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Assessment of Lean-Green Integration Throughout Manufacturing Transportation Activities

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Abstract

This aims of this research is to study the effect of all transportation activities through lean and green management perspective. AL-Kufa /Iraq Cement plant is considered as a case study to examine the effect of individual and overall results that may contribute in the lean-green integration. Life cycle assessment was used as an environmental key performance indicator for lean green integration. Relationship matrix, Pie, and Pareto charts were tools and techniques used to assess the present results. Results were generated using Minitab Version 17 and Edraw Max. Version 7 software. Results showed that the material transported throughout processing was crucial in effecting on lean green integration not the transportation media. Since the same transportation media could be, synergistic, or conflicting according to position of this media to the process and relative material type transported. Results also show that transportation activities, throughout grinding resulted particulate matters that causes winter smog environmental impact. Thus human health impairments (Hi) damage in this transportation activity resulted 42.94 %. Followed by kiln production and cooling by 25 %. The rest value was divided between packaging, and finish grinding processes.

Keywords: Lean, Green, Transportation, Media, Synergy, Conflict, Neutral, LCA, Relationship matrix, KPI**.**

1. Introduction

The materials are dynamic differ in their transport cost and times, as log as material movement.Transportation is a fundamental activity to convey the inventories, raw material, semi-complete and complete production from one point to other by transportation activities. It is required in the whole production procedures, from manufacturing, delivery to the final consumers and returns. Although transportation system joints the separated activities, accounts one-third of the logistics costs, influence the performance of logistics system hugely. But transportation represents handling more than once, delays in moving materials, and unnecessary moving or handling [1,2].Transportation media may be manual, mechanized, automated and subcategorized as conveyor, hopper, crane, centrifugal pump, elevator, industrial trucks, and manual operations. The operation of transportation determines the efficiency of moving products. The progress in techniques and management principles improves the moving load, delivery speed, service quality, operation costs, the usage of facilities and energy saving. [1,3].

Lean and green are complementary and are governed by three main principles: waste reduction, a process-centered focus, and high levels of involvement and participation by people [4]. The main argument supporting the idea of the virtual convergence between lean and green are using lean principles in environmental projects will help create a cooperative approach to continual improvement [5]. A shortage of lean and green research focused on the company level, and in particular, on developing measurement methods or models for specific processes and industries, also lack of lean –green research is highlighted in transportation activities [5,6].

The aim of this research is to study the effect of all transportation activities through lean and green management perspective. Assessment of transportation activities on lean-green integration is employed through different, environmental, operational tools and statistical techniques. The next paragraph presents theoretical background, global interest in lean-green integration, activities, relative integration tools, and performance indicators. This paragraph is followed by data collected from Al-Kufa Cement plant on 2015 as case study. These data are further analyzed, different key performance indicators are employed to quantify lean-green integration throughout different transportation activities. The last paragraph is summarizing conclusions; also recommendations for future work are

reported. Manufacturers simultaneously select and join lean and green paradigms so as to make an environmental status that may decrease costs, increase profit, "Lean is Green" have been increasingly conventional [7]. Integration of lean and green management is driven by both internal and external factors. Internal factors include cost reduction and profitability, commodity risk management, and the preservation of a corporate culture. While external factors include government norms, environmental pressures, a similar focus on continuous innovation and process improvement [8,9]. Tilina et al., [10] referred lean as the catalyst for green while Roya Kalbassi believed that not only lean is beneficial for green practices but also the implementation of green practices has positive influence on current lean practices [11]. To depict the synergies, trade-offs and the cause-effect relationships between lean and green paradigms and their effect on eco-performance, relationship matrix technique is used to integrate lean and green practices to clarify their integrated impact on activities and key performance indicators [12]. Conflict is referred to a balancing of adaptation and mitigation when it is not possible to carry out both activities fully at the same time. But synergy is the interaction of adaptation and mitigation so that their combined effect is greater than the sum of their effects if implemented separately [13]. Resrearchers world wide investigate, lean, green interlation, implementation throughout different methodologies, tools,and performance indicators[2,14,15].

Khalil et al.,(2013) described work undertaken to implement lean practices in the continuous process for Cement production in Turkey. One of the major barriers to lean implementation is providing evidence of its potential benefit to end-users. Their work aim was to overcome this obstacle by producing a tool which can be used to easily visualize the benefits of adopting lean practices without requiring disruption to the production environment. As they used process mapping, computational simulation and Taguchi method for design of experiments [16].

Ruisheng et al., (2015) proposed methodology to adopt and streamline of metal stamped parts production in Singapore (a case study). Their methodology which aims to integrate metrics derived from lean and green implementation, an easy-to-track metric called Carbon-value efficiency,. Their results showed that Carbon-value efficiency was improved by 36.3%, lead time by 64.7% and reduction in Carbon footprint by 29.9% [17].

Dhiravidamani et al., (2016) focused on the sustainability of green environment through lean tool implementation in auto parts manufacturing industry in India. They used value stream mapping in the entire lean process through reduction of waste, and described how environmental performances were improved by eliminating the wastes. Their result showed improvement in performance for the future state map in terms of reduction in non-value activities as product pollution cost, human effort and product manufacturing time. [18].

Brunilde et al., (2016) reviewed the main scientific lean and green contributions where Toyota industrial best practices were presented. Also comprehensive analysis of synergies between lean and green wastes. They found an appropriate way to combine and implement lean and green tools and methodologies within firms that have different corporate cultures and process specificities [15].

Lamyaa and Zuher, (2017) developed paradigm that demonstrated integration of lean and green management throughout manufacturing activities, inventory, and transportation. They employed AL-Kufa /Iraq Cement plant as a case study to investigate the developed methodology. The effect of individual activity and overall outcomes that could contribute in the lean-green management integration is also revealed. They assess the interrelation throughout two key performance indicators are;-life cycle assessment, and lead time. Using relationship matrix, Pie, and Pareto chart tools to assess and present results. Their results show crushing process has also the major effect towards the four environmental categories of Eco-95 indicator; human health impairment has major damage of 91.60 % [19].

Different Key performance indicators could be used to investigate integrative lean-green management activities. Life Cycle Assessment (LCA) is an environmental Key Performance Indicator KPI that measures impact of certain activities ,while process cycle efficiency, and efficiency of resource consumption, are operational performance indicators [20,21,22].

Pie and Pareto charts are effective statistical tools to illustrate proportions of the overall effects of activities and lean and green integration contribution [22, 23].

2. Case Study

In order to study the effect of different transportation activities through lean and green management. AL- Kufa Cement Plant is employed as a case study since this plant suffers from different waste (environmental, and physical) types. The plant produces different types of Cement such as ordinary, and Sulphate resisting (currently is producing Sulphate resisting) throughout wet process. Four production processes are served by nineteen different transportation media i.e. almost five times the amount of production processes. Figure (1) shows the flow diagram of the production processes and relative transportation media, while table (1) briefly explains both each production process and the relative transportation media.

Table (1) Brief Description of Al-Kufa Wet Cement Manufacturing

Process	Process Description	Transportation Activities Description
Grinding and blending	Limestone, Clay, Sand, Iron Ore and Water are fed to the grinding and blending machine with at a specified quantity to obtain wet slurry.	Limestone is transferred by conveyor belt to be mixed with sand and clay that are transpoted by hoppers.They are mixed with to produce slurry that is transprted to corrected basin by
Kiln productio n and cooling	Wet slurry is fed to the rotary kiln to obtain Clinker that is passed through cooling system to reduce temperature to 150 C^o.	Centrifugal pumps are used to feed slurry to Kiln productin and cooling. Then Clinker is transported by rotary Kiln and chains to conveyor belts that are utilized to transport produced
Finish grinding	Clinker with a particular percentage of Gypsum is fed to finish milling so as to obtain Cement that is pumped to the packaging area.	The Clinker is transported from Kilns to special hoper for each mill with a special hoper for Gypsum. This hoper conveys Gypsum by rubber conveyor which fed to the finish grinding, after that centrifugal pumps

Packaging	Packaging system consists of seven filling machines, one for bulking and rest for packaging, each machine consists of many pipes move with rotary to package cement inside the paper	Finally, Cement is pushes by centrifugal pump to package and packaged Cement transports by rubber conveyers to supplier cars with different quantities according to customer's desire, but bulk cement transports by centrifugal pump to supplier cars directly.

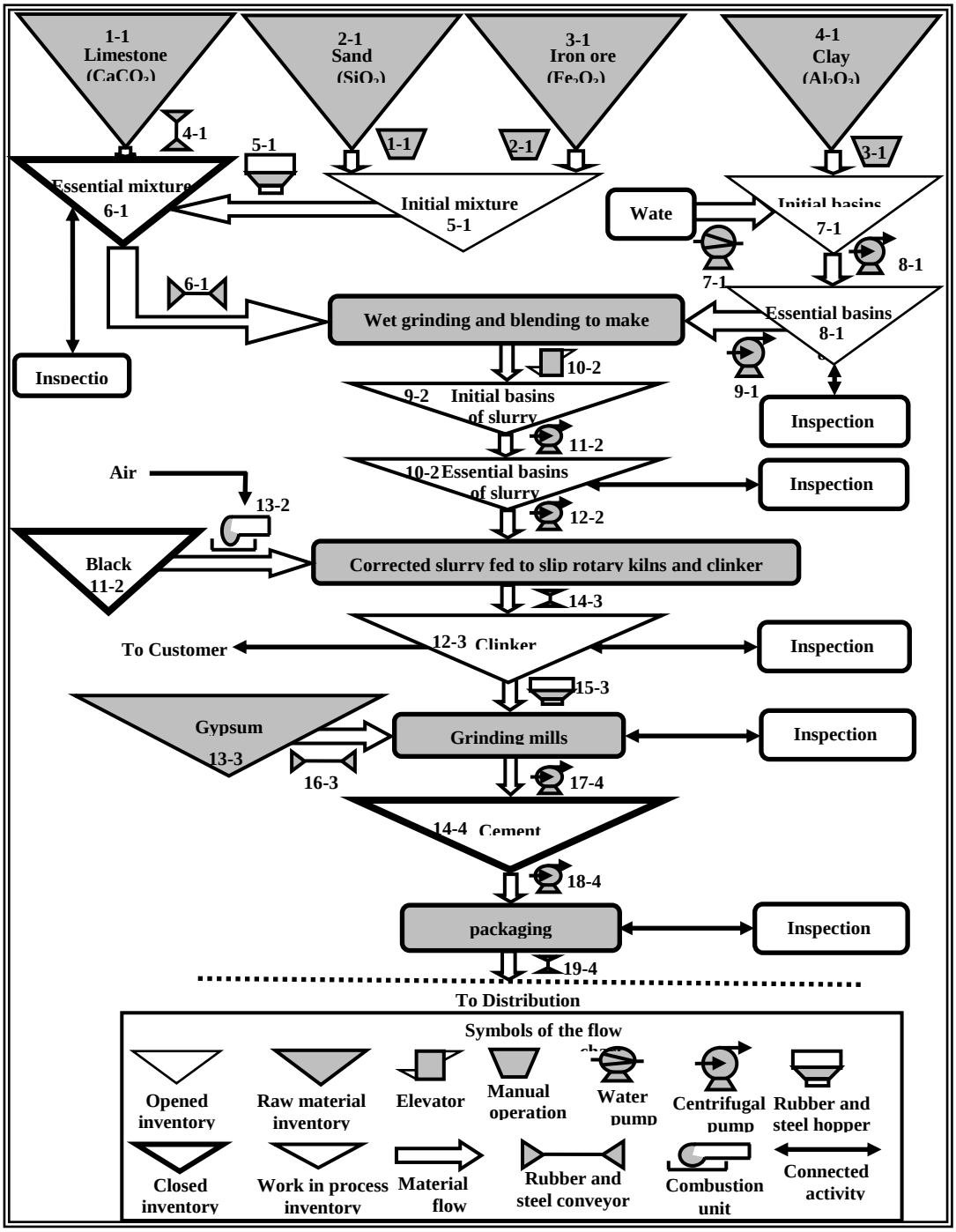

Figure (1) Flow Diagram Of Manufacturing Transportation

3. Data collection, Analysis and Discussion

The relationship matrix shown below in Table (2) where synergy,conflict and neutral attributes are depicted throughout the transportation activities of Al-kufa Cement manufacturing plant.This matrix shows that transportation is positively affect lean-green integration for transportation media relative to processes No. one (Grinding and blending, two (Kiln production and cooling) and three (Finish grinding). But lean-green integratin is almost negatively affected by process No. four (Packaging). It is note from table (2) below that the material transported throughout processin is crucial cause as transportation may be not effective (neutral) noticed for centrifugal pump (11-2), while other centrifugal pump are synergetic to lean green. Manual operation (1-1), (2-1), and (3-1) could be improved towards lean green integration. Ranking of lean green integration attributes, their Relative Symbols, and ranking explanation is shown in Table (3).

Table (2) Effect of Transportation Activity onto Lean-Green Integration

Inventory-Process	Transportation activity	Integration		Remarks
		Lean	Green	
1-1	Manual operation	↓	-	synergy
2-1	Manual operation	↓	-	synergy
3-1	Manual operation	↓	-	synergy
4-1	Rubber conveyor	↑	-	synergy
5-1	Rubber hopper	-	-	Neutral
6-1	Rubber conveyor	↑	-	synergy
7-1	Water pump	↑	-	synergy
8-1	Centrifugal pump	-	-	synergy
9-1	Centrifugal pump	↑	-	synergy
10-2	Elevator	-	-	Neutral
11-2	Centrifugal pump	-	-	Neutral
12-2	Centrifugal pump	↑	-	synergy
13-2	Combustion unit	-	↓	synergy
14-3	Steel conveyor	-	-	Neutral
15-3	Steel hopper	↑	-	synergy
16-3	Rubber conveyor	↑	-	synergy
17-4	Centrifugal pump	-	↓	synergy
18-4	Centrifugal pump	↑	↓	conflict
19-4	Rubber conveyor	-	-	Neutral
Legend: increase; ↑ decrease; ↓ – neutral				

Table (3) Ranking of Lean-Green integration Attributes and Their Relative Symbols

Ranking Value	Explanation	Relative Effect	Symbols
5	Very Bad	Synergy	S1
5	Very Bad	Conflict	C1
3	Bad	Synergy	S2
1	Non	Neutral	N
3	Good	Synergy	S3
5	Very good	Conflict	C2
5	Very good	Synergy	S4

From table (4) illustrates individual results of transportation activities and attributes in which major effect of synergy, conflict and neutral attributes onto lean-green integration are (21.818 %, 18.182 %, 10.912 %) for centrifugal pump, and conveyor activities respectively.

Table (4) Individual and Overall Results of Lean-Green Integration

Transportation activities	**Attributes**		
	Synergy %	**Conflict %**	**Neutral %**
Manual operation	16.363	----	----
conveyor	16.363	----	3.636
Hopper	5.454	----	1.820
Water pump	5.454	----	----
Centrifugal pump	21.818	18.182	3.636
Elevator	----	----	1.820
Combustion unit	5.454	----	----
Total	70.906	18.182	10.912

From table (4), three major contributors toward lean green integration are centrifugal pump followed by manual and conveyor belts by almost the same positive contribution. On the other hand centrifugal pumps interact negatively by almost the same values. From figure (2) centrifugal pump activities have

major effect onto lean-green integration of 43.636 %, part of it has appositive synergy and conflict effect on the lean-green integration of 40 % due to possibility increase speed of centrifugal pump.

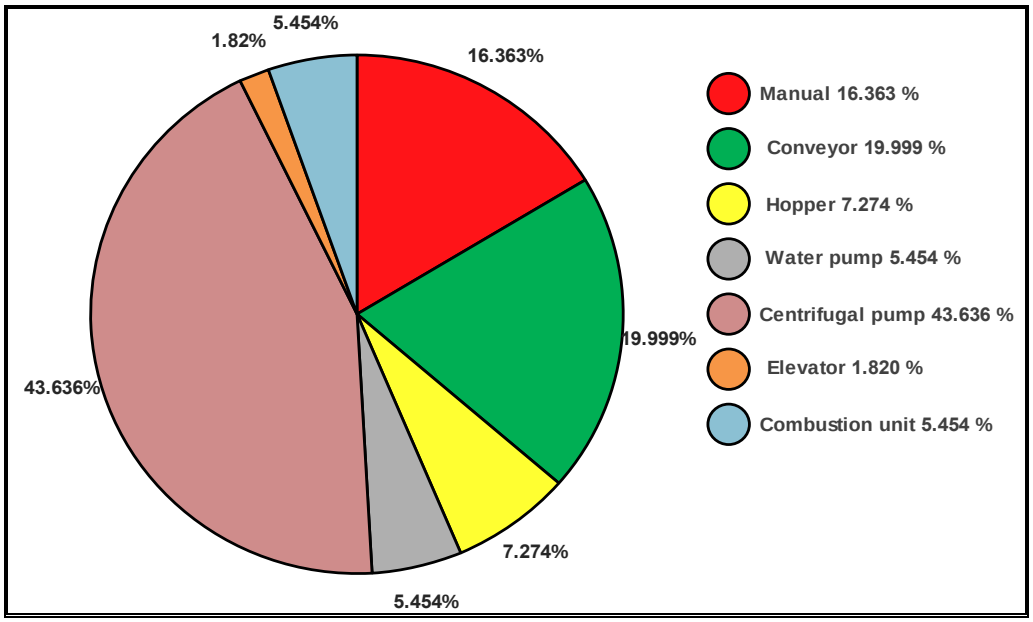

Figure (2) Pie Chart of Individual Effect of Transportation Activities

4. Environmental Performance measurments

Wastes throughout transportation activities are generated to air as shown in table (5) during the year 2015. Emission rate values are based on Cement plant **[Iraqi Cement State Company]**. These emission rates are further multiplied by characterization factors as shown in table (5). From table (5) the particulate matter (dust) generated to air is higher in grinding and finish grinding processes through transportation activities.

These values are reflected according to the four categories are Eutrophication, Acidification, , Greenhouse effect, and Winter Smog of Eco-95 [24]. Figure (3) illustrates effect of particulate matter (dust) on environment from transportation activities, in which grinding process has major environmental contribution of 42.94 % which this has major effect onto human Health impairment (Hi).

Table (5) Emission Factors, Rates and Environmental Impact of Transportation Activities

Classification of cement	Environmental impact	Winter smog			
	Process / Activity	Grinding	Kiln production and cooling	Finish grinding	Packaging
Sulphate resisting -2015	Transportation %	0.047	0.05	0.035	0.05
	Transportation dust (ton)	715	424	217	309
	Contribution %	42.94	25.47	13.03	18.56

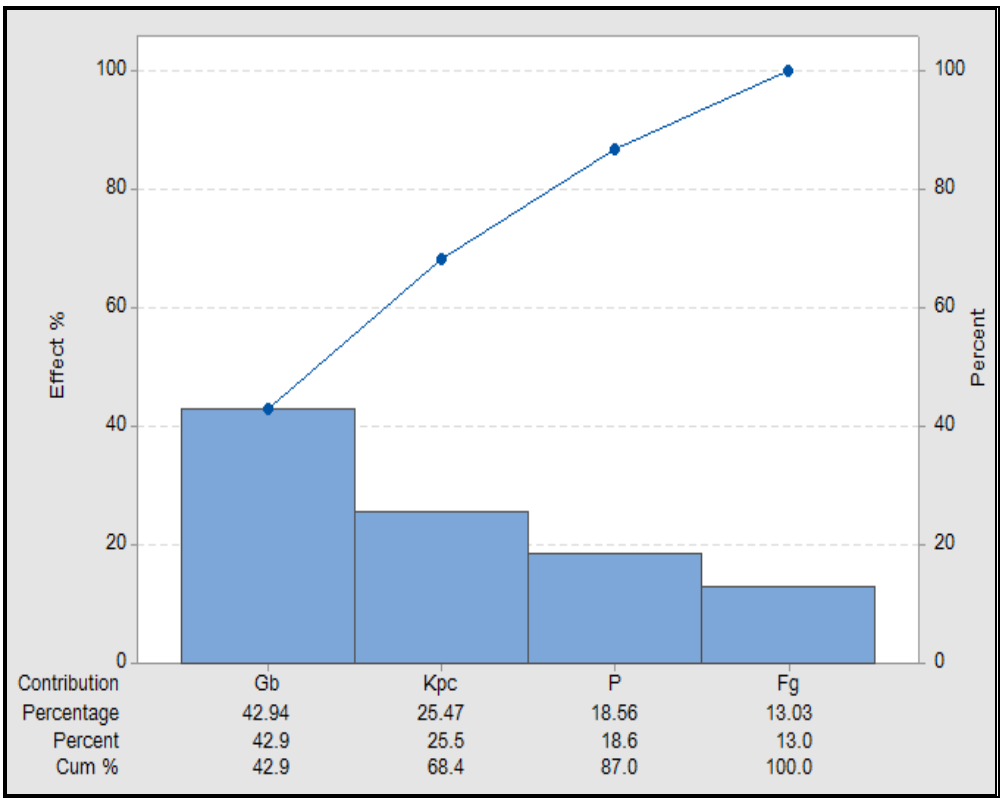

Figure (3) Contribution of Winter Smog Impact Through Transportation Activities

5. Conclusions and Further Recommendations

i- Results shows that the material transported throughout processing is crucial in effecting on lean green integration not the transportation media. Since the same transportation media could be, synergetic, or conflicting according to position of this media to the process and relative material type transported.

ii- Although manual operations are negative contributors toward lean these transportation activities can be utilized effectively toward green integration therefore, resulting contribution almost by third of synergetic lean green integration.

iii- transportation activities, throughout grinding resulted particulate matters that causes winter smog environmental impact. Thus human health impairments (Hi) damage in this transportation activity resulted 42.94 %, followed by Kiln production and cooling by 25 %. The rest value is divided between packaging, and finish grinding processes.

It is recommended to study further other KPI such as lead time to reflect the detailed effect of transportation activities in this manufacturing system.

6. References

[1] T. Srinivas and M.Srrennivas,(2005),"The Role Of Transportation in Logistics Chain" Proceedings of the Eastern Asia Society for Transportation Studies, Plagiary, Vol. 5, PP. 1657 – 1672.

[2] Cory R.A Hallam, and Caroline Contrereas,(2016),"The Interrelation of Lean and Green Manufacturing Practicess:A Case Study of Push Or Pull in Implementation,2016 proceedings of PICMET` 16 :Technology Management for Social Innovation.

[3] B.T.D. Praveen Varma and K.P.Sirisha, (2013)," Study of Processing and Machinery in Cement Industry", International Journal Of Engineering And Innovative Technology, Vol. 3, No. 5,PP.385-393.

[4] Dües, C. M., Tan, K. H., and Lim, M., (2013),” Green as the New Lean: How to Use Lean Practices As a Catalyst to Greening Your Supply Chain”, Journal Of Cleaner Production, Vol.40, PP.93–100.

[5] Garza-Reyes, J.-A., (2015),” Lean And Green - A Systematic Review of the State of the Art Literature”, Journal of Cleaner Production,Vol.102,PP. 18-29.

[6] Martinez-Jurado, P.-J., Moyano-Fuentes, J., (2014),” Lean Management, Supply Chain Management and Sustainability: A Literature Review “Journal of Cleaner Production, Vol. 85,PP.134–150.

[7] Corbett, C.-J., Klassen, R.-D, (2006),” Extending The Horizons : Environmental Excellence As Key To Improving Operations. Manufacturing & Service Operations Management, Vol. 8, NO. 1, PP.5–22.

[8] Mollenkopf, D., Stolze, H., Tate, W. L. & Ueltschy, M., (2010),” Green, Lean, And Global Supply Chains”, International Journal Of Physical Distribution And Logistics Management, Vol.40, NO. 1, Pp. 14 – 41.

[9] Sarkis, J., Zhu, Q. & Lai, K.-H., (2010),“ An Organizational Theoretic Review Of Green Supply Chain Management Literature”, Georgev Perkins Marsh Institute.

[10] Tilina Dana Iuliana1, Zapciu Miron, And Bendic Vasile, (2014),”The Link Between Lean And Green Manufacturing- A Way To Reach Sustainable Development”, Applied Mechanics And Materials Vol. 656, Pp. 534-541.

[11] Roya Kalbassi , (2015),”Lean And Green Parallel Implementation Impact On Outcomes Of Supply Chain In Canadian Aerospace Industry”, Master Of Applied Science (Quality Systems Engineering) at Concordia University.

[12] Dües, C. M., Tan, K. H., & Lim, M. , (2013)” Green As The New Lean: How To Use Lean Practices As A Catalyst To Greening Your Supply Chain” Journal Of Cleaner Production, Vol.40, PP.93–100.

[13] Roya Kalbassi , (2015),”Lean And Green Parallel Implementation Impact On Outcomes Of Supply Chain In Canadian Aerospace Industry”,

Concordia University School Of Graduate Studies.

[14] ECORYS, (2011),” Sustainable Industry: Going for Growth and Resource Efficiency” Report for Directorate General- Enterprise and Industry.

[15] Brunilde Verrier, Bertrand Rose, Emmanuel Caillaud, (2016),” Lean and Green Strategy: The Lean and Green House and Maturity Deployment Model”, Journal of Cleaner Production, Vol.116,PP.150-156.

[16] Khalil, R. A., Stockton, D. J., Tourki T., Mukhongo L.M,(2013),” Implenetaion of Lean in Coutinuous Process-Based Industries” International Journal of Scientific and Engineering Research, Vol.4, No. 10,PP.723-735.

[17] Ruisheng Ng, Jonathan Sze Choong Low, Bin Song, (2015), “Integrating and Implementing Lean and Green Practices Based on Proposition of Carbon-Value Efficiency Metric”, Journal of Cleaner Production.,Vol95,PP.242-255.

[18] P. Dhiravidamani; A. S. Ram Kumar,(2016),” Sustainability of Green Environment Though Lean Tool Implementation in Auto Parts Manufacturing Industry – An Industrial Case Study” Asian Journal of Research in Social Sciences and Humanities, Vol. 6, No. 7, PP. 2069-2077.

[19] Lamyaa Mohammed Dawood, Zuher Hassan Abdullah,(2017),” Effect of Manufacturing Activities on Lean - Green Management Integration”, Proceedings of the Seventh International Conference on Industrial Engineering and Operations Management, Rabat, Morocco, Accepted as the Best Research.

[20] Chase, R.B, Jacobs, F.R. And Aquilano, N.J., (2005),” Operations Management for Competitive Advantage”, Eleven Edition, Mcgraw-Hill.

[21] M. Braglia, G. Carmignani, And F. Zammori,(2006)” A New Value Stream Mapping Approach for Complex Production Systems”, Journal International Journal of Production Research ,Vol.44,No.18-19,PP. 3929-3952.

[22] Issa Bass Barbara Lawton,(2009),”Lean Six Sigma Using Sigmaxl and Minitab” Mcgraw-Hill Companies.

[23] Montgomery, Gouglas C.,(2005),”Design And Analysis of Experiments: Response Surface Method and Designs”, New Jersy, John Wiley And Sons,Inc.

[24] Goedkoop M,(1994), "The ECO-Indicator 95: Final Report", Consultants, Europe.

تقييم أنشطة النقل لعمليات التصنيع من خلال التكامل الرشيق-الأخضر

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الخلاصة

يهدف هذا البحث إلى دراسة تأثير جميع أنشطة النقل من خلال منظور الإدارة الرشيقة-الخضراء. تم توظيف مصنع سمنت الكوفة/العراق كدراسة حالة لدراسة تأثير النتائج الفردية والكلية التي يمكن ان تسهم في التكامل الرشيق-الاخضر. تم استخدام تقييم دورة الحياة كمؤشر رئيسي للأداء البيئي لغرض التكامل الرشيق-الاخضر. مصفوفة العلاقة، مخطط القطاع، ومخطط باريتو هي الأدوات والتقنيات المستخدمة لتقييم وعرض النتائج. تم توليد النتائج باستخدام برنامج Minitab الإصدار 17 وبرنامج Edraw Max. الإصدار 7. تظهر النتائج أن المواد المنقولة خلال مراحل المعالجة هي مهمة في التأثير على التكامل الرشيق-الاخضر وليس وسائل النقل. بما أن وسائل النقل نفسها يمكن أن تكون متحدة أو متضادة وفقاً لموقع هذه الوسائط إلى العملية ونوع المادة المنقولة. تظهر النتائج أيضا أن أنشطة النقل، خلال عملية الطحن أنتجت اتربة متطايرة التي تسبب التأثير البيئي المصنف بدخان الشتاء. وبالتالي فإنها انتجت ضرر بيئي على حياة الانسان بنسبة 42.94 % , تليها إنتاج الفرن والتبريد بنسبة 25 %. مقدار الضرر المتبقي تم تقاسمه بين عمليات التعبئة والطحن النهائي.

الكلمات المفتاحية: الرشيق, الاخضر, الاتحاد, التضاد, التعادل, تقييم دورة الحياة, مصفوفة العلاقة, مؤشرات الاداء الرئيسية.