

The Function of Ergonomics in Lean Manufacturing Design and Control

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Introduction

Nowadays, manufacturing industries around the world are getting through intensifying challenges amongst peer businesses and market requests [1]. This results in companies searching for new and better practices to increase employee commitments and workings to improve their positions in the global market. Many businesses are using modern strategies such as Total Quality Management (TQM) [2], Just-in-Time (JIT) [3], Lean Production (LP) [4], and best practices [5] for improved employee involvement and functioning. These tactics are exploited as a means of increasing worker liability so that industries seem to experience an increase in quality and productivity [6]. Staff members' involvement also has an impact on safety by reducing incidents and injury awareness [7].

A recent literature shows that a combination of ergonomics principles and lean ideas provides reductions in work-related risks and injuries through business as well as increases in quality and productivity [8]. This study demonstrates that the use of lean strategies through a Kaizen event as a means to encourage communications between varying departments can improve in productivity as well as worker safety and job satisfaction.

Lean is a popular method of process improvement in many industries and workplaces. Lean manufacturing is producing the most reliable products and/or services whilst having the lowest possible operational costs and inventory levels [9,10]. Although there are no united working tools or solutions for every project or business, a Kaizen event helps areas to require fast enhancement [11]. Kaizen is a lean tool and can be used in an individual unit of the manufacturing operation as well as the overall process [12]. By using lean strategies with ergonomic principles, safety, and job satisfaction tools, both individual workers and the overall process can benefit. LP can also be used as a tool for companies to reinforce their safety programs [7]. Kaizen events help to encourage communications between varying departments. As a result, companies seem to experience an increase in employee satisfaction and productivity [13,14].

Developing and managing an ergonomics process is one of the most effective ways to proactively prevent, mitigate, and manage injuries and illnesses in the workplace. It will reduce claim frequencies, severities, and the associated direct and indirect costs. Ergonomic approaches have remained as attentive devices and/or tools by primarily focusing on functions and impacts at workstations rather than medical diagnoses and treatments. Ergonomic concepts, guidelines, and principles address the matters of safety and health working environments to prevent and manage injuries and risks effectively. There are also alleged social and moral obligations to preserve workers' security and well-being for a longer and more constructive work life.

Ergonomics is not another step but seems to be a part of the whole procedures. With ergonomic practices, lean processes can reduce costs

and the payouts from workers' compensation claims. Therefore, to fully operate and effectively practice lean manufacturing, ergonomics, and material handling interlinks, ergonomists should comprehend lean and ergonomics concepts and principles as well as the intersections between them.

Lean Process and Ergonomic Approaches

Lean manufacturing and lean production

Lean manufacturing has replaced mass production formats for almost half of the US industries. The lean process has helped managers to improve operational productivities and support industrial occupations. Unfortunately, many of managers have noticed that their workers' compensation costs climb sharply after implementing lean concepts. Increased injury rates seriously impede the intended results for lean processes, because injured workers cannot perform and added workers may not be as efficient at implementing the tasks [15]. On the other hand, higher workers' compensation costs are not expected if lean manufacturing is implemented carefully.

Over the past few decades, a number of industry improvement initiatives and/or programs have been developed to achieve external productivity excellence, most notably lean manufacturing [16]. Optimising worker performance, reducing rotation times, and implementing measurable business processes are some of the achievements from lean processes. All of them may serve to increase industry's enthusiasms, accessibilities, and capacities to deliver enhanced services and efficiencies. By integrating these approaches, industry workplaces become a stronger business partner to all stakeholders by delivering [16]: Increased cost effectiveness; lower operating expenses; inspired consumer- and process-focused workforces and devoted dedications to constant enhancement.

However, the recent literature reviews in defining lean productions emphasise the confusion in the conceptual and operational spaces surrounding lean manufacturing and garner a set of operational capacities that can be used to represent them [17]. The reviews also state that there exist many descriptions of lean production and its underlying components along with several conceptual definitions rather than providing a comprehensive list for capturing the salient similarities between the terms.

Although it is difficult to chase items or causes from analysis to analysis, the review study highlights three critical problems which have serious implications for theory developments [17]. A first problem arises because some concepts have undergone a change in status over time. Preventive maintenance is a case in point. In most of the early research, it was used as one of the underlying dimensions of JIT [18,19] but it is recognised as an independent concept [20] and is used to predict industrial operations [21,22]. A second problem arises when

duplicated items are used to engage greatly different concepts and thirdly, the opposite case is used to invoke the same build.

Findings from the overall literature reviews also stress the sprawling nature of conceptual definitions of LP and the difficulty in discriminating its underlying components from each other and the system. This specifies that both conceptual and operational areas surrounding LPs need to be developed. LPs require holistic approaches by capturing both internal and external practices to better align with its origins and develop an appropriate set of measures [17].

LPs may be perceived as an arrangement of practices and/or tools because the relationships amongst the elements of LP are neither explicit nor precise in terms of linearity or causality [17]. A structured approach may assist to elucidate how a lean system is designed from the interaction of its constituent elements taken as a whole, rather than how a lean system is designed from its constituent elements to one element at a time. Thus, observing LP with ergonomic approaches may provide industries with the logic that binds its multiple aspects concurrently.

Ergonomic principles

Ergonomic studies show as they relate to the human body and its limits [23,24]. Ergonomics can help manufacturing and industrial engineers to produce maximum work outputs without physical harms to workers [25,26]. This means that ergonomics is about designing for human use [27] and its research and applied areas have grown to comprehend the design of work systems including equipment, environment, interfaces, materials, and tools within human capabilities in order to reduce injuries and fatigues, and improve outputs [28,29].

Ergonomic guidelines and principles are valuable to prevent worker exhaustions and strains leading to potential work-related musculoskeletal and neurovascular disorders (WMSDs and WNVDs). Many of ergonomic values can be met by using techniques such as redesigning and standardising works, and reducing or eliminating risk factors for potential development of WMSDs, especially physical risk factors [30,31]. Many types of assistive devices can be utilised to adhere to ergonomics principles [32].

Ergonomics is simply another tool that can be embedded into lean processes to make them more successful. Integrating ergonomic philosophies into the lean process begins in the planning stages. To ensure that ergonomics is a key component of the lean process, ergonomists and safety practitioners need to make sure their lean practices not only to reduce wastes but also create core values of the lean development. All lean managers and team members should understand the mission of lean procedures and the role plays of ergonomic principles in the successful implementation of lean manufacturing. Ergonomic metrics must be included in the lean process to evaluate how the lean "improvements" affect the WMSD risk factors associated with a job or jobs that are changed.

Ergonomics also should act as a significant role in achieving the goals of lean ideas by limiting the number of repetitions and excessive actions [33]. As a result, industries will save time and money. Thus, it appears that ergonomics plays into lean as much as lean plays into ergonomics.

Ergonomic roles and lean manufacturing

Lean manufacturing and lean process pursue to generate values, minimise access to manage higher profits on industries' capital

investments, and compete in the global marketplace. When implemented effectively, the lean process creates a culture of worker involvement and empowerment and establishes a positive working environment in which workplace changes are expected and accepted.

Integrating ergonomic concepts and principles into the lean manufacturing process may allow industry stakeholders to recognise latent risk factors and to design work flows, methods, and workstations that reduce or remove hazards to the workers [15]. Since lean manufacturing and ergonomics share the goals of eliminating surplus and adding values, there are natural ergonomic integration points in most lean processes.

When investigating the values of ergonomics and lean processes, they seem to be interconnected with each other [33]. For example, establishing the best lean process with the proper ergonomic principles can often be accomplished with material handling-aid tools. They allow the worker to stay in the middle of the process whilst maximising production and decreasing process surplus. They range from simple lifts to complex manipulators but all achieve the same goals such as increasing productions, decreasing worker fatigue, and enhancing qualities [33].

Although lean manufacturing and ergonomics may have different intents and purposes, they can complement each other in making the workplace a more efficient and safer place through team works and cooperative assessments [34]. Because ergonomics principles and lean concepts instigated in the manufacturing industries at different times, they are not fully integrated but may soon be. Ergonomics is a fairly recent science that is growing quickly as an increasing number of companies and their corresponding industries take notice of its significance in the reduction of injuries and costs.

Factors that should be considered to integrate ergonomics into manufacturing lean process effectively include prioritisation. Many industries use value stream mapping or other prioritisation methods to visualise their operations and select work areas or production processes for lean analyses. Incorporating ergonomic risk assessments and quality metrics into the value stream mapping process provides a structured method for prioritising lean opportunities. Production processes with high levels of WMSD risk factors are leading candidates for lean design changes. Using scored risk assessments offers a method of identifying jobs with design flaws, whilst the assessment tool also can be used to validate the effectiveness of new lean designs. Thus, risk factor scorings and quality metrics from ergonomics can be used as additional data points in the value stream mapping process to prioritise work areas for lean manufacturing interventions.

Conclusion

The lean scheme needs effective ergonomic approaches to operate properly. Effective ergonomic practices are a necessary part of any sustainable industry establishment. Neither concept is really a novel, but the trend in most industries has made the appropriate application of these operating ways. Effectual implementations of lean concept and ergonomic principles comprise the redesign of work, standardising work, and reduction or elimination of WMSD risk factors. Successful applications often involve the operation of material handling assist devices [33].

Removing wastes from the system decreases lead-times and costs whilst increasing qualities and productivities seems to make potential ergonomic challenges visible so that these issues may be corrected [33].

Making processes more flexible may allow the industry to better position itself for competitive advantage. It also generates an environment where it is normal to making pulls to the work, forming new opportunities to continuously find creative improvements. Worker fatigue can be significantly reduced through application of sound ergonomic principles. All of these ideas, techniques, and tools are just as valuable in the workplace and the service areas as they are in the manufacturing environments in satisfying user prospects.

Focusing the lean practices on ergonomic design concepts will help to accomplish lean goals as they consider how the employees interface with tools, parts, and environmental factors in the workplace. Applying ergonomic design notions will lessen pricey mistakes, improve productivities, and reduce WMSD risk factors that will control higher workers' compensation budgets. Ergonomic design goals also focus on producing strong and capable body postures, decreasing the amount of force required to complete a task, and avoiding recurring postures and movements throughout the work shift. Applying forces take time, increase the risk of strains and other injuries, and cause workers to fatigue which slows their work pace and decreases productivity. Obviously, the aims of ergonomics design are to enhance the goals of a lean process and can mitigate the risks created by some lean solutions.

Sharing the missions and goals of lean process and recognising workers who create meaningful contributions to achieving cost savings seem to make the process successful and effective. Ergonomics provides additional tools for the lean process to reduce wastes and create values within manufacturing industries. Ergonomics is not another step but seems to be a part of the processes. Without ergonomics, lean processes can lead to costly workers' compensation claims in the months and years after implementations. With ergonomics, lean processes can reduce costs and payments from workers' compensation claims [15]. Thus, it becomes clear that any industry should pay great attention to ergonomics in order to establish a lean workplace.

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