Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Journal of University Studies for Inclusive Research

Vol.9, Issue 18 (2023), 10470- 10489

USRIJ Pvt. Ltd.

University of Tabuk

Faculty of Engineering

Department of Industrial Engineering

MSc Engineering Management

Improving Factory Management to Increase Production and Reduce Time, Operating Costs and Electricity In a Carton Factory in Saudi Arabia

Name	ID
Fawaz Mofareh Alanezi	431000421
Mohammed Saleh Alatawi	431007286

Submit to :

Dr. Abdulaziz Aldalbahi

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Table of Contents

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Abstract

A carton factory in the Kingdom of Saudi Arabia used to produce 2,500,000 pieces of cardboard per year at a cost of 4.70 riyals while having a demand for 11,000,000 pieces annually. There were nine steps in the production process that were all manually carried out by workers. The factory was consequently compelled to buy carton parts from other factories. In order to solve this problem and save time, money, and effort, the company decided to construct a new automatic manufacturing line with nine steps. In nine months, the new production line produces 11,000,000 pieces, achieving its nine-month production target. As a result, it no longer has to buy products from other businesses and instead produces 3,666,666 pieces for export during the final three months of the year. The new production line, we conclude, increases output by 12,166,666 pieces annually while lowering labor expenses, expenditures related to procuring materials from other firms, and production costs. Before the new line, the price to produce a piece was 4.70; after the new line, the price to produce a piece is 4.38. The study recommended that other factories in Saudi Arabia can benefit from the results of this research, and start searching for ways to increase production at the lowest costs, and factories should rely on automatic machines instead of people to increase production at a lower cost and in less time.

Keywords: Improving Factory Management; Manufacturing; Operating Costs; Energy Efficiency; Value stream Mapping (VSM); Overall Equipment Effectiveness (OEE); Saudi Arabia

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Introduction

The global energy landscape has grown increasingly complex over the past few decades as a result of rising fossil fuel prices, the economic downturn, and new international environmental and energy regulations (Weinert et al., 2011). Companies, and the manufacturing sector in particular, which accounts for 51% of global energy consumption and 90% of industry energy consumption, are being forced to adapt (Holechek et al., 2022). In addition to the study already available of the aforementioned regulatory and economic concerns, Recent research has examined and demonstrated the importance of energy efficiency for manufacturing systems, as well as the strong and reciprocal relationship between it and productivity efficiency and the numerous non-energy benefits realized through implementing energy efficiency measures, such as the enhancement of corporate reputation and the reduction of environmental impact. Thus, in recent years, Energy Efficiency has developed into a crucial element for the competitiveness of industrial plants and is now unquestionably regarded as a fundamental driver of economic development and sustainability.

However, despite all, many businesses still find it challenging to comprehend its effectiveness, in large part due to the challenges encountered in emphasizing its technical and economic benefits, as Laitner emphasizes "Energy Efficiency has been an invisible resource. We do not observe energy efficiency in action, unlike a new power plant or oil well. Energy efficiency can be viewed as the economically advantageous use of

the energy we do not use to generate a specific number of goods and services within the economy. In actuality, the majority of businesses still find it difficult to achieve their goals for energy efficiency (Kostka et al., 2013). The vast variety, complexity, and adaptability of the fields, technologies, and methodologies involved in its improvement in production systems are primarily to blame for the slowdown in their resolution and the spread of Energy Efficiency measures and culture. As previously mentioned, many challenges remain in quantifying its benefits and evaluating the cost-effectiveness of related investments. In fact, a thorough understanding of a wide range of topics and disciplines (ranging from physics and thermodynamics to economy and project management) is required, in addition to a good ability and willingness to identify and prioritize appropriate improvement interventions and Energy Efficiency opportunities, design and customize the Energy Management System or the Monitoring and Control System in accordance with the needs of a specific company (Zhang et al., 2012).

Manufacturing processes face many challenges in today's market. Factories must remain competitive to keep the doors open; selling what is manufactured at a cost higher than the cost of producing it. Global competition says it should be lean and efficient. Production costs can include items such as raw materials, labor, plant, equipment, maintenance, utilities, warehouse and freight to name a few. Reducing the cost of any of these items can increase corporate profitability and increase shareholder value. Managerial performance is recognized when production costs are reduced and profits are increased. Running an efficient factory can improve a company's competitive position. Well-maintained and efficient equipment

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

improves reliability, reduces scrap rate and increases productivity. Increase revenue by increasing productivity. An often overlooked area is utility costs. Depending on the process, electricity, natural gas, and municipal water costs can be a significant portion of the manufacturing cost.

Problem Statement

As carton factories in Saudi Arabia with several old production machines face an increasingly competitive environment, they look for opportunities to reduce production costs without negatively affecting yield or product quality. Uncertain energy prices in the market today negatively affect expected earnings. This is a concern, especially for publicly traded companies in the carton industry. Successful and cost-effective investment in energy efficiency technologies and practices meets the challenge of maintaining high quality product output at low production costs. This is particularly important, because energy-saving technologies often include "plus" benefits, which increase plant productivity even further. Finally, energy efficiency is an important component of a plant's environmental strategy. End-of-pipe solutions are often expensive and inefficient while energy efficiency can often be the cheapest opportunity to reduce pollutant emissions. In short, investing in energy efficiency is a sound business strategy in today's manufacturing environment. Voluntary government programs aim to help industry improve competitiveness by increasing energy efficiency and reducing environmental impact.

This research is his idea about a cardboard factory in Saudi Arabia, which has several old machines for production. This research will develop the factory and solve the problems in it by installing a single line machine that

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

shortens time, increases production, and reduces operating and electricity costs. Finally, we discuss energy efficiency opportunities in carton factories. We focus on measures and technologies that have been successfully proven in individual factories in Saudi Arabia or abroad, but can still be implemented in other factories. Although new technologies are constantly being developed, we focus on proven practices that are currently commercially available.

A carton factory in the Kingdom of Saudi Arabia used to produce 2,500,000 pieces of cardboard per year at a cost of 4.70 riyals per piece, although its production need was 11,000,000 pieces per year, and the production process consisted of nine stages carried out by workers manually. So the factory had to buy pieces of cartons from other factories. To solve this problem, the factory decided to open a new automatic production line that includes nine stages to reduce time, cost, and effort.

Aim and Objectives

Following the study problem the main objective of the study is to explain the effect of improving factory management on increased production and reducing time, operating costs, and electricity in a carton factory in Saudi Arabia.

Following the main objective, the sub objectives of this study are:

1. To explain the effect of improving factory management on increased production.
2. To explain the effect of improving factory management on reducing time.

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

3. To explain the effect of improving factory management on operating costs, and electricity.

Literature Review

Reduce Energy Consumption Costs For Machine

One of the key causes of higher production costs at industrial facilities is the rising cost of energy, which motivates decision-makers to approach this issue in various ways (Shrouf et al., 2014). Shrouf et al., (2014) denoted that reducing the expenses associated with industrial systems' energy use is a key step in this trend. This work suggests a mathematical approach to reduce energy consumption costs for single-machine production scheduling during manufacturing operations, taking changeable energy prices into consideration over the course of a single day. This model enables the operations manager to apply the least expensive production scheduling throughout a production shift by making judgments at the machine level to decide the launch times for task processing, idle time, when the machine must be shut down, "turning on," and "turning off." The use of genetic algorithm technology has produced "near-optimal solutions. Additionally, an analytical solution has also been run to establish the best potential timetable for lowering energy expenses in order to see if the heuristic method offers the lowest cost. The analytical answer and heuristic solutions are then compared; the heuristic method is better for bigger issues. The findings show that avoiding times of high energy prices can result in significant reductions in energy costs. By reducing energy use during peak hours, this minimization procedure also benefits the environment by

increasing the likelihood that CO2 emissions from power plant sites would be reduced.

Cut Costs By Getting Rid of Wasteful Activities

Lean manufacturing tools are designed to cut costs by getting rid of wasteful activities (also known as Muda or non-value-added activities), which makes room for ongoing improvement. In a lean manufacturing setting, value stream mapping (VSM) is crucial, and this paper's focus is on the Indian electrical appliance industry (Chaudhary et al., 2020). Chaudhary et al., (2020) study attempt to show how lean tools can be applied to lower bottlenecks, satisfy customer demand, and boost output. To identify the areas that needed improvement, a mapping of the current status was done. A variety of lean instruments were used to gauge the production pace. According to the study, the wiring and connection workstation was the biggest bottleneck, which is why the client demand wasn't satisfied. Additionally, a wireless link was included as a production process intervention to shorten the bottleneck in the cycle time. Future state VSM allows for the visualization of the improvement. The productivity of the organization may be significantly increased by using lean tools in conjunction with a few minor interventions.

Improve Productivity

Regardless of their types—business, government, and society—productivity is the top priority of any modern organization. Every firm seeks to boost production, but only a small percentage of the total number of founded organizations have been successful. Because of this, Ojha, (2014) tries to

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

investigate what factors determine productivity, what issues arise in the organizations during the production process, who is accountable for such unproductive organizations, how can be assessed that organizations are unproductive, how concerned authorities from inside the organizations (managers) and outside the organizations (government authorities) tackle the situations, etc. This essay was created using data gathered from the experiences of some officials from various organizations. The information sample group consisted of employees, managers, and public servants. Several studies conducted elsewhere were reviewed. The conclusion implies that variables both internal and external are to blame for productivity decline.

A metric for calculating the equipment effectiveness of industrial systems is called overall equipment effectiveness (OEE). Tsarouhas, (2019) study uses an OEE assessment to find possible maintenance improvement areas within the croissant production line. The job is completed by examining the line's failure and repair data. The failure data span a 15-month timeframe. During this time, the croissant production line typically works in three 8-hour shifts throughout the day (24 hours per day), pausing only on weekends. On the basis of planned and unplanned interruptions, descriptive statistics of the failure and repair data for the line were performed. Additionally, the whole OEE for each working day for the croissant production line as well as the real availability (A), performance efficiency (PE), and quality rate (Q) measurements were displayed. Understanding the operation management of the croissant production line and precisely quantifying the OEE features are the major goals. The company may identify the main issues relating to A, PE, and Q via OEE analysis and take prompt action. The paper shows a

successful OEE evaluation that will serve as a beneficial guide to many parts of the production process and identify the line's important points in need of further improvement through efficient maintenance tactics (i.e. total productive maintenance). Additionally, the study offers a helpful viewpoint and aids managers and engineers in making wiser choices regarding how to raise manufacturing productivity and quality.

The purpose of (Alamoudi and Alamoudi, 2019) study was to examine the effects of introducing Lean methodology in a low-voltage cable plant in order to improve productivity and timeliness. This study made use of a number of distinct Lean methodology tools, such as scheduled maintenance, autonomous maintenance, focused improvement, and OEE & daily performance review. The present manufacturing procedure used in power cable factories must be understood. This study describes the useful outcomes and benefits of various tools to assist businesses in implementing lean thinking. Practical ramifications; results show that managers may quickly identify and get rid of production waste by using the technique. They will be able to maximize resource allocation by making the process more effective. For the manufacturing industry to successfully implement lean methods, the methodology must be validated. Lean approach adoption contributed to successful project execution by reducing changeover time. This suggests a quicker delivery of raw materials. For instance, applying this practice could result in a decrease in time by 50%, from 180 minutes to 90 minutes. This approach can be used by other sectors, such as the manufacturing sector, to speed up production and delivery. In order to apply lean approaches to other machines, pilot examples of how to use lean are also presented.

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Reducing Time in Production

By paying attention to the time that has become essential to handle the difficulties, businesses have come to understand the significance of global competition. With internal environment changes minimizing non-host time to the organization, the significance of time plays a part in success. As a result, it helps to lower product prices and provide quick customer service, increasing customer satisfaction. The purpose of Kareem et al., (2019) study is to determine whether increasing manufacturing time efficiency reduces product cost and allows for the presentation of the product within a given timeframe, thereby achieving the effectiveness of the cost. The key takeaway is that all procedures depend on having enough time to stand out. The customer's satisfaction will then be impacted. In order to outperform the competition, innovation, and development started to move at a faster pace with pearls. Identifying the instances when production adds little value will help the organization respond to clients more quickly while also cutting costs. The ten suggestions are, of course, the adoption of a manufacturing efficiency metric. They will then help to shorten the leadership of the production cycle. It lowers the price and quickens the client response time.

The redesign of machine tools and selective control can greatly boost energy efficiency without reducing productivity, it can be determined at the level of the unit process. On average, there is a lot of room for improvement, requiring only tried-and-true procedures and techniques, due to the machine tool builders' clear lack of attention for energy efficiency. Moreover, when allocating machine tools during process and production planning, it is strongly advised to make a suitable decision at a level of

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

capacity that is close to nominal. Case examples show how energy needs can be influenced. Additionally, energy consumption can be decreased by the optimization of process parameter settings and well-optimized control (Duflou et al., 2012).

Methodology

Table (1) Factory data before introducing the new machine

Production quantity	The cost of one carton	The factory needs piece / year	Number of pieces purchased from other factories
2,500,000	4.70	11,000,000	8,500,000

The factory used to produce 2,500,000 pieces of cardboard per year, the cost of one piece is 4.70 riyals, but the factory needs 11,000,000 pieces per year, so the factory buys the remaining quantity (8,500,000) from an external factory to reach the target which amounts to 11,000,000 pieces. To solve the problem, increase production, reduce the cost of running electricity, and shorten the time the factory opened a new production line

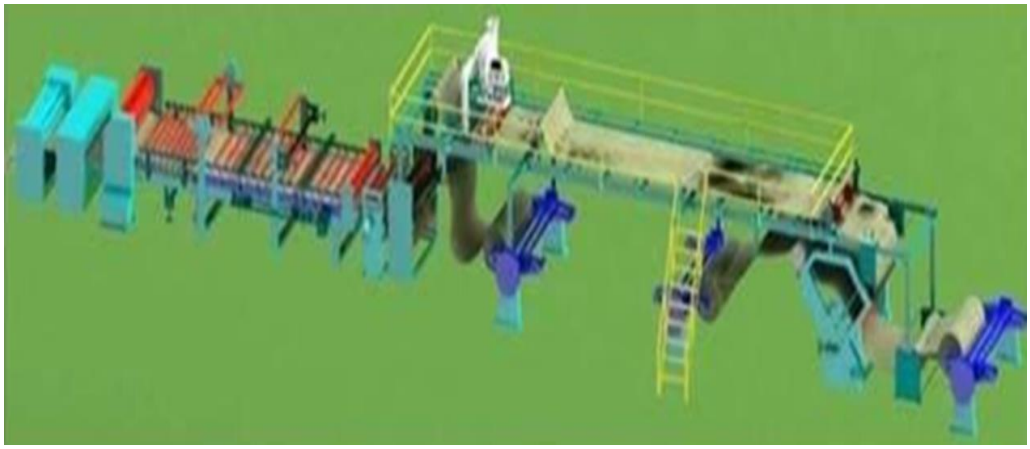
which includes all nine stages and covers all needs so that the factory does not need to buy from external factories, and the factory produces 11,000,000 in nine months, which mean the new line reach the target in just 9 months, so the factory benefit from the remaining three months by manufacturing and exporting.

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Table (2) Factory data after introducing the new machine

Production quantity	The cost of one carton	The factory needs piece / year	Number of pieces purchased from other factories	Overproduction
12,166,666	4.38	11,000,000	0	3,666,666

The new production line produces 11,000,000 pieces within nine months, which means that it reaches the target of production in nine months, so it does not need to buy pieces from other factories, but is satisfied with its production, and exploits the remaining three months in the year to produce 3,666,666 pieces and export them abroad. We conclude that the new production line increases production by 12,166,666 pieces per year, reducing time and the cost of purchase from other factories, and the cost of production, the cost of producing one piece before the new line was 4.70 which, while the cost of producing one piece after the new line is 4.38.



Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

plan parts

Shaftless Paper mill Roll Stand	3
Pre Heater “Roller”	1
Pre conditioner	
Single facer	1
Over Head Bridge Unit	1
Pre Heater “Duplex”	1
Pasting unit	1
Double backer	1
Thin blade slitter scorrer	1
N C cutter	1
Stacker	1
Electrical	1

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

Project Plan

Table (3) Project Timeline

2023						
Months	**Jan**	**Feb**	**Mar**	Apr	**May**	**June**
Introduction						
Literature Review						
Methodology						
Conclusion						
Tests						

It took three months to work on the introduction and about ten months on the literature review, and the methodology took one year, Finally, the conclusion took about one month.

Conclusion and Recommendations

With an environment that is more competitive than ever, Saudi Arabian carton firms that have a number of outdated production machines look for ways to cut production costs without sacrificing yield or product quality. Expected earnings are significantly impacted by the market's uncertain energy prices today. This is a problem, especially for publicly traded carton firms. The problem of sustaining high product output at low production costs is met by successful and cost-effective investment in energy efficiency

technology and techniques. This is especially crucial because energy-saving solutions sometimes come with "plus" features that raise plant output even higher. Finally, a plant's environmental strategy must include energy efficiency. Energy efficiency is frequently the least expensive way to minimize pollution emissions, in contrast to expensive and ineffective end-of-pipe alternatives. In the current manufacturing environment, investing in energy efficiency is a wise business decision. Government programs that are voluntary are designed to assist businesses become more competitive by enhancing energy efficiency and minimizing environmental impact.

Despite having a demand for 11,000,000 pieces annually, a carton plant in the Kingdom of Saudi Arabia used to manufacture 2,500,000 pieces of cardboard annually at a cost of 4.70 riyals per piece. The production process included nine phases that were all manually completed by employees. Therefore, the factory was forced to purchase carton parts from other factories. The firm decided to build a new automatic manufacturing line with nine phases to address this issue in order to save time, money, and effort.

The new manufacturing line produces 11,000,000 pieces in nine months, which means it fulfills its production goal in nine months. Because of this, it no longer needs to purchase items from other companies and instead uses the final three months of the year to make 3,666,666 pieces for export. We come to the conclusion that the new production line increases output by 12,166,666 pieces annually while decreasing labor costs, costs associated with purchasing goods from other factories, and production costs. The cost

Journal of University Studies for inclusive Research (USRIJ)
مجلة الدراسات الجامعية للبحوث الشاملة
ISSN: 2707-7675

of producing a piece before the new line was 4.70, while the cost of producing a piece after the new line is 4.38.

Based on the conclusions reached by the study, the study came out with the following recommendations:

- Other factories in Saudi Arabia can benefit from the results of this research, and start searching for ways to increase production at the lowest costs.
- Factories should rely on automatic machines instead of people to increase production at a lower cost and in less time.

References

Chaudhary, A., Singh, A. K., & Meena, M. L. (2020). Productivity improvement of an electrical appliance industry by implementing lean manufacturing tools and a low-cost intervention (a case study). *International Journal of Productivity and Quality Management*, *31*(3), 390-411.

Duflou, J. R., Sutherland, J. W., Dornfeld, D., Herrmann, C., Jeswiet, J., Kara, S., ... & Kellens, K. (2012). Towards energy and resource efficient manufacturing: A processes and systems approach. *CIRP annals*, *61*(2), 587-609.

Holechek, J. L., Geli, H. M., Sawalhah, M. N., & Valdez, R. (2022). A global assessment: can renewable energy replace fossil fuels by 2050?. *Sustainability*, *14*(8), 4792.

Kareem, A. D. A. A., Jihad, A. D. A. G., & Pachi, A. N. (2019). Suggested Framework for Reducing the Cost of Production by Using the Cycle of Manufacturing Efficiency. *Transylvanian Review*, *27*(44).

Kostka, G., Moslener, U., & Andreas, J. (2013). Barriers to increasing energy efficiency: evidence from small-and medium-sized enterprises in China. *Journal of Cleaner Production*, *57*, 59-68.

Ojha, S. K. (2014). Management of Productivity. *Management*, *1*(2).

Shrouf, F., Ordieres-Meré, J., García-Sánchez, A., & Ortega-Mier, M. (2014). Optimizing the production scheduling of a single machine to

minimize total energy consumption costs. *Journal of Cleaner Production*, *67*, 197-207.

Tsarouhas, P. (2019). Improving operation of the croissant production line through overall equipment effectiveness (OEE) A case study. *International journal of productivity and performance management*, *68*(1), 88-108.

Weinert, N., Chiotellis, S., & Seliger, G. (2011). Methodology for planning and operating energy-efficient production systems. *CIRP annals*, *60*(1), 41-44.

Zhang, L., Li, X., Gao, L., Zhang, G., & Wen, X. (2012, May). Dynamic scheduling model in FMS by considering energy consumption and schedule efficiency. In *Proceedings of the 2012 IEEE 16th International Conference on Computer Supported Cooperative Work in Design (CSCWD)* (pp. 719-724). IEEE.

Alamoudi, M., & Alamoudi, R. H. (2019). Implementing Lean Methodology in a Power Cable Factory: A Case Study of a Low Voltage Cable. *American Journal of Industrial and Business Management*, *9*(12), 2083-2097.