

KEY PERFORMANCE INDICATORS ON WASTE MINIMIZATION: A LITERATURE REVIEW

D. Deepika Sterlin¹, S.Surya², A. Sivakumar³, P.Karthikeyan⁴

^{1,2}P.G Students, ³Assistant Professor, Department of Civil Engineering,

⁴Assistant Professor, Department of Management studies,
Kongu Engineering College, Perundurai, Erode-638 060, Tamilnadu

ABSTRACT :- Waste within the construction industry has been the subject of several research projects around the world in recent years. The lean manufacturing is a popular means of continuous improvements that have reshaped manufacturing process, practices and principles globally. Originating from the construction industry, the approach has been used extensively in the manufacturing sectors. Lean manufacturing centred around the philosophy of continuously improving performances by consistently eliminating wastes. Lean construction considers construction wastes as potential wastes that hinder the flow of values to the client and should be eliminated. The aim of the study is to advance knowledge in construction site waste minimization through the lean principles. The main objective of this study is to assess the impact of lean principles in construction using key performance indicators. KPI can be used to help a group to describe their ideas in a pictorial form which has been applied in many different areas; elimination of waste, shifts in organizational behaviour, procurements, quality, and delivery as fast as possible, continuous improvements. After the step, the KPI will be evaluated using those results from which, it will be concluded that, how the construction companies can apply in construction firm its continuous improvements.

KEY WORDS: Lean principles, Key performance indicators, Waste, Construction, Lean manufacturing.

1. INTRODUCTION

The core plan is that and maximizes client worth while minimizing waste. Simply, lean means creating more value to customers with fewer resources. A lean organization understands customer value and focuses on its key processes to continuously increase through it. The ultimate goal is to provide that the perfect value to the customer through a perfect value creation process that has zero waste. To accomplish this, lean thinking changes the main focus of management from optimizing separate technologies assets and vertical departments to optimizing the flow of products and services through entire value streams and that flow horizontally across technologies assets and departments for the customers. Eliminating waste along entire value streams, instead of isolated points, creates processes that need less human effort, less space, less capital and less time to make products and services and fewer costs and with much fewer defects, compared to the traditional business systems. Companies are able to respond to changing customer desires with high variety, high quality, low cost and very fast throughout the times. Also, information management becomes much simpler and more accurate to the customers. Construction projects usually involve multiple discrete organization workings all together on jam-packed sites. They suffer from waste that is manifested in waiting time for crews, reworks, unnecessary movements and handling of materials, unused inventories of workspaces and of materials, etc. achieving smooth workflow with minimal waste require not only appropriate construction planning but also effective production management. A Lean operation product produces just what is needed when it is needed with no additional labour, costs, inventory or time. Learn the skills necessary to apply Lean techniques to reduce waste and improve the process more efficient. Gain a practical understanding of Lean continuous improvement the techniques and how to use them to reduce fewer errors, inventory, and production lead time.

2. WASTE MININMIZATION

2.1. PRINCIPLES OF LEAN

Lean principles at Toyota evolved out of their Toyota Production System. There square measure many alternative principles, however we are going to cluster our work into four broad categories: request the elimination of waste, seek improved quality, seek increased product flow, and get reduced value, get the Elimination of Waste. By eliminating wasted resources from any producing or service system, we will straight off increase that system's productivity. If we tend to increase productivity whereas reducing the resource inputs into the system, we tend to cut back prices, that square measure passed on to the client in terms of lower costs, leading to an increase in market share that will improve profitability in the long-term (Chandan Deep Singh, Rajdeep Singh, Jaskanwal Singh Mand and Sukhvir Singh); A basic aim of Lean Construction is to help within the delivery of external price by managing the interior

price generation method. To aid in internal price generation, the foremost unremarkably named Lean techniques in construction square measure work flow management through the Last Planner system (Anders Bjornfot and Lars Stehn 2007); Lean Construction refers to the appliance and adaptation of the underlying ideas and principles of the Toyota Production System, to construction. As in TPS, the focus is on reduction in waste, increase in value to the customer, and continuous improvement; Last Planner System; LPS, collaborative planning and scheduling system developed.

The system provides a detailed production planning and control workflow that tackles variability and “flow” aspects in the construction management and involves the operatives in the field in the planning method Lean Construction Management System: refers to any software-based construction management that supports the lean construction management workflows, and notably LPS (Bhargav Dave, Sylvain Kubler, KaryFrämling, LauriKoskela, 2015); The principles of Lean manufacture are now well established and it is a viable process not only within the automotive industry, but also in the initially reluctant aerospace industry. While the application of Lean principles in themselves is not a strategy, there is much evidence that they are a powerful enabler when applied effectively (BadrHaque And Mike James-Moore 2004); Our alternative for Liker's principles is because of 3 main reasons: (i) their broad read of what a lean system appearance like; (ii) their high abstraction level, that makes them meaningful in different contexts; and (iii) their clear links with most practices commonly associated with a lean system (Marlon Soliman , Tarcisio Abreu Saurin, Michel Jose Anzanello 2018); Typical lean methods embody total internal control, just-in-time, visual management, re-engineering, worker involvement multi-skilled and/or self-reliant groups, style for assembly and manufacturability (Qian Chen, Georg Reichard and YvanBeliveau 2007); The model proposed was infinitely superior to Ford's mass production system because it provided small quantities of parts for the batch production.

It needed smaller physical areas, fewer resources and a smaller inventory of staple and adds method. The general approach within Lean Construction was to make the construction process leaner by reducing non-value generating activities (Qi Shenjun, Ding Lieyun, LuoHanbin 2010); Here, principles are explicitly derived from both concepts. With the exception for a few key relationships, the advanced interrelations between the principles don't seem to be mentioned during this short account. Each principle is conferred in generic terms, however if its application in construction deviates from the thought, the construction-specific options are in short commented (Rafael Sacks, LauriKoskela, Bhargav A. Dave and Robert Owen 2010); Managing variability is an important dimension of lean thinking. Lean production implementation begins with leadership commitment and is sustained with a culture of continuous improvement. When the principles are applied properly, dramatic improvements in safety, quality, and efficiency can be achieved at the project level. Improvements at the process and enterprise levels are enablers that make improvements at the project level more successful and allow such improvements to be sustainable (RemonFayekAziz, Sherif Mohamed Hafez 2013); Computer power-assisted visual image, not solely of the development product, however additionally of the development method, will facilitate coverage of project standing. More important, however, it can provide a unique service to support decision making to achieve stable flows and to communicate pull flow signals (R. Sacks, M. Treckmann and O. Rozenfeld, Ph.D. 2009); “In recent studies, experiments have focused on the definition and design phase of projects, applying concepts and methods drawn from the Toyota Product Development System, most especially target costing and set based design. In the Lean Project Delivery System, it's assumed that the duty of the project delivery team isn't solely to produce what the client needs, however to initial help the customer decide what they want.

Consequently, it's necessary to grasp client purpose and constraints expose the client to different suggests that for accomplishing their functions on the far side those they need antecedent thought of, and to help customers understand the consequences of their desires. This method inevitably changes all the variables: ends, suggests that and constraints (Xavier Brioso 2015); Lean production shifts the attention of production improvement from the worker's productivity in craft production and the machine's productivity in mass production to the entire production system, and consequently, avoids the high value in craft production and therefore the rigidity in production (Xiaoming Mao and Xueqing Zhang 2008).

2.2. LEAN CONCEPT

In general, manufacturing systems offer conversion process from resource as input to results as output, where the essence of lean is to realise fewer resources with higher level of results than ordinary manufacturing processes (Hiroshi Katayama 2017);

- Standardize work packages and educate the sub trades to eliminate handover problems;
- Implement total quality control to raise the yield rate to 100%;
- Develop FIFO-lane-based flow from excavation through to drilling and pile placement with 1 week lead time;
- Develop an internet-based booking system;
- Establish supermarket-based pull flow between excavation and releasing of construction files;
- Restructure work packages-depending on the availability of cross-function teams_;
- Reduce lead time between tasks to the level shown on the future-state map (Haitao Yu, Tarry Tweed, Mohamed Al-Hussein and Reza Nasserri 2009);

Lean style is that the application of lean production principles, that promote the elimination of waste and non-value adding activities in processes, to engineering and style. The distinction within these visions is in the manner that they create mentally the process-in alternative words, the manner within which they describe their aspects and properties. These symbolic representations build them vary from their essential principles to the ways and practices to hold out their sensible contribution (Javier Freire and Luis F. Alarcon 2002); the application of six lean tools in a construction project: Last Planner, increased visualization, huddle meetings, first-run studies, 5S (sort, set in order, shine, standardize, and sustain), and fail-safe for quality. The implementation of these lean tools helped in completing the project within the set

schedule, under budget. It reduced the incident rate and also helped in improving the relationship between subcontractors and general contractors.

The outcome of the study showed that the lean strategies can be implemented in the construction sector with small modifications in the construction industry environment (Laura H. Ikuma, Isabelina Nahmensand Joel James 2011); lean noted that the current debate on lean approach centres on the idea of doing more with less effort, material, equipment, personnel and space while focusing on what adds value to customers/clients and eliminating waste in the value chain of production (Oluwatosin Babalola, Eziyi O. Ibem & Isidore C. Ezema 2018); Lean applied to service sector helps in enhancing value added along the operational process and high speed service performance through elimination of waste, thereby reducing the overall cost of operations (Prattana Punnakitikashem, Nattapan Buavaraporn, Lin Chen 2010); In its tool-based mode, the classification scheme can be used to define clearly the nature (identification of waste, measurement of waste, elimination of waste, or some combination of these three) and application of each tool (S. J. Pavnaskar, J. K. Gershenson and A. B. Jambekar 2010); This framework consists of five phases such as analysis and model of the present state, identification of problems and opportunities, experimentation and selection of future state, implementing the change and stabilising the new mode of operations (Sherif Mostafaa, Jantanee Dumraka and Hassan Soltanb 2013).

2.3. LEAN MANUFACTURING

Lean manufacturing is not a new concept. In past decades, this concept has progressed from a technical homeward facet to human homeward facet. The human parts in lean producing share the company's vision and teamwork, that embody labour flexibility, multi-skilled facet, and bigger responsibility in maintenance, quality improvement, and personnel problems (Norani Nordin et al. 2014); Lean construction design research has identified a number of prescriptive actions, some of which relate to management of information flows (Effi Tribelsky and Rafael Sacks 2011); The factors were classified in step with their association with the four subsystems that kind a socio-technical system: human, technical, work organisation and external surroundings (Giuliano Almeida Marodin and Tarcisio Abreu Saurin 2013); A construction project, in contrast, presents a unique design, specifications, and context, and must be constructed accordingly following a unique construction process-value stream (Haitao Yu, Tarry Tweed, Mohamed Al-Hussein and Reza Nasser 2009); Despite significant study, the field has struggled with a lack of clarity about what lean production is and what it is not. Significant recent work has defined the "how" of lean production in manufacturing (Bradley R. Staats, David James Brunner, David M. Upton 2011); The core goal of TPS is the elimination of waste, defined as any activity that fails to meet production standards and anything that does not help create value.

The search for waste extends beyond the production line to product development and other workflows (Chien-HoKo and Neng-Fu Chung 2014); This has led emerging companies to seek the possibility of study their environment variables and adapt practices that are the best acceptable for the organization, impacting directly on export growth and profitability. Therefore, is it important for this research inquires, what are the environment variables that every organization should consider to search the adaptability of world class manufacturing practices (Mario Roberto Acevedo Amaya, Cesar H. Ortega Jimenez 2011); The management-driven initial lean enhancements enclosed the relocation of packing lines into additional user-efficient modules cells that might be managed by one operator.

Relocating the new instrumentation into 'U-shaped' layouts enabled one operative to attend to a bigger proportion of the road. This restructuring of the layout and flow raised each operational potency through the employment of newer instrumentation and a 5 per cent reduction in labour prices (David Bamford, Paul Forrester, Benjamin Dehe, Rebecca Leese 2013); When the production managers were questioned about the situations recorded, the response was that the company had always worked in this way and that because of the type of article produced, with all the productive operations associated, there was no other way to do it. The way to show how the productive part of the company could be reorganized was to show clearly to the top management the wastes that exist along the productive flow, as well as the costs that these have for the company (oliveira, fernandes 2017); Lean manufacturing, also known as the Toyota Production System (TPS), was originated by Taiichi Ohno and Shigeo Shingo at Toyota. It is now widely recognized that organizations that have mastered lean manufacturing methods have substantial cost and quality advantages over those still practising traditional mass production (S. J. Pavnaskar, J. K. Gershenson and A. B. Jambekar 2010); Quality in producing is said a lot of closely to method management than to product conformity. Common tasks are defect prevention, monitoring, and intervention.

Rework is generally avoided, and in some cases, parts are discarded rather than reprocessed. In distinction, quality in construction primarily associated with product conformity (O. Salem, M. ASCE, J. Solomon, A. Genaidy and I. Minkarah, M. ASCE 2006); Lean production techniques make this conceivable by incorporating and engaging the effort of all the project participants, thus, lean construction. The term "Lean" simply means to make work as easy as possible to understand, perform and manage and the fundamental idea behind this concept is about minimizing wastes (Richard Hannis Ansah, Shahryar Sorooshian 2017).

2.4. KEY PERFORMANCE INDICATORS IN WASTE MINIMIZATION

The primary objective of the validation activities is to validate the KPIs identified by the previous questionnaire. Another objective is to refine the KPIs and the implementation including data providers, the weightings of KPIs, and the definition of the scorings. An action

Research is conducted to validate whether these KPIs are measurable and could fulfil the measurement requirements. A focus group meeting and follow-up interviews are also used to validate the identified KPIs and refine the implementation the action was carried out with the cooperation of a group of construction practitioners who were taking the subject

“Value Management in Construction and Property”. These construction practitioners are the same as the targeted participants who are from the works departments of the government, contractors, construction consultant companies, and architectural companies in the real-life VM studies in Hong Kong. The researcher attended the whole process of the VM study as an observer and scored the KPIs. (Gongbo Lin, Geoffrey Qiping Shen, M.ASCE, Ming Sunand John Kelly 2011)

3. LITERATURE REVIEWS

David Romero, Monica Rossi (2017) identified to demonstrate the compatibility of circular economy and lean principles within the context of PSSs and contribute to their integration so as to form customer-oriented solutions that minimize resources consumption and enhance the last word added to the end-user.

Hemanta Doloi et al. (2012) have analysed initial knew the key factors impacting the delay in Indian industry then established the link between the important attributes for developing prediction models for assessing the impacts of these factors on delay.

James A. Bahensky et al. (2003) studied of these efforts is to use the Lean techniques for reducing cycle times and the Six Sigma concepts for reducing product defects. The Iowa Business Council with several advocates worked with the University of Iowa Hospital and Clinics (UIHC) and two other Iowa hospitals to determine whether Lean.

R. Sacks, M. Treckmann and O. Rozenfeld, Ph.D (2009) explained that Lean construction and building information modelling BIM are quite different initiatives, but both are having profound impacts on the construction industry, if properly understood in theoretical terms, can be exploited to improve construction processes beyond the degree to which it might be improved by application of either of these independently, the matrix is not considered complete but rather a framework for analysis to explore the degree of validity of the interactions. Construction executives, managers, designers, and developers of data technology systems for construction may also take pleasure in the framework.

Thomas J. Kull et al. (2014) have identified use of lean manufacturing practices requires more than the use of tools. Although producing facilities worldwide use luminous flux unit practices, dimensions of a nation's culture could moderate LM's impact on in operation performance.

4. APPLICATIONS FOR WASTE MINIMIZATION

In order to achieve previously mentioned objectives, many applications of lean construction principles have been developed. These applications, which are discussed in the following sections, are categorized under three main headings as: Lean Project Delivery System (LPDS), Last Planner System (LPS) of Production Control, and Practical Applications of Lean Construction Principles. (1) Lean Project Delivery System (Huseyin Erol, Irem Dikmen, M. Talat Birgonul 2016); The introduction of Lean Production ways isn't solely attainable, it brought additionally enhancements and blessings for the delineated company. We have seen additionally that plenty of business homeowners expect from native and national associations and chambers initiatives to reinforce the power Transfer (D.T. Matt, E. Rauch 2013).

5. CONCLUSION

The lean manufacturing literature speaks of lean implementation as a deliberate act of adopting a manufacturing philosophy that focuses primarily on waste elimination through the acquisition or production of materials just that the material is required by internal or external customers. The lean manufacturing literature also speaks of a full adoption of the lean manufacturing philosophy in order to achieve successful implementation new lawn exponents, particularly in service sectors, must beware rapidly launching a lean programmer which is certain to create much early noise and activity, but is less certain to deliver sustainable long-term benefits and behaviours. This lesson has learned the hard way by the manufacturing product sector and new exponents in the service should take note to avoid the same costly mistakes. Lean is a worthwhile end of the line for those who take the time to carefully map to route and stick to their objective despite many distractions along the way. Many more will produce lots of good early success stories, which do not take real business benefit and long-term belief. Lean is a management philosophy aligns well with clear, inclusive and powerful management principles.

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