

Sustainability analysis of Industries using AHP and Fuzzy AHP methods: A review paper

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Abstract— Sustainability is a factor which is being considered as having utmost importance in the now a day's industries. Sustainability considerations consist of many factors. Sustainability of an industry can be improved with slight considerations of these factors. Thus the factors which affect the sustainability of the industries are considered and the prioritization of these factors is being done using the appropriate method. Thus three major factors namely Environmental effects, waste minimization and zero defects is being considered to study its affects on the sustainability of the industries. Thus these factors are than prioritized utilizing the AHP and Fuzzy AHP techniques. Thus a literature review is being done by studying research papers related to AHP, Fuzzy AHP, sustainability and EWZ.

Keywords— Sustainability, Environmental affect, Waste minimization, Zero defect, AHP, Fuzzy

I. INTRODUCTION

With the coming of the Industrial Revolution, humans were able to advance further into the 21st century. Technology developed rapidly, science became advanced and the manufacturing age came into view. With all of these came one more effect, industrial pollution. As the factories used to work for definite hours a day, the levels of pollution did not grow considerably. But after the subsequent growth of these factories, the industrial pollution has become a factor of high disturbance. Any type of pollution which can sketch its immediate source to industrial practices is known as industrial pollution. The majority of the pollution on the planet occurs due to the industries of some kind. Also, industrial pollution has taken on the momentous importance for agencies fighting against environmental degradation. Countries with an increase in the industries are finding it difficult to cope with this kind of pollution.

Industrial pollution can affect the environment in a number of ways:

It may increase the chances of degradation of human health as this pollutants might get into the water sources hence might degrade water quality.

It may interfere with **natural processes**. For example, industrial waste could change local climatic conditions or destroy wildlife habitats.

It may impact on **people's livelihoods**. For example, pollution of the sea will affect people who are involved in the fishing and tourism industries.

Thus environmental factors play an important role in today's industrial scenario. To make an industry sustainable to various changes in the industrial working, environment plays an important role. With the proper control of the effects of these environmental factors, the Sustainability of an industry can be further increased.

Waste minimization is the phenomenon which works to reduce the wastes produced in an organization. Hence reducing the losses in the organization in the form of wastes. Thus waste minimization is a positive approach to indirectly increase an organizations profit.

Waste management should be considered as a matter of utmost importance. The waste management requires a significant amount of time and resources; therefore, it is important to understand the benefits of waste minimization and how it can be implemented in all sectors of the economy, in an effective, safe and sustainable manner.

Zero defects are referred to as a viewpoint, a state of mind, or a movement that targets to reduce the number of defects in manufactured products and service as much as possible. It does not have different steps to follow or rules to stand by, which leaves companies open to customizing how they want it to work for themselves. Hence, a certain product is said to have achieved quality if and when it meets those requirements. However, this should not be confused with higher standards of products. For instance, it'll be unrealistic to say that a basic mobile phone is of low quality compared to the latest iPhone because they both have to meet different quality standards to pass the quality test. Based on this, Zero Defects means the basic mobile phone is a quality product if it meets the initial requirements set for it. That is, if it can make and take phone calls clearly, send and receive text messages, among other things, then it is only realistic to say it conforms to quality and has (close to) zero defects. Zero defect helps reduce the wastage and losses to the industries. With Maintaining zero defect in all possible industrial processes an improvement can be made in the entire industrial working scenario. Thus Zero defects can be considered as an important tool in making an industrial working more sustainable

II. LITERATURE REVIEW

A literature review is conducted mainly on the factors considering the environment, waste minimization, and Zero defects based on AHP

Thomas L Saaty et al. (1990) in this paper titled How to make a decision: The analytic hierarchy process the paper deals with the study of the process called AHP. AHP is a decision-making process wherein different factors which are to be considered while making a decision about any of the given situations are formulated in a hierarchical form. The hierarchy is being made based on the relative importance of those factors. The procedure is initialized by determining the factors affecting the given situation after that those factors are ranked according to their relative importance. Thus, as a result, the measurements of a set of the object on a standard scale can be converted to relative scale measurements through normalization.

Vikas Acharya et al. (2017) this paper titled Analysing the factors in industrial automation using analytic hierarchy process this paper stated the importance of automation in the industries in the present scenario. Also, the automation should be applied only to the most essential parts of the organizations so as to be more profitable for the organization. Thus to select where in to apply automation, AHP is being utilized. With the help of AHP, various possibilities of the automation process are being ranked with the help of literature reviews and also

taking expert advice. And hence a model can be prepared based on the results obtained by applying automation to possibilities with higher AHP rankings.

Shanshak Thanki et al. (2016) the paper titled An investigation on lean-green implementation practices in Indian SMEs using analytical hierarchy process (AHP) approach The paper focuses on the making the industries lean and green in order to get the overall development of an organization. According to this study, not only industrial production but also the environmental factors are to be considered in the development of the organization. Thus to study the environmental factors AHP is being used. With the help of AHP different criteria and sub-criteria are being ranked based on their relative importance in the organization. The relative importance of these criterions is determined by conducting researches and taking advice from the experts.

Sunil Luthra et al. (2016) in this paper titled Using AHP to evaluate barriers in adopting sustainable consumption and production initiatives in a supply chain the study deals with the different factors which affect the formulation of a means to adopt sustainable consumption and production in a supply chain. The barriers considered are then formulated in the AHP in order to rank them according to their relative importance. 15 factors are selected which would affect the sustainable consumption and production and after that, these are evaluated on analytic hierarchy process to determine the ranks of the factors depending on their intensity with which they affect the procedure. Hence a layout is being prepared for the managers for the possible barriers.

Chandrasah et al. (2015) in this paper titled Maintenance strategy and decision making – ahp method the main focus is to study the different methods of maintenance which can be applied to a particular case. Each and every maintenance process has its own advantages and disadvantages. Thus there are certain strategies which are more suitable to a situation than the other strategies. Thus the decision on which maintenance process to be applied is to be made. Thus AHP can be utilized in here to determine the various possibilities about the type of maintenance to be applied. Using AHP the methods which yield more advantages can be given more ranking and thus the strategies with more ranking can be referred to as the most suitable Maintenance strategy.

Damian Maletičl et al. (2014) this paper titled An Application of Analytic Hierarchy Process (AHP) and Sensitivity Analysis for Maintenance Policy Selection states that maintenance is an important process in any of the industry also different process involve different types of the maintenance process. Also, some processes are more suitable for some process than the other one. Hence to decide which process to be used AHP can be helpful. With the help of AHP, the hierarchy based on the factors favourable and the factors less favourable can be made. This hierarchy can then be utilized in deciding the method to be used.

Slawomir Klos et al. (2014) in this paper titled Using the ahp method to select an ERP system for an SME manufacturing company the main purpose of this paper is to formulate a procedure to develop an Enterprise resource planning system in an SME manufacturing industry. While considering AHP in the selection of the different factors in the development of the ERP system the factor which is considered of extreme importance is that which is related to the functionality of the ERP system. Further, the factors like total cost of ownership, technical support, implementation time, vendor experience are considered. Thus the ERP system can be developed using the AHP by ranking different factors.

Minchoel Kim et al. (2013) this paper titled Application of Delphi-AHP methods to select the priorities of WEEE for recycling in a waste management decision-making tool In these paper the study is based on reducing the wastes in an electrical products industry. Here in Delphi and ahp techniques are used to reduce the wastes accomplished in the organization. Different products are considered of which if reused would lead to a reduction

in wastes. These products are then ranked by ahp on the basis of the dates on which they reduce the wastes. Hence these products are reused as to reduce the waste minimization in the organization.

Veera P Darji et al. (2013) in this paper titled Application of AHP/EVAMIX Method for Decision Making in the Industrial Environment this paper states that the process of selection in any industry is not an easy task hence for the process of decision-making AHP technique is being used. The Evaluation of mixed data (EVAMIX) and AHP techniques are both combined in order to make decisions on the various situations that occur in an environmental condition. Here in this paper five examples are considered and hence decision is made on these conditions using the AHP method.

Edris Madadian et al. (2012) in this paper titled Application of Analytic Hierarchy Process and Multicriteria Decision Analysis on Waste Management: A Case Study in Iran the main purpose of this research paper is to study various methods of waste management and thus to analyze the best amongst them using the multi-criterion analysis. In this regards, AHP is being used for the analysis. Hence the study involves four waste management techniques namely Source Separation (SS), Biological and Mechanical Treatment (BMT), Refused Derived Fuel (RDF), Incineration and Landfilling. Thus these methods are studied and a comparison is being made in order to determine the best possible method.

Antonio C Caputo et al. (2012) this paper titled AHP-based methodology for selecting safety devices of industrial machinery this study states the importance of safety instruments in the machines being used in the industries. Here in the main goal is to employ safe working conditions of the machines by employing various safety devices. Thus the selection of these safety devices in the organization is done by AHP. With the help of AHP the various possible safety devices which can be employed are ranked and thus this ranking defines the rate of employment of the devices. The ranking of the devices is done by the relative importance of these devices in the safety factors. Hence a detailed layout can be prepared with the help of AHP.

Clare Chau et al. (2012) this paper titled A strategic service quality approach using analytic hierarchy process states that quality is an utmost requirement in all the modern day industries. Thus the most prior importance must be given to the quality factors which effect the most. Thus with the help of AHP, a hierarchy is being prepared as which of the factors affects the most. Thus the factors of the most important can be prioritized by this process.

Mohd Armi et al. (2010) in this paper titled Application of AHP Model for Evaluation of Solid Waste Treatment Technology the main focus of the study is to compare various means of solid waste treatment and also establish a result as which method would be more profitable to the organization. With the help of AHP, a hierarchy is being made and based on various factors which either favors or opposes the use of that particular procedure, Based on this hierarchy ranking to the processes is given and thus decision can be made about the method to be used for the treatment of the solid waste.

Ozden Bayazit et al. (2004) this paper titled Use of AHP in decision-making for flexible manufacturing systems deals with creating a means with which an organization can be facilitated through a manufacturing system which would yield in a proper sequence and flow of work with which the manufacturing system becomes more flexible. Thus with the help of AHP, the different manufacturing process can be prioritized on the basis of the factors which affect the manufacturing systems the most. Hence the manufacturing procedure can be more prioritized in a way which would lead to better manufacturing ability.

Fu Haw Ho et al. (2004) this paper titled Analytic Hierarchy Process-Based Analysis to Determine the Barriers to Implementing a Material Efficiency Strategy: Electrical and Electronics Companies in the Malaysian Context this study states that material efficiency is of very much importance and thus this must be considered in all organizations in order to increase the efficiency of the organization. Hence in reaching the optimum material utilization, there are certain barriers to doing so. Thus to overcome this barriers AHP technique is utilized to determine the barriers in the effective material utilization. The barriers are identified by performing surveys in the organization.

Julius Solnes et al. (2002) in this paper titled Environmental quality indexing of large industrial development alternatives using AHP This paper is the study of the two industrial development opportunities. One is to build a large aluminum smelter and the other one is the construction of a 6-million-ton oil refinery. These two processes will lead to certain environmental downfall. These factors are then considered in AHP and than the conclusion is made on the selection of either of the opportunities is being made.

H.M.M.M Jayawickrama et al. (2016) in this paper titled Fuzzy AHP based Plant Sustainability Evaluation Method in this paper the author has discussed the methods which are responsible for the sustainability of the plant and has applied fuzzy based analytical hierarchy process to the different factors which are important in making the plant sustainable.

Mustafa batuhan et al. (2013) in this paper titled A fuzzy ahp approach for supplier selection problem: a case study in a gear motor company a case study is being conducted in a gear motor company for the selection of supplier selection. The supplier selection in this industry is a matter which can lead to drastic change in its sustainability. Hence the different options are selected and then prioritized using the fuzzy ahp process.

Doraid Dalalah et al. (2010) in this paper titled Application of the Analytic Hierarchy Process (AHP) in Multi-Criteria Analysis of the Selection of Cranes a case study is being considered wherein the study is based on the selection of the variety of crane to be used in the corresponding plant. A number of cranes can be used which are having similar functions but a few can be termed as better suited for the job and hence the selection of the type of crane is done by using Fuzzy AHP process.

Slavica Do_zi_c et al (2017) in this paper titled Fuzzy AHP approach to passenger aircraft type selection the focus is a selection of the type of the passenger aircraft. There are a number of aircraft which can be used as a passenger aircraft. Some of them might be having some advantages and some others might have some other benefits. This benefits can be rated and thus the type of the passenger aircraft can be prioritized by further using the Fuzzy AHP process.

III. CONCLUSION

A detailed Literature review is being done with the study of twenty research papers. Thus with the study being done the following research gap is being found:

The appropriate literature survey has been conducted in the field of AHP based case study on the parameters of environmental effects, waste minimization, and zero defects. thus the description of the research gaps are as mentioned below:

1. With the literature review considered it can be interpreted that till now the many parameters are considered on the individual basis but here in this project we are using three parameters integrated to find out the sustainability.
2. Sustainability prediction using the Fuzzy AHP using the three factors being used has not been done.

3. Comparison between the normal AHP calculation and Fuzzy calculation has not been done.

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