomic design layout increases the production quality, hygiene and safety, financial benefits for workers and management.
Metallurgical Industry	M. Brito	In the PVD region productivity improved by about 7%, in the packing region by 140%, in the tuning region by 40% and in the polishing and sanding region by 50%.
Manufacturing	Rosnah Mohd Yusuff	Ergonomics can function as a lean manufacturing technique as it can be used to define danger, as well as to decrease the risk factors connected with the danger.

ments and none of them are committed to workstations or the region of manufacturing.

5. Conclusion

- The ever growing Lean implementation in the workplace has enabled researchers to explore how this strategy interacts with other jobs. Ergonomics is one of the key professions to be studied in conjunction with lean efforts.
- Constructing workstations with respect to the values of Lean and Ergonomics results in productivity gains for both staff and companies.
- This research is anticipated to assist scholarly community and professionals pay more attention to the Lean and Ergonomics connection.

CRediT authorship contribution statement

H. Vinoth Kumar: Methodology, Writing - review & editing. **Sivakumar Annamalai:** Supervision. **N. Bagathsingh:** Validation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] B. Cirjaliu, A. Draghici, Ergonomics issues in lean manufacturing, Procedia – Soc. Behavioral Sci. 221 (2016) (2016) 105–110, https://doi.org/10.1016/j.sbspro.2016.05.095.

[2] L. Botti, C. Mora, A. Regattieri, Integrating ergonomics and lean manufacturing principles in a hybrid assembly line, Comput. Indus. Eng. 111 (2017) (2017) 481–491, https://doi.org/10.1016/j.cie.2017.05.011.

[3] C. Alayón, K. Säfsten, G. Johansson, Conceptual sustainable production principles in practice: Do they reflect what companies do?, J Cleaner Prod. S0959–6526 (16) (2016) 31420–32245.

[4] Dr. Rosnah Mohd Yusuff, Nor Suhada Abdullah, Ergonomics as a Lean Manufacturing tool for improvements in a Manufacturing company, Int. Conf. Indus. Eng. Oper. Manage., 8–10, 2016.

[5] Isabel L. Nunes, Integration of ergonomics and lean six sigma. A model proposal, Procedia Manuf. 3 (2015) 890–897, https://doi.org/10.1016/j.promfg.2015.07.124.

[6] Zélio Geraldo dos Santos, Leandro Vieira, Giles Balbinotti, Lean manufacturing and ergonomic working conditions in the automotive industry, Procedia Manuf. 3 (2015) 5947–5954, https://doi.org/10.1016/j.promfg.2015.07.687.

[7] P. Srinivasa Rao, Malay Niraj, A Case study on implementing lean ergonomic manufacturing systems (LEMS) in an automobile industry, Mater. Sci. Eng., 149 (2016)012081. doi; 10.1088/1757-899X/149/1/012081.

[8] Thandapani Sakthi, Nagaraj, Rajamani Jeyapaul, K.E.K Vimal, Kaliyan Mathiyazhagan, Integration of human factors and ergonomics into lean implementation: ergonomic-value stream map approach in the textile industry, Prod. Planning & Control 30 (15) (2019) 1265–1282, https://doi.org/10.1080/09537287.2019.1612109.

[9] Annamalai Sivakumar, Kaliannan Saravanan, A simulation based analysis for improvement of productivity in sick chemical dyeing factory: A research article, Int. J. Electro. Transp. 10 (1) (2011) 96–110.

[10] Micael Teixiera Gonclaves, Konstantinos Salonitis, Lean assessment tool for workstation design of assembly lines, Procedia CIRP 60 (2017) (2017) 386–391, https://doi.org/10.1016/j.procir.2017.02.002.

[11] Faisal Aqlan, Sarah S Lam, Srikanth Ramakrishnan, Warren Boldrin, Integrating lean and ergonomics to improve internal transportation in a manufacturing environment, Indus. Syst. Eng. Res. Conf. – Res. gate (2014).

[12] Lucia Botti, Cristina Mora, Francesco Piana and Alberto Regattieri. 2018. "The impact of ergonomics on the design of Hybrid Multi model production lines in Lean Manufacturing." Advances in Ergonomics of Manufacturing: Managing the Enterprise of the future, Advances in intelligent systems and computing 606. doi: 10.1007/978-3-319-60474-9_16.

[13] Pedro M. Arezes, Jose Dinis-Carvalho, Anabela Carvalho Alves, Workplace ergonomics in lean production environments: A literature Review, IOS Press 52 (2015) (2015) 57–70, https://doi.org/10.3233/WOR-141941.

[14] Saveta Vukadinovic, Ivan Macuzic, Marko Djapan, Marko Milosevic, Early management of human factors in lean industrial systems, Safety Sci. 119 (2019) 392–398, https://doi.org/10.1016/j.ssci.2018.10.008.

[15] M. Brito, A.L. Ramos, P. Carneiro, M.A. Goncalves, Integration of lean manufacturing and ergonomics in a metallurgical industry, Int. J. Occupational Environ. Safety 2–2 (2018) (2018) 21–31, https://doi.org/10.24840/2184-0954_002.002_0003.

[16] Theoni Koukoulaki, The impact of Lean production on musculoskeletal and psychosocial risks: An examination of sociotechnical trends over 20 years, Appl. Ergonomics 45 (2014) (2014) 198–212, https://doi.org/10.1016/j.apergo.2013.07.018.

[17] A. Sivakumara, A. Saravanan, A Systemized operational Planning, implementation and Analysis of Robust Framework for improvement of partial and total productivity in Textile Fabric industry : A Research paper, European Journal of Scientific Research 53 (3), 385-399, 2011.

[18] Guilherme Luz Tortorella, Lizandra Garcia Lupi Vergara, Evelise Pereira Ferreira, Lean manufacturing implementation: an assessment method with regards to socio-technical and ergonomics practices adoption, Int. J. Adv. Manuf. Technol. 89 (9-12) (2017) 3407–3418, https://doi.org/10.1007/s00170-016-9227-7.

[19] Lucia Botti, Cristina Mora, Alberto Regattieri, Improving ergonomics in the meat industry: A case study of an Italian ham processing company, IFAC-Papers Online 48–3 (2015) (2015) 598–603, https://doi.org/10.1016/j.ifacol.2015.06.147.

[20] Pedro M. Arezes, Jose Dinis-Carvalho, Anabela Carvalho Alves, Workplace ergonomics in lean production environments: A literature review, IOS Press 00 (2014) (2014) 1–14, https://doi.org/10.3233/WOR-141941.