Relationship Between Lean Manufacturing and Ergonomics

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Abstract. Lean manufacturing philosophy has been perceived by numerous organizations in order to respond to economic recession occurred at the beginning of the twenty-first century. Two key reasons for this trend are associated with attempting to cost reduction and customer satisfaction improvement. Along with this issue, a broad research domain for investigation is created for scholars. There is a dearth of published information about the relationship between lean manufacturing and ergonomics. This idea was the initial interest of this work. While ergonomics concerns improving worker's productivity through adaptation between people and their job, lean tools and techniques provide overall productivity within the workplace through waste elimination from work processes. Thus, it seems that lean manufacturing and ergonomics can be interlinked. By identifying the interrelations between ergonomics and lean manufacturing, both can be addressed simultaneously. In addition, the synergism between lean and ergonomics can be achievable. In the present study, existing literatures are analyzed to better understand the common viewpoints between lean manufacturing and ergonomics.

Keywords: Lean manufacturing · Ergonomics · Relationship

1 Ergonomics Definition

Ergonomics is a profession that studies the interaction among people and other elements of a system. Principles, theories, methods, and data are employed to improve human well-being and overall performance of the system. Ergonomics initiatives are taken to prevent occupational risks and musculoskeletal disorders which result in increasing employees' productivity. Helander [1] illustrates the purpose of ergonomics on creating productive, safe, and comfortable system. Additionally, Salvendy [2] describes ergonomics as a body of knowledge to successfully adapt job requirements to individuals. This definition is supported by Niebel and Freivals [3] where they introduce ergonomics as the science of designing systems with regard to human's capabilities and limitations. In that sense, if tools, equipment, and workplace's design are not adapted with human's characteristics, human error, occupational accident, and occupational disease can

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happen [4]. Also, when job demands exceed capabilities of humans (psychological and physical), musculoskeletal disorders are arisen [5]. Through fitting job demands to human capabilities, ergonomics contributes to improvement of quality and productivity in the workplace.

2 Importance of Musculoskeletal Disorders (MSDs)

One of the key goals of ergonomics is preventing from musculoskeletal disorders. Various ergonomics methods and techniques exist to prevent and detect MSDs in the workplace. The key causes of MSDs are: awkward postures, repetitive motion, and high force requirements. Following rapid globalization, changes in the workplace have resulted in a significant increase of MSDs. For instance, the reason of 49.9% of workdays lost at European Commission in 2005 is reported in connection with MSDs [6]. In another example, an impressive increase in MSDs occurred is shown in the Republic of Korea, from nearly1600 cases in 2001 to 5500 in 2010. Additionally, in a study published by Kester [7] an increase of 100 percent of MSDs in an automotive industry directly related to lean implementation is reported.

Direct and indirect effects of musculoskeletal disorders can result in productivity loss in the organization. Therefore, any disciplines that facilitate adaptation between employees and their jobs not only contribute to MSDs reduction but also increase productivity in workplace.

3 Lean Manufacturing

The term of lean manufacturing arose from the Toyota Production System (TPS) in Japan. In response to mass production after World War II, Toyoda and Ohno rebuild the Toyota. They studied the Ford Production System (FPS) to constitute the concepts and tools for new production system which was called the Toyota Production System (TPS). As described by Ohno in his book, Toyota Production System, primary goal of the new system was waste elimination of production. Therefore, lean manufacturing was introduced as a philosophy to reduce or ideally eliminate non-value added activities, which called waste, from work processes. Seven types of wastes are recognized, which is known by the acronym of DOWNTIME as follows: Defects, Overproduction, Waiting, Nonutilized resources/talent, Transportation, Inventory, Motion, Excess processing [8]. In order to implement lean philosophy, several tools and techniques have been developed. The Most common are: 5S, VSM, Kaizens, SMED, Standard Work, Kanban, Total Productive Maintenance, Cellular design, and One Piece Flow. Despite the emergence of lean from manufacturing sector, it is not limited to this sector itself. Today various industries utilize lean tools and techniques in their systems, such as healthcare, restaurants, banks, electronics, pharmacy, and supermarket.

4 Relationship Between Lean Manufacturing and Ergonomics

Within lean principles, three types of wastes are known which in Japanese called 3 Ms: Muda, Mura, and Mudi. Among these types, the Mudi is more associated to ergonomics initiatives as Elbert [9] defines Mudi by "excess physical strain to perform work" [p. 129].

The goals of ergonomics and lean manufacturing are similar; improve productivity. The interest of ergonomics is on labor productivity and lean manufacturing concerns overall productivity of organization. Table 1 depicts an overview of lean and ergonomics and their underlying objectives and goals. It can be seen from the table that ergonomics addresses workstation, material handling, employees' capability, human error, and worker safety, and lean manufacturing regards overall organizational issues, such as suppliers, delivery, logistics, purchase, price.

Table 1. Lean and ergonomics concepts

Concepts	Tools and techniques	Objectives	Goals
Ergonomics	OWAS	Evaluate the load caused by the work posture	Increase labor productivity
	RULA	Evaluate the required body posture, force, and repetition	
	NIOSH Lifting Equation	Assess the manual material handling risks	
	Ergonomics Standards	Provide guidelines for the design of work systems	
	Ergonomics Risk Assessment Checklist	Evaluate ergonomic risk factors	
Lean manufacturing	One Piece Flow	Reduce inventory internal to a workcell and forces improvements and work balance	Improve overall productivity
	VSM	Analyze the current and designing future state of the value chain	
	KANBAN	Facilitate just in time delivery	
	Standard Work	Reduce variation from differences in work method	
	Total Productive Maintenance	Improve process capability and consistency	

In order to meet the overall productivity in the workplace, lean professionals can benefit from ergonomic principles. For instance, designing workstations with respect to worker's capabilities and limitations can result in decreased worker fatigue and d creased human errors that finally bring forth the increased production. Alternatively, ergonomics professionals can benefit from lean principles to improve worker's productivity. As an illustration, waste reduction due to lean principles in work processes brings various benefits to workers, such as decreased unnecessary motion, walking, handling, and force that all improve the workplace ergonomics.

In the sense of interrelation between lean and ergonomics, overlooking one of these two principles while the other one is implementing, can jeopardize both of them. For instance, several studies illustrate the negative impacts of lean implementation on worker safety and health directly related to ignoring ergonomics principles which consequently resulted in lean objectives' losses [10–13].

The common areas of lean and ergonomics can be outlined in the workstations, where the majority of workers' activities is undertaken and typically addressed during lean implementation in the workplace. One of the key tools in lean philosophy is cellular design. The basic rules for an ideal work cell that are established to increase production efficiency should be as follows as Elbert states:

1. "Safety is number one.
2. Follow good ergonomic practices.
3. Design in mistake proofing.
4. Manual tasks should be close together (limit the steps an operator has to make).
5. Use automated equipment only when it makes good business and economic sense.
6. Automated tasks should be secure and safe.
7. Use auto-load and auto-eject when operator safety is in question.
8. Heavy or awkward parts to handle are good candidates for automation.
9. Use simple one-touch automation whenever possible with automation.
10. Avoid batching whenever possible. Remember that one- piece flow is the goal.
11. Use visual signals and automated sensors to stop machines if a part fails.
12. Design machine changeovers to be accomplished within one takt time cycle.
13. Design in machine maintenance." [p. 134]

As it can be figured out from rules, ergonomics principles play the most essential role in designing ideal work cell. Through designing work cells like "U" shape with respect to lean principles, operator's movements decreased and interaction with workstation is facilitated and, consequently, human error tends to be very small.

In order to meet the requirements of creating continuous flow in production line, several pertinent items to ergonomic factors should be addressed, including number of human errors per day, amount of reduction in physical activities, and employees' productivity per hour. Additionally, in standardizing work within lean initiatives three steps are addressed:

1. Checking work area from outside
2. Checking work area in details
3. Checking operators' position and its movements, especially hand movements

Therefore, following both lean and ergonomics principles help ergonomic and lean professionals to meet their goals concurrently.

5 Conclusion

The ever-growing of lean application in the workplace has allowed scholars to study the interaction between this approach and other professions. Ergonomics is one of key professions that needed to be studied along with lean initiatives. In spite of similarities between lean and ergonomics principles to improve productivity, less attention has been devoted to analyze the common areas of them. Following this issue, the present study shines new light on the relationship between lean and ergonomics. The common areas of these two concepts are in connection with the workstation. Designing workstations with regard to lean and ergonomics principles brings forth the productivity gains for both employees and employers. It is expected that this study can help academic community and practitioners to pay more attention on the relationship between lean and ergonomics.

References

1. Helander, M.: A Guide to Human Factors and Ergonomics. CRC Press, Boca Raton (2005)
2. Salvendy, G.: Handbook of Human Factors and Ergonomics. Wiley, New York (2012)
3. Niebel, B.W., Freivalds, A.: Methods, Standards, and Work Design. McGraw-Hill Professional, New York (2003)
4. Jazani, R.K., Mousavi, S.: The impacts of ergonomic aspects on the quality. Open J. Saf. Sci. Technol. **4**, 15–21 (2014)
5. Occupational Health and Safety Council of Ontario (OHSCO): Resource Manual for the MSD Prevention Guideline for Ontario: Musculoskeletal Disorders Prevention Series. OHSCO Ontario (2007)
6. Naranjo-Flores, A.A., Ramírez-Cárdenas, E.: Human factors and ergonomics for lean manufacturing applications. In: Lean Manufacturing in the Developing World, pp. 281–299. Springer (2014)
7. Kester, J., Stranski, M., Johnson, T., Knight, T., Ruder, D., Guan, X., Aft, L.: A lean look at ergonomics. Ind. Eng. **45**(3), 28–32 (2013)
8. Cudney, E.A., Furterer, S., Dietrich, D.: Lean Systems: Applications and Case Studies in Manufacturing, Service, and Healthcare. CRC Press, Boca Raton (2013)
9. Elbert, M.: Lean Production for the Small Company. CRC Press, Boca Raton (2013)
10. Arezes, P.M., Dinis-Carvalho, J., Alves, A.C.: Workplace ergonomics in lean production environments: a literature review. Work **52**(1), 57–70 (2015)
11. Saurin, T.A., Ferreira, C.F.: The impacts of lean production on working conditions: a case study of a harvester assembly line in Brazil. Int. J. Ind. Ergon. **39**(2), 403–412 (2009)
12. Koukoulaki, T.: The impact of lean production on musculoskeletal and psychosocial risks: an examination of sociotechnical trends over 20 years. Appl. Ergon. **45**(2), 198–212 (2014)
13. Womack, S.K., Armstrong, T.J., Liker, J.K.: Lean job design and musculoskeletal disorder risk: a two plant comparison. Hum. Factors Ergon. Manuf. **19**(4), 279–293 (2009)