Layout Green Logistics Moving Materials by Gravity

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Abstract. The consumption of electricity in industry is receiving a lot of attention as electricity is one of the main drivers in the industry. We can make a huge savings in electricity by using gravity as we always strive for sustainability. Therefore, this paper aims to explore, as an empirical research, the relationship between the type of industry and the moving of materials by gravity, which is known as “green logistics”; using statistical techniques namely Pearson Chi-Square and Likelihood Ratio test.

The theme of green logistics was chosen as one of the forms of sustainability, i.e. the use of gravity for handling materials during the manufacturing process, so that it does not consume any electrical energy, but rather moves materials or goods from one “working place” to the next using the force of inclination or humans. The research sample is the factories of the Kingdom of Saudi Arabia, specifically the plastic industries and the furniture industries, this is due to the appropriateness of the material for handling by gravity, moving materials or products regardless of their shape, size or weight. The research will also study the most prominent production stations in which gravity is used, such as packing, packaging, loading and unloading, and others. It is expected that the results of this research will lead to the proposal of some legislation, whether related to the construction of industrial facilities or manufacturing processes, so that these legislations can be adopted, at least in a gradual manner. This topic of research was chosen specifically in view of the modern global trend towards considering sustainability and extending its applications in most aspects of life, including the industrial sector, which consumes about 47% of primary energy. This means that reducing dependence on electricity in a country that accommodate nearly 8,000 factories will be a tangible impact on enhancing the concept of sustainability.

Keywords: Logistics; Green; Gravity; Sustainability; Plastics; Furniture; global warming; Green Logistics
1. Introduction

1.1 Subject & Research questions

The topic of this paper is about sustainability. More precisely, the extent to which gravity is widely used in handling and moving materials through manufacturing plants until it becomes a final product. In this research, two important sectors of the industrial sectors in the Kingdom were targeted: the plastic industries sector and the furniture industries sector. Each of these sectors was chosen as the first to consume high electrical energy that can be reduced through green logistics, and the other as the shape, size and weight of its materials can benefit from the green logistics.

As far as research question concern, two questions were asked by phone. These question were:
Q1: Are you moving materials from one station to another by gravity?
Q2: If yes, at what station?

1.2 Objectives & Importance

For this paper, as any other published paper, the main objective is to determine the presence of green-logistics presence within the manufacturing process; plus to test a hypothesis of causal relationship between the “use of Gravity” and “the type of the industry”.

The importance of this project came from many dimensions, namely:
- The sustainability is receiving substantial support from the whole of the word.
- KSA, per se, needs to promote sustainability with the kingdom, especially, the industry sector.
- The ability of this paper to understand the relations between the “use of Gravity” and “the type of the industry”; and increase public awareness.
- To help make the business more profitable by using green logistics.
- To find out any opportunities for further work, new ideas and business improvement.
- Proactively, investigating any problems that must be overcome.

2. Literature Review

Green logistic, or handling by gravity, is the use of gravity to move parts, pieces or finished products from one station to the next station without the need for any use of power, rather only the use of the inclination that causes the force of the gradient, likewise, it is sometimes used to move materials from the highest floor to the next floor. Green logistics can be depicted by conveyors and chutes. Therefore, it cannot be said that this system is better than this system, but the decisive factor in choosing the best system depends a lot on the type of operation required and on the piece’s size, weight, shape, and the place it will move to and from. Green logistics is also a fertile field for enjoying many advantages such as safety and saving of time, space and cost.

Although automation has proven to be an effective to improve the performance of production systems, the cost associated with this automation makes it necessary to reconsider or search for other sustainable alternatives, especially with regard to small industrial systems, which are greatly affected by the high costs of electricity, as well as the ease of replacing some parts of the current sub-systems by sustainable alternative.
Material handling systems account for about 25% of production costs. Therefore, striving to make this activity sustainable is a goal, as it preserves natural resources on one hand, plus it also reduces production costs and thus maximizes the profitability of the project.

Like any other concept, green logistics have been criticized in terms of the length of time required for the industrial process or the handling process; plus sometimes poor safety. However, this criticism is limited for some applications and for some products, with evidence that it has proven exactly the opposite in other industries and products where it shortened the time of the handling process. The moving of materials was also safe for the worker and product itself, as it arrived safely and smoothly.

Sustainability literature is unanimous on its importance as a major component of manufacturing systems. Some research even used the concept of environmental sustainability to achieve commercial sustainability [6]. Work is still underway to maintain green logistics while enhancing promising opportunities in improving the quality and effectiveness of these systems. Some of the materials that make up the system have been developed in a way that has led to reducing the total weight of the system as well as improving the environment of movement and handling, as the activation of sustainability in industrial systems is not only limited to the presence of handling based on gravity. Rather, the engineers’ ambition rose to make the handling system itself sustainable by manufacturing the handling system from materials that promote the concept of sustainability[7] without sacrificing the carrier’s strength and structural characteristics[9].

There is no doubt that the use of gravity in most production processes, including handling, is considered self-evident because, in short, it is inexpensive and does not require the presence of engines or other mechanical parts that need to be moved by electricity, and therefore it is of low initial cost as well as low cost of maintenance. This means that this topic [1] is of interest to researchers, business owners and policy makers in the manufacturing community, and can serve as a basic guide for future studies in these areas. In particular, consideration should be given to both sustainability and energy efficiency, as this relationship has not been adequately studied.

Not only that, but it is clear from the research literature that it is difficult to move towards technical development and modern industrial concepts without linking these technologies and concepts to sustainability [2] despite the difficulties that may face this integration or connection. Whether in terms of the amount of data needed and the difficulty of analyzing them, or the limitations of some methods due to the diversity and difference of the type of factory or type of product on the effectiveness of green stirring [5].

It should be noted that this research has adopted the empirical method because of the empirical results of an important role in presenting proposals and frameworks that help spread sustainability in movement systems[4] and mobility, inspired by what was stated in the research [8], which made the handling system the available solution to the problem of increasing demand in light of limited production capacities, which had a positive impact on the diversity, safety and sustainability of the manufacturing system in the facility. Not only that, but he found many success stories that indicated the feasibility and effectiveness of replacing manual handling systems with handling systems based on gravity, and we did not choke with some development [10].

3. Methodology & Tools

The empirical approach was used to clarify the relationship between the influencer and the effect through the experimental method, which shows the cause-effect relationship. Hypotheses have been proven or denied by relying on experiment with controlled variables and influences.[3]

The tools which were used in this paper was the phone-survey by calling the factories managers and asking them to answer the two-research question.
4. Sample & limitations

The sample size was 50 factories, out of which is 37 are plastics factory, whereas the remaining 13 was furniture factories.

|                | Plastics factories | Furniture factories |
|----------------|-------------------|---------------------|
| count          | 37                | 13                  |

As can be seen above, this research was limited to plastics and furniture factories, as well as, whether the GL is exist or not. Other impacts were not considered rather left for further future work.

5. Statistical analysis

In this section, we use two statistical tests (Pearson Chi-Square test and Likelihood Ratio test) to test the relationships between the “use of Gravity” and “the type of the industry” using SPSS v. 24 software. Our sample was 50 observations (37 plastic factories plus 13 furniture factories).

|                  |   | No | Yes | Total |
|------------------|---|----|-----|-------|
| PLASTIC          |   |    |     |       |
| Count            |   | 23 | 14  | 37    |
| Expected Count   |   | 22.9 | 14.1 | 37.0 |
| % Within Factory |   | 62.2% | 37.8% | 100.0% |
| FURNITURE        |   |    |     |       |
| Count            |   | 8  | 5   | 13    |
| Expected Count   |   | 8.1 | 4.9  | 13.0  |
| % Within Factory |   | 61.5% | 38.5% | 100.0% |

As shown in Table 1, 62.2% of the plastic factories don’t use gravity to move parts between the manufacturing processes, while 37.8% of the plastic factories use gravity. Almost the same parentages were achieved in the furniture factories as 61.5% don’t use the gravity, whereas 38.5% use the gravity. More to note as per the below chart.
Null Hypothesis (H0): There is no significant difference between the use of gravity to move parts between the manufacturing processes of the two industries (plastic and furniture).

Alternative Hypothesis (H1): There is significant difference between the use of gravity to move parts between the manufacturing processes of the two industries (plastic and furniture).

| Test                  | Value | Df | P-Value |
|-----------------------|-------|----|---------|
| Pearson Chi-Square    | .002  | 1  | .968    |
| Likelihood Ratio      | .002  | 1  | .968    |

As shown above on Table 2, the value of the Pearson Chi-Square and Likelihood Ratio tests is 0.002 with p-value = 0.968, then we cannot reject H0 because the p-value of the two tests is greater than 0.05. This means that there is no significant difference between the use of gravity to move parts between the manufacturing processes of the two industries (plastic and furniture).

As far as the second research question concerner, the use of green logistics in handling is currently focused on the last stage of manufacturing process which is what is known as packaging, as stated by the factories themselves; it is also used within the manufacturing process. And as we mentioned in the summary, the main objective of this research is to explore the use of the green logistics or the sustainable handling in Saudi factories and the extent of the need to enhance, frame and regulate this use.
6. Discussion and conclusions

It is important to recall that the objective of this paper is to explore the usage of “green logistics” within KSA factories; particularly plastics and furniture sectors. As they were asked whether they use “green logistics” to move materials? and where?.

As can be seen from the statistical analysis, both sectors did not use “green logistics” to move materials for production. This conclusion approved the Null Hypothesis (H0) which stated that: There is no significant difference between the use of gravity to move parts between the manufacturing processes of the two industries (plastic and furniture). From the liturtal review and other papers, such this paper, the need to have governmental framework is important.

This would lead us to flag the need to alert the decision maker to issue regulations and legislation that encourage factories to use sustainability, among which, green logistics. Conversely, neglecting using sustainability/green logistics, would have serious negative impacts on the industry and likewise the country. neglecting may lead to burning more fuel, reducing profitability and increasing global warming.

As we know, most of the factories are (SME) which means it is very easy for them to adopt and re-set their production line to accommodate sustainability, as of which, green logistics.

It can be understood that some manufacturing processes can not accommodate “green logistics”, but which can not be understood that other industries which can accommodate green logistics are reluctant to do so.

7. Recommendations

In light of the above analysis and conclusions, the author can come up with the following recommendations:

1- The limited, if not poor, use of sustainability in the plastic and furniture industries, specifically for the process of handling materials with gravity, which is what we called green logistics.
2- Urging decision makers to issue legislations that encourages the use of sustainability, such as gravity during the manufacturing process, including green logistics.
3- publicizing the concept of sustainability by constantly talking about it across most of the platforms related to business and industry.
4- Encouraging academic field visits to factories with the aim of introducing and persuading the benefits of sustainability, including green logistics.
5- Linking the concepts of sustainability, including green logistics, to economical benefits in particular, as well as other technical benefits such as flexibility, safety, time and others.
6- participating toward reducing global warming by utilizing sustainability/green logistics as possible as we can.

8. future work

Despite the validity of the findings of this research on the extent of the spread and use of green logistics in Saudi plastic and furniture factories, given the small sample of the research, whether in terms of number or type of industry, it is suggested to have more future work such as

• good to apply the same investigation into other industries, such as packaging, canning, etc.
• other dimensions of sustainability, such as “open air” and “natural light” can also be investigated.
• explore why factories, who have said “yes”, have used green logistics, what is common among them and what they gain by doing so.
• explore why factories, who have said “no”, have not used green logistics, what is common among them and what they lose by doing so.
• add more question that many include some impacts of using/not using sustainability/green logistics.

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10. References

1. Meng, Y.; Yang, Y.; Chung, H.; Lee, P.; Shao, C.; Enhancing sustainability and energy efficiency in smart factories: A review. *Sustainability (Switzerland)*. 2018, 12, 1-28.
2. Furstenau, L.; Sott, M.; Kipper, L.; Machado, E.; Robles, J.; Dohan, M.; Cobo, M.; Link between Sustainability and Industry 4.0: Trends, Challenges and New Perspectives. *IEEE Access*. 2020, 10, 1–18.
3. Ejsmont, K.; Gladysz, B.; Kluczek, A.; Impact of industry 4.0 on sustainability-bibliometric literature review. *Sustainability (Switzerland)* 2020, 14, 1–29.
4. Nath, S.; Eweje, G.; Bathurst, R.; The Invisible Side of Managing Sustainability in Global Supply Chains: Evidence from Multitier Apparel Suppliers. *Journal of Business Logistics* 2019, 1–26.
5. Pirouz, B.; Arcuri, N.; Pirouz, B.; Palermo, S.; Turco, M.; Maiolo, M.; Development of an assessment method for evaluation of sustainable factories. *Sustainability (Switzerland)*. 2020, 12, 1–15.
6. Lars, N.; Towards a Target System to Incorporate Sustainability in Multi-project Management in Factories. 2020.
7. Lokhande, N.; Pagare, M.; DESIGN OF GRAVITY BASEDMATERIAL CONVEYOR EQUIPMENT. *Multidisciplinary Peer Reviewed*. 2018, 4, 1–4.
8. Bergenstock, D.; Beck, T.; Pneumatic Material Handling Systems for Cement Terminals. 2016, 12, 1-10.
9. BKharage, M.; Nelge, B.; Ketan, D.; *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*. International Journal of Engineering Sciences. 2015, 4, 1–6.
10. Prayoga, A.; Ismail, A.; PEMBUATAN CHUTE POLYBOX RING GEAR DENGAN METODE GRAVITY ROLLER CONVEYOR, PNEUMATIC, DAN PROGRAMMABLE LOGIC CONTROLLER (PLC) DI PT INTI GANDA PERDANA. 2019.