Samarawickrama, Sumanthri, et al (eds), 2019, *"Re-evaluating Space across disciplines": Proceedings of the 12th International Conference of Faculty of Architecture Research Unit (FARU), University of Moratuwa, Sri Lanka, December 03, 2019 Colombo* pp. 190–201. ©

INTEGRATING ENTERPRISE RESOURCE PLANNING SYSTEM WITH LEAN CONCEPT TO MINIMISE WASTE IN SRI LANKAN CONSTRUCTION INDUSTRY – A THEORITICAL REVIEW

RASANJALI W A.[1], DISARATNA V. & WITHANAGE K.T.
[1,2,3]Department of Building Economics, University of Moratuwa, Si Lanka
[1]*ayesharasanjali99@gmail.com*

Abstract
Construction industry is currently facing severe challenge that producing high rate of waste at the end of the construction process. Lean philosophy has arrived and expanded over the various industries by providing an imperative solution for most of the challenges facing by the industries. Accordingly, construction industry accommodates lean concept to provide the modest output in the shortest possible time, while attaining maximum value and quality at reasonable cost. Enterprise Resource Planning (ERP) system is developed as an approach that integrates all business functions into a single process to enhance the efficiency of all activities by supporting organizations to uphold the competitiveness within the industry. ERP system affords accurate data of current performance in a single database with more transparency for the users who demands them. Construction companies used to adopt ERP system with the intention of enforce supply chain partnerships, enhance organizational flexibility, improve decision making capabilities and reduce project completion time and costs. The ERP system diminishes labour-intensive processes and eliminate the root causes for waste production in construction industry and already offers lean support in their software. This paper highlights the literature findings on the lean philosophy and synchronizes ERP system and lean principles in the course of lean ERP route. These basic findings will aid to assessing the possibility of integrating ERP system with lean principles in order to eliminate construction waste. Sri Lankan construction industry practitioners can directly use these findings of the research to eliminate the challenge of producing high rate of waste at the end of the construction process.

Keywords*: Enterprise Resource Planning, Lean Principles, Construction Waste, Construction Industry*

1. Introduction

The construction industry is an inestimable sector which plays an important role in converting the various desires, needs and requirements of the people into reality by physically executing various construction projects (Ibrahim, et al., 2010). When it comes to Sri Lankan context, the construction industry makes a significant contribution to the development of the economy in Sri Lanka (Silva, et al., n.d). In the developing world, the construction industry is always facing problems and challenges, because of the limited resources, population growth and economic expansion within the country (Jayalath & Gunawardana, 2017). According to Subramani, Khan, Raj, Najeeb, and Rajan (2018) construction industry is generally recognized as one of the largest amounts of waste generating sector. Therefore, minimising construction waste is a key factor to be concerned within the industry today (Ayemba, 2018).

The concept of lean production was possessed by the Toyota Production System (TPS) (Dinesh, et al., 2017). Subramani et al. (2018) defined lean concept as a set of principles that was implemented in order to minimise the material wastage and time effort required to generate the maximum amount of value within the construction industry. Successful implementation of lean concept for the construction may help to gain a significant cost advantage by minimising wastage and eliminating the most cost consuming activities (Senaratne & Wijesiri, 2008). Thus, Macomber & Howell (2003) identified lean construction as one of the best solutions to overcome wastage in the construction industry.

Koskela, Bolviken, and Rooke (2013) stated that these concepts are defined to eliminate waste and manage resources which connected with time, activities, inventory and waste of space and deliver high quality products as per the client's requirement. Li, Liu, & Li (2012) has identified the Enterprise Resource Planning (ERP) system is identical to manage all these resources by integrating all the information from different areas such as product planning, inventory control, purchasing, financial resources, and human resources.

ERP system is one of the most substantial technological developments introduced during the last decade (Nwankpa, 2015). It can be used for planning, organizing, managing and utilizing organization resources effectively, to obtain the absolute output from their resources (Ghosh, 2012). Olson, Johansson, and Carvalho (2018) defined the goal of ERP system is to integrate and combine all the systems across an organisation into one system that can meet and serve each department's unique needs and tasks. ERP acts as an important backbone of the organisation since it integrates the business activities of different departments by providing a proper circulation of information within the organisation (Osnes, et al., 2018). Implementing good practices of waste minimisation methods on construction projects will help to reduce the significant amount of construction waste and create the base for making a sustainable environment (Wrap, 2014). Thus, Peddavenkatesu and Naik (2016) described that this can be achieved by using new technological applications that evolve with innovative designs for construction management, construction scheduling, and online monitoring while considering the durability and design life of the construction products.

Esa, Halog, and Ismail (2015) found that one of the major reasons to increase the wastage in construction industry, is not giving a high priority to proper waste minimization methods. Lean concept has made a significant contribution in this area by identifying the mostly expected seven types of waste during the construction (Lean Construction Institute, 2015). The proper implementation of ERP solutions can help to reduce waste while providing all the functionality required (Cunha, 2018). Hence this research aims to study the possibility of integrating the Enterprise Resource Planning system with Lean principles in order to enhance the performance by eliminating waste generation in the Sri Lankan construction industry.

2. Research method

Research is a process of critically examine solutions for a problem by thorough study or analysing situational factors or else implementing new thing which is not addressed by any others up to now (Bodla, n.d). Thereby the research methodology was developed as a systematic approach to examine these problems. A research method is developed with a properly organised research design, research approach, research techniques and research process. Every research needs to have an advanced design or structure in order to achieve the aim of a study (Walliman, 2011). The research approach is a systematic procedure which is used to organize the research activities within the developed research design framework. Qualitative, quantitative and mixed method are the most common approaches used to analyse the findings from the data collection. Among those approaches qualitative research method was used with critical documental review.

3. Literature Findings

3.1 DIFFERENT TYPES OF CONSTRUCTION WASTE

The construction sector plays an important role in every developing country (Foo, et al., 2013). Increasing the rapid growth of construction activities will escalate arising of construction waste problems all around the world (Nagapan, Rahman, & Asmi, 2011). Shankari et al. (2017) found that such increment of construction waste will increase the overall project cost, reduce the excepted profitability and gives a negative impact for environment also.

Koskela (1992) described waste is a combination of material losses and execution of unnecessary work which significantly generates additional costs without adding any value to the final product. Thus, Emuze and Smallwood (2011) emphasized from the client's point of view, waste can be defined as non-value adding activities since it directly or indirectly generates some costs from the activities which does not add any value to the final output.

Further to that, Formoso, Soibelman, Cesare, and Isatto (2002) described that any inefficiency that results in the use of labour, material, equipment, and money can be considered as non-physical waste in construction processes. Nevertheless, Formoso et al. (1999) stated that waste in the construction

industry is not limited to the quantity of excess material remain on site. It comprises many other facts such as inventories, material handling, unnecessary movement of workers, waiting time and overproduction which are invisibly occurred throughout the construction process.

3.2 LEAN CONCEPT AS A WASTE MINIMISATION PHILOSOPHY

The lean concept was implemented by Shigeo Shingo and Taiichi Ohno based on Toyota Production System in mid-1940's (Namrouty & AbuShaaban, 2013). Lean manufacturing is one of the most precious tools which is used to eliminate waste in different industrial sectors (Chahal & Narwal, 2017). Ballard (1990) defined "Lean production is a concept that aims to systematically eliminate wastes, simplify production procedures, and speed up production". Harish & Selvam (2015) expressed "Lean is a way of achieving more with less resources, creating an organization that responds to greater flexibility with shorter lead time and where the focus is on the customer, both external and internal". According to these definitions, lean concept can be seen as a methodology introduced to use the resources efficiently and effectively by eliminating waste and develop the final output.

3.2.1 Lean Tools & Techniques

The main goal of lean production is to produce products with minimal waste and to continuously improve all activities and processes involved in every type of work (Modi & Thakkar, 2014). Therefore, many researchers, Chahal and Narwal (2017); Sumant and Patel (2014); Rewers, Trojanowska, and Chabowski (2016) have highlighted lean production paradigm can be accomplished by applying a wide variety of lean manufacturing tools such as Value Stream Mapping, 5S, Just –In-Time (JIT), Single Minute Exchange of Die, Kanban, Kaizen, Jidoka, Heijunka, Standardized Work, Poka-Yoke and Kamishibai in their researches.

3.2.2 Classification of Lean's Waste

Waste can be classified based on the source of its origin. Osmani , Glass, and Price (2008) emphasized that even though generally waste is visible during the production or construction stage, it can be originated at initial stages such as planning, designing, material supply and material manufacturing processes. Ohno (as cited in Formoso et al., 2002) presented seven categories of waste which was identified in Toyota Production System. They are;

- Unneccessary movement of people - including waste of human energy
- Waiting by employees for process equipment to finish its work or an upstream activity
- Defects in products
- Overproduction of goods not needed
- Inventories of goods awaiting further processing or consumption
- Unnecessary processing
- Unnecessary transport of goods

Table 2.1 shows the lean waste types. Among these seven categories, first two refer to waste related to operations and works performed by people. Other categories have been identified as waste related to flow of material process.

Table 1 : Lean's waste types

Waste type	Description	Reference
Overproduction	Making more than that is required by the next process, making earlier than that is required by the next process, or making faster than required by the next process.	Arunagiri and Gnanavelbabu (2014)
Defects/ Rework	Failure of any work can be called as a defective work. Rework may require once the defect is occurred.	Rawabdeh (2005)
Inventory	Inventory waste can be identified as having level of raw material unnecessarily, works in progress and	Capital (2004)

	finished products.	
Transportation	Any movement of material without adding a value to the final product.	Hines and Rich (1997)
Waiting	Waiting generally comes up with the idleness. Waste of waiting is occurred when the time is being used ineffectively.	Formoso et al., (1999); Hines and Rich (2007)
Movement/ Motion	Any excess movement of either machines or employees that adds no value to the final product.	McGee-Abe (2015)
Over processing	Over processing generally occurs when processing a work more that it requires to obtain its quality or any other feature.	Capital (2004)

3.2.3 Causes for lean waste generation

Table 2.2 presents the causes for generation of lean waste types as identified by Domingo (2013).

Table 2 : Causes for lean waste generation

Waste Type	**Waste causes**
Overproduction	High capacity equipment Poor production planning Volume incentives Engineering changes Fails to forecast producing Poor scheduling Unclear requirements Long set-up times
Over Processing	Unclear customer specifications Unclear work instructions Poor communication Frequent engineering changes Overdesigned equipment Inadequate value analysis/ value engineering Excessive reports Excessive quality Re-entering data and duplicated data
Inventory	Overproduction and buffers Line imbalance Big batch sizes Poor monitoring systems Mismatched production speeds High rework rate Long set-up times Misunderstood customer needs Unreliable suppliers/ JIT-incapable suppliers Lack of material requisition and issuance standards
Transportation	Unnecessary or excessive steps in the process Complex material flows Poor plant/office layout (Disorganised workplace) Misaligned process flow Line imbalance
Waiting	Inflexible work force Insufficient staffing/ over-staffing Unplanned/ unscheduled machine downtime Long set-up times Material/ manpower shortage or delay Unbalanced workloads

	Work absences Poor communication Unsynchronized Processes (Line imbalance)
Motion	Poor process design and controls Poor workstation/shop layout Disorganized work place and storage locations Shared tools and machines Workstation congestion Unclear, non-standardized work instructions Unclear process and materials flow Lack of standards
Organizational	Poor design and specification Unclear customer specifications Incapable processes Lack of planning and control Poor qualification of the team work Lack of integration between design and production Poor quality controls Poor documentation Lack of standards Weak or missing processes Misunderstanding customer needs Uncontrolled inventory levels Poor design and undocumented design changes or repair

Source: (Domingo, 2013)

3.3 IMPLEMENTATION OF LEAN CONCEPT TO THE CONSTRUCTION INDUSTRY

Mao and Zhang (2008) identified the manufacturing industry and construction industry has similar characteristics in terms of delivering a constructed facility or manufactured product to the customers. Howell (1999) explained that lean construction is designed to maximize customer satisfaction concurrently through the design of a constructed facility and the construction process while providing the consequent control during each phase of the construction project.

The principles of Lean Manufacturing applied in the construction industry could achieve many positive results in many areas of the construction industry, with enhanced value, lower cost and better customer satisfaction (Mao & Zhang, 2008). Figure 1 shows the categorization of waste in the construction industry considering the lean thinking approach.

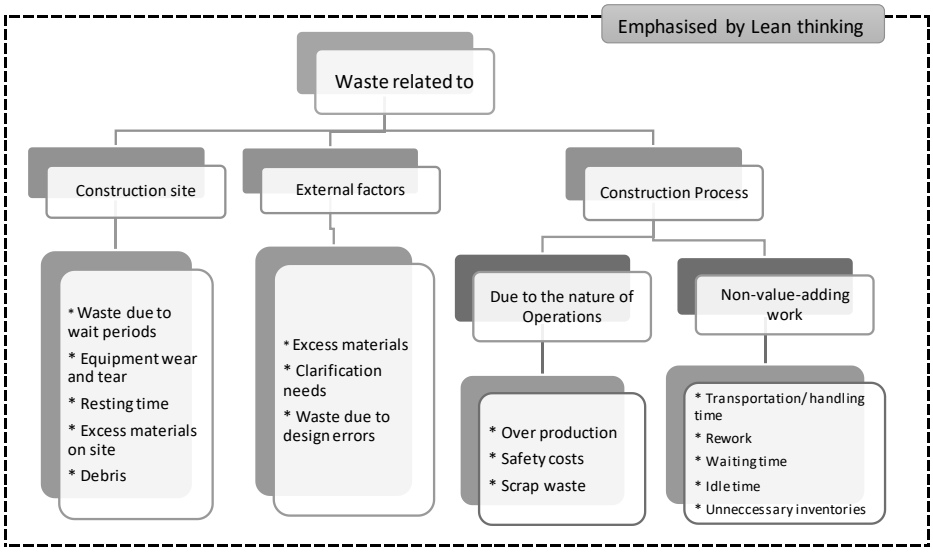

Figure 1 : Waste categorisation in construction industry considering the lean thinking approach
Source: (Nikakhtar et al., 2015)

3.3.1 Benefits of lean implementation

To remain competitive and profitable, the construction team must find ways to maximize value and efficiency, or reduce waste, or do less (Ayala, 2018). Applying the principles of Lean principles to a project is a way of challenging old consolidated processes and constantly evaluating ways to eliminate waste and obtain the following benefits.

- Higher quality construction
- Greater productivity
- Greater customer satisfaction
- Smoother operation - improved continuous flows
- Greater profitability
- Reduced operating costs
- Increases Employee Collaboration and Accountability

3.3.2 Drawbacks of lean implementation

The application of some lean principles derived from manufacturing industry to construction sector has encountered varying degrees of difficulties (Mao & Zhang, 2008). They have further highlighted that main reason for this as the unique and complex nature of the construction process and high level of risks and uncertainties are engaged throughout the construction process.

However, Garbie (2010) emphasised that despite the benefits of lean, more efforts are needed to explore ways to overcome lean-related shortcomings. Furthermore, findings of (Issa, 2013) confirms that lean construction does not address the risk factors such as change in material prices or price escalation, delay in running bill payments to the contractor, design errors and suitability to the nature, and poor quality of local materials. Therefore, Ward and Zhou (2006) identified there is a need of leveraging another technique with Lean to overcome the drawbacks associated with it.

3.4 ENTERPRISE RESOURCE PLANNING SYSTEM

Today every industry is turning into more complicated because of the requirement of continuous data flow among each department for decision making and resource allocation within the organization (Madanhire & Mbohwa, 2016). Therefore, efficient and effective data frameworks would improve intensity by reducing costs and better coordination (Holland & Light, 1999).

Nah, Lau, and Kuang (2001) defined ERP system is “a packaged business software system that enables a company to manage the efficient and effective use of resources (materials, human resources, finance, etc.) by providing a total, integrated solution for the organization's information processing needs” (p.285).

Tenkorang and Helo (2011) have also undertaken a critical review on an ERP system. According to their findings, ERP system has been identified as an approach that integrates all the business functions into a single process to increase the efficiency of all the activities by supporting to that organization to maintain the competitiveness within the industry. Moreover, it was identified that successful implementation will ensure achieving project benefits by improving productivity and competitive advantage.

By considering the different definitions provided by the authors, ERP can be identified as an enterprise wide information system which integrates all the business functions in order to manage and control all the resources within the organization.

3.5 IMPLEMENTATION OF ERP SYSTEM

ERP implementing will require major changes to employees and work practices. Therefore, in order to improve cost effectiveness, it is recommended to use external consultants who have the ability to provide specific training for ERP implementation (Madanhire & Mbohwa, 2016).

Gefen and Ragowsky (2005) identified the consultant is responsible for the initial phase, staff training, workflow research, custom interface, troubleshooting and ERP problem assistance. Further, they discovered that it is important to involve all the employees in the particular project because many changes will affect almost everyone in the organization and ultimately it leads to make the ERP system successful and useable.

3.5.1 Implementing ERP system to Sri Lankan Construction Industry

The acquisition and implementation of ERP systems often improve productivity and quality of the work with standardisation and simplifying the multiple, complex operating procedures throughout the company (Nah et al., 2001). According to the findings on Gunasekara et al. (2018) there are several reasons to adopt ERP system to the construction organisations.

- Integration of application
- Business process reengineering
- Competition
- Increased demand for real time information
- Integration of information system
- Cost reduction
- Better customer interaction and improve on-time deliveries
- Information generation for decision making
- Supportive for planning and budgeting activities
- More user friendly reports
- Improved security applications

Among the above mentioned reasons, competition, better customer reaction, information generation for decision making and providing more user friendly reports were identified as mostly influenced reasons to implement ERP system to the Sri Lankan construction industry.

3.5.2 Benefits of ERP Implementation

Organizations invest in ERP systems in order to achieve significant benefits. These benefits can occur in the form of increased business productivity, such as reduced lead times, reduced cost and increased communication efficiency between functional limits (Nwankpa & Roumani, 2014). Further, Davenport (2000) explained the benefits of ERP may vary from industry to industry and in many cases, it may depend on the firm in which it is implemented.

Shang and Seddon (2002) clustered ERP benefits into five categories namely, operational, managerial, strategic, IT infrastructure and organizational. Table 2.3 illustrates the key benefits which derive under each category.

Table 3 :Key Benefits of ERP system

Dimensions	Subdimensions
Operational	Cost reduction Cycle time reduction Productivity improvement Quality improvement Customer service improvement
Managerial	Better resource management Improved decision making and planning Performance improvement
Strategic	Support for business growth

	Support for business alliance Building business innovations Building cost leadership Generating product differentiation Building external linkages
IT infrastructure	Building business flexibility for current and future changes IT cost reduction Increased IT infrastructure capability
Organizational	Changing work patterns Facilitating organizational learning Empowerment Building common vision

Source: (Shang & Seddon, 2002)

3.5.3 Drawbacks of ERP Implementation

Even though there are numerous benefits that can be achieved through the implementation of ERP system to the organisations, Gunasekara, et al. (2018) identified some of the drawbacks of ERP implementation through a critical review undertaken by them. Following are the drawbacks they have identified.

- Higher initial investment
- Higher maintenance and development cost
- Misfit with the business requirement
- Lack of skilled employees to work on
- Users' resistance to change
- Poor knowledge transfer
- Poor top management support
- Poor quality of testing
- High turnover rate of project team members
- Lack of strong infrastructure for the system
- Lack of support services from the system supplier
- Lack of storage services (in-house / cloud)

3.6 CHALLENGES FOR ERP IMPLEMENTATION

Successful ERP implementation can be achieved by identifying the challenges engaged with its implementation in local companies (Otieno, 2010). There are several challenges identified by different researchers throughout their studies.

3.6.1 Interconnections/ Integration problems

Previously all the information were maintained by different departments. With the implementation of ERP system all of them were integrated and perform as a single system (Otieno, 2010). Since the change of the whole process is a challenge for the employees because they may not be prepared for these new procedures and rules (Rishi & Goyal, 2008).

3.6.2 Technological complexity

According to Lowe & Locke (2008), ERP systems are perhaps the most complex and comprehensive of business information systems. Managers found that it is very challenging to manage the technological complexity of different platforms and to harness the power of new business technologies.

3.6.3 Lack of proper ERP management

Enterprise systems require managers to have a greater understanding of their actions, including other products, departments and even external business companies (Bingi, et al., 2002). Therefore, ERP systems must be developed and implemented step by step under the guidance of a common vision of the

goals. Laudon & Laudon (as cited in Otieno, (2010)) highlighted that many organizations face difficulties to develop a shared corporate-level vision to guide the implementation of the system.

3.6.4 Staff turnover

Once the selected employees have been trained and invested heavily, it is a challenge to hold them back, especially in markets that require qualified consultants. Employees can double their salaries by accepting other positions (Skok & Legge, 2002). Loyalty plans, company benefits, salary increases, ongoing training and loyalty strategies for company loyalty can be effective (Skok & Doeringer, 2001).

3.6.5 Cost of technology

Monk & Wagner (2006) found that the total cost of implementation could be three to five times the purchase price of the software. This is because ERP is a semi-finished product and that must be configured and customized according to the needs of the consultant's organization.

3.6.6 Organisational change

Umble, Haft, & Umble (2003) stated that ERP implementation may have an impact for the change of overall organization process. By the time Wagner, Scott, & Galliers (2006) also discussed that successful implementaion of ERP system is not an easy task because it changes the business process and it requires adequate attention by the senior management with co-operation and good teamwork background.

3.7 ERP AND LEAN SYNCHRONISATION

Implementation of Lean and ERP together shows commonalities in different terms of cost, time and effort required for implementation (Djuric, 2008). Implementation of ERP system emphasises accurate and real time reporting of an organisation. This is exactly what lean needs for its continuous improvement principle. Adam, Keckei, Kostenzer, and Klepzig (2013) stated that accurate data of current performance with high visibility is essential to fulfill lean principles.

Adam et al. (2013) further eloborated that, if there is no single database, dedicated data entry points and analysis and visualization features provided by ERP and business intelligence systems, it can be time consuming and erroneous. ERP reduces labor-intensive processes and facilitates performance visibility, error management, work status and inventory. So it is recognised as Lean ERP or ERP systems that support lean principles (Nakashima, 2000).

3.7.1 ERP support for Lean production

Organisations are basically focused on increase the productivity, eliminate the time and resource wastage, reduce the cost of production and ultimately achieve the streamlined business process through it (Powell, et al., 2011). They have identified such achievements can be fulfilled by using ERP system and lean methodologies, tools and techniques. They have further elaborated that complementing these techniques may overcome the deficiencies of each method and companies can achieve business excellences. Thus, it can be elaborated as the following way.

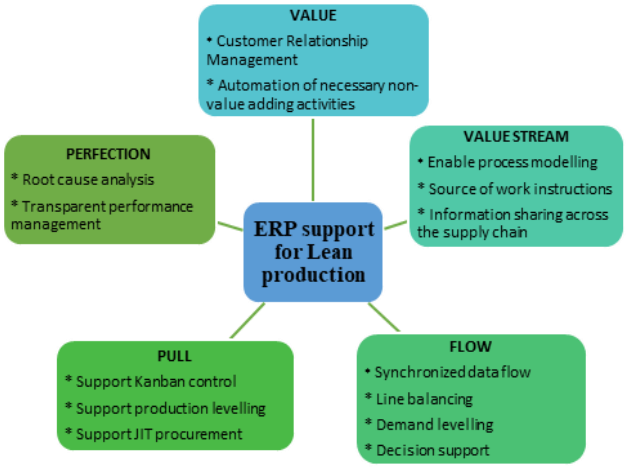

Figure 2: ERP support for Lean production
Source: (Powell et al., 2011)

Figure 2 presents how ERP system supports for the lean production principles. As the first principle value of the product can be determined by using the customer relationship management feature in the ERP system. Then, mapping the value stream by eliminating non-value-added tasks with the use of information sharing across supply chain of ERP system. Remaining value-added tasks will be taken into the flow with the decision support. Pull and perfection is enhanced by the support of better management ERP system.

3.7.2 ERP for waste minimisation

At the beginning, ERP systems were implemented in order to integrate business functions and to support the management for decision making processes (Powell, Riezebos, & Strandhagen, 2013). Riezebos (2010) identified that many of the lean practices depend on the high-quality data and it is essential for problem solving process and effective production control. As a result of that, companies have created hybrid environments in which they use both methods and facilitate by the development of information technology. Furthermore, Ward and Zhou (2006) identified that even companies that have experienced success through implementing lean practices may benefit from IT integration practices that are available through ERP system implementation.

4. Conclusion

Today, waste generation in the construction industry is becoming a severe issue to both the economy and environment. Lean concept is introduced as a waste elimination concept to the manufacturing industry. Though it originated from the manufacturing industry, later on many of the researchers identified those lean principles can provide benefits for construction industry also. With the time being the researchers could categorize the waste that occurred throughout the construction projects, into seven basic types namely overproduction, over processing, inventory, transportation, motion, waiting, motion and defects. Even though there are many tools and techniques introduced to eliminate those wastes, some researchers identified there are certain drawbacks on those tools which drive the waste elimination unsuccessful. Thus, the ERP system was merged as one of the best options to overcome these issues.
This paper represents the basic idea about how the lean concept affects to the construction industry by examining the lean concept, lean waste types, lean tools and techniques with the support of ERP system and the way of synchronizing lean concept and ERP system together to minimize construction waste in Sri Lanka.

5. References

Ansah, R. H., Sorooshian, S. & Mustafa , S. B., 2016. Lean construction: An effective approach for project management. *ARPN Journal of Engineering and Applied Sciences,* February, 11(3), pp. 1607-1612.

Ayala, R., 2018. *5 Unexpected Benefits of Lean Construction Management*. [Online]
Available at: https://blog.plangrid.com/2018/02/5-unexpected-benefits-lean-construction-management/
Ayemba, D., 2018. *5 Waste management tips for the construction industry*. [Online]
Available at: https://constructionreviewonline.com/2018/03/5-waste-management-tips-for-the-construction-industry/
Ballard, G., 1990. *Improving work flow reliability*. Berkeley, Calif, University of California, pp. 275-286.
Bingi, P., Sharma, M. K. & Golda, J. K., 2002. Enterprise systems. *Best Practice Series,* pp. 425-438.
Chahal, V. & Narwal, M. S., 2017. Impact of lean strategies on different industrial lean wastes. *International Journal of Theoretical and Applied Mechanics,* Volume 12, pp. 275-286.
Cunha, L., 2018. *7 ways to cut waste with ERP*. [Online]
Available at: https://www.to-increase.com/7-ways-cut-waste-erp/
Davenport, T. H., 2000. The Future of Enterprise System-Enabled Organizations. *Information Systems Frontiers,* pp. 163-180.
Dinesh, S., Sethuraman, R. & Sivaprakasam, S., 2017. The review on lean construction an effective approach in construction. *International Journal of Engineering Research and Modern Education,* April.pp. 119-123.
Djuric, M., 2008. *Lean ERP systems: Existence and viability in today's manufacturing industry,* San Luis Obispo: s.n.
Domingo, R. T., 2013. *Lean management principles,* s.l.: s.n.
Emuze, F. & Smallwood, J., 2011. Non-value adding activities in South African construction: A research agenda. *KICEM Journal of Construction Engineering and Project Management,* December, 1(3), pp. 38-44.
Esa, M. R., Halog, A. & Ismail, F. Z., 2015. Waste management in construction industry: A review on the issues and challenges. *International Conference on Environmental Research and Technology,* pp. 100-106.
Foo, L. C. et al., 2013. Classification and quantification of construction waste at housing project site. *International Journal of Zero Waste Generation,* 1(1), pp. 1-4.
Formoso, C. T., Isatto, E. L. & Hirota, E. H., 1999. *Method for waste control in the building industry*. Berkeley, University of California, pp. 1-10.
Formoso, C. T., Soibelman, L., Cesare, C. D. & Isatto, E. L., 2002. Material waste in building industry: Main causes and prevention. *Journal of Construction Engineering and Management,* Volume 128, pp. 316-325.
Ghosh, R., 2012. A comprehensive study on ERP failures stressing on reluctance to change as a cause of failure. *Journal of Marketing and Management,* 3(1), pp. 123-134.
Gunasekara, B. D. K. I. et al., 2018. ERP systems' impact on the accounting process in Sri Lankan companies. pp. 1-27.
Harish, K. A. & Selvam, M., 2015. Lean wastes: A study of classification from different categories and industry perspectives. *The Asian Review of Civil Engineering,* 4(2), pp. 7-12.
Holland, C. & Light, B. A., 1999. Critical success factor model for ERP implementation. *IEEE Software,* 9(3), pp. 30-36.
Howell, G. A., 1999. *What is lean construction?*. Berkeley, California, s.n., pp. 1-10.
Ibrahim, A. R. B., Roy, M. H., Ahmed, Z. U. & Imtiaz, G., 2010. Analyzing the dynamics of the global construction industry: Past, present and future. *Benchmarking: An International Journal,* 17(2), pp. 232-252.
Jayalath, A. & Gunawardana, T., 2017. Towards sustainable constructions: Trends in Sri Lankan construction industry-a review. *International Conference on Real Estate Management and Valuation 2017,* pp. 137-143.
Keys, A., Baldwin, A. & Austin, S., 2000. Designing to encourage waste minimisation in the construction industry. *Proceedings of CIBSE National Conference, CIBSE2000*..
Koskela, L., 1992. *Application of the new production philosophy to construction,* Finlad: Stanford University.
Koskela, L. J., Bolviken, T. & Rooke, J. A., 2013. *Which are the wastes of construction*. Fortaleza, Brazil, University of Salford, pp. 3-12.
Lean Construction Institute, 2015. *Learning to see waste,* Arlington: Lean Construction Institue.
Li, Y. X., Liu, M. H. & Li, Z. L., 2012. The dual implementation of lean and ERP in manufacturing. *Advanced Materials Research,* Volume 591-593, pp. 400-404.
Macomber, H. & Howell, G. A., 2003. Linguistic action: Contributing to the theory of lean construction.
Madanayake, U. H., 2015. *Application of lean construction principles and practices to enhance the construction performance and flow*. Colombo, Sri Lanka, Ceylon Institute of Builders.
Madanhire, I. & Mbohwa, C., 2016. *Enterprise resource planning (ERP) in improving operational efficiency: Case study*. s.l., Elsevier B.V, p. 225 – 229.
Mao, X. & Zhang, X., 2008. Construction process reengineering by integrating lean principles and computer simulation techniques. *Journal of Construction Engineering and Managemen,* Volume 134, pp. 371-381.
Matende, S. & Ogao, P., 2013. Enterprise resource planning (ERP) system implementation: A case for user participation. *CENTERIS 2013 - Conference on Enterprise Information Systems / PROJMAN 2013 - International Conference on Project Management / HCIST 2013 - International Conference on Health and Social Care Information Systems and Technologies,* Volume 9, pp. 518-526.
Modi, D. B. & Thakkar, H., 2014. Lean thinking: Reduction of waste, lead time, cost through lean manufacturing tools and technique. *International Journal of Emerging Technology and Advanced Engineering,* March, 4(3), pp. 339-344.
Nah, F., Lau, J. & Kuang, J., 2001. Critical factors for successful implementation of enterprise systems. *Business Process Management Journal,* 7(3), pp. 285-296.
Nakashima, B., 2000. *Lean and ERP: Friend or foe?*. [Online]
Available at: http://www.advanced-manufacturing.com/index.php?option=com_staticxt&staticfile=informationtech.htm&Itemid=44
Namrouty, K. A. & AbuShaaban, M. S., 2013. Seven wastes elimination targeted by lean manufacturing case study "gaza strip manufacturing firms". *International Journal of Economics, Finance and Management Sciences,* 1(2), pp. 68-80.

Nikakhtar , A., Hosseini, A. A., Wong, K. Y. & Zavichi, A., 2015. Application of lean construction principles to reduce construction process waste using computer simulation: A case study. *International Journal of Services and Operations Management,* 20(4), pp. 461-480.
Nwankpa, J. K., 2015. ERP system usage and benefit: A model of antecedents and outcomes. *Computers in Human Behavior,* Volume 45, p. 335–344.
Nwankpa, J. K. & Roumani, Y., 2014. The influence of organizational trust and organizational mindfulness on ERP systems usage. *Communications of the Association for Information Systems,* Volume 34.
Olson, D. L., Johansson, B. & Carvalho, R. A. D., 2018. Open source ERP business model framework. *Robotics and Computer–Integrated Manufacturing,* pp. 30-36.
Osnes, K. B., Oslen, J. R., Vassilakopoulou, P. & Hustad, E., 2018. ERP systems in multinational enterprises: A literature review of post-implementation challenges. *Procedia Computer Science,* Volume 138, pp. 541-548.
Otieno, J. O., 2010. *Enterprise resource planning systems implementation and upgrade,* s.l.: Middlesex University.
Peddavenkatesu, Y. & Naik, B. H., 2016. Waste minimisation in construction industry. *International Journal of Innovative Research in Science, Engineering and Technology,* October, 5(10), pp. 18023-18030.
Powell, D., Alfnes, E., Strandhagen, J. & Dreyer, H., 2011. *ERP support for lean production.* Stavanger, Norway, HAL archives-ouvertes, pp. 115-122.
Rashid, M. A., Hossain, L. & Patrick, J. D., 2002. The evolution of ERP systems: A historical perspective. pp. 1-16.
Rishi, B. J. & Goyal, D. P., 2008. Designing a model for the development of strategic information systems in Indian public sector undertakings. *International Journal of Business Information Systems,* 5(3), pp. 529-548.
Senaratne, S. & Wijesiri, D., 2008. Lean construction as a strategic option: Testing its suitability and acceptability in Sri Lanka. *Lean Construction Journal,* pp. 34-48.
Shang, S. & Seddon, P. B., 2002. Assessing and managing the benefits of enterprise systems: the business manager's perspective. *Information Systems Journal,* Volume 12, pp. 271-299.
Shankari, R. S., Ambika, D. & Kavithra, S. S., 2017. A review on waste material minimization in construction industry. *International Research Journal of Engineering and Technology (IRJET),* 4(1), pp. 1306-1309.
Silva, N. D., Rajakaruna, R. W. D. W. C. A. B. & Bandara, K. A. T. N., n.d. Challenges faced by the construction industry in Sri Lanka: Perspective of clients and contractors. pp. 158-169.
Skok, W. & Legge, M., 2002. Evaluating Enterprise Resource Planning (ERP) systems using an interpretive approach. *Knowledge and Process Management,* 9(7), pp. 72-82.
Subramani, T. et al., 2018. Lean technology and waste minimization in construction industry using SPSS. *International Journal of Emerging Trends & Technology in Computer Science,* 7(2), pp. 224-234.
Tenkorang, R. A. & Helo, P., 2011. *Enterprise Resource Planning (ERP): A review literature report.* San Francisco, USA, s.n.
Uni Assignment Center, 2013. *Waste minimization construction essay*. [Online]
Available at: https://www.uniassignment.com/essay-samples/construction/research-is-focused-on-waste-minimization-construction-essay.php#reference
Vidalakis, C., Tookey, J. E. & Sommerville, J., 2011. Logistics simulation modelling across construction supply chains. *Construction Innovation: Information, Process, Management,* 11(2), pp. 212-228.
Womack, J. P. & Jones, D. T., 1996. *Lean thinking: banish waste and create wealth for your cooperation*. Newyork: Simon and Schuster.
Womack, J. P. & Jones, G. T., 2003. *Lean thinking*. New York: Simon and Schuster.
Wrap, 2014. *Achieving good practice waste minimization and management,* Oxon: Waste & Resources Action Program.