

## Investigating the Green Manufacturing Approaches in Kani-Faravaran Mining Company

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**Abstract:** *Green marketing is a concept that is both developing in acceptance among many different types of organizations and becoming a way for those organs to demonstrate their environmental and sustainable commitment to the market and their customers. So, On the basis of the present study, we investigated the eco audit, annoy elements foot printing and eventually green manufacturing indexes in Kani-Faravaran Company. Accordingly, questionnaire was investigated among the total population of 75 persons and questionnaire reliability is examined by calculating total Variance and coefficient alpha. Progressively, Friedman test is implemented to analyze the results of distributed questionnaires and SPSS software was used for data analyzing. Results reveal that the eco audit, annoy elements foot printing and green manufacturing indexes facilitate the trend of green manufacturing and implementing sustainable development variables in manufacturing process in the Company. Moreover, customers increasing awareness of environmental approaches is considered as a prominent market demand strategy.*

**Keywords:** *Green marketing, Green supply chain management, Sustainable development.*

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### 1. GREEN MANUFACTURING

As concern of most societies regarding to the natural environment has increased during the last decades, organizations worldwide have been forced to become more environmentally conscious. Just as it is considered important for organizations to take responsibility for the environmental effects of their actions, sustainability has become a concept that is expected to be a moral obligation in the future. Therefore, green marketing strategy, also known as GMS, has appeared more in academia in recent years.

### 2. GREEN MARKETING STRATEGY

Market demand is a critical factor in today's business environment. Fierce competitions in the market force firms to have flexible strategies for their products and process (Chang and Chiu, 2007). Various studies have emphasized that customer benefit and price are key elements for market demand (Kammerer, 2009; Zhou et al., 2009).

A few researchers (Hoffmann, 2007; Zhu et al., 2008; Yung et al., 2011) have argued that customers increasing awareness of environmental Issues. According to Nair and Ndubisi (2011), green marketing strategy is referred to 'environmental marketing', 'ecological marketing', 'sustainable marketing', and 'enviropreneurial marketing'. Banerjee, Iyer and Kashyap (2003) define environmental strategy as the extent to which environmental issues are integrated with a firm's strategic plans. Fraj et al. (2011) use Hart's approach to define green marketing strategy. This approach poses GMS as a competitive strategy that will allow firms to optimize different dimensions of organizational performance, and these are viewed as expressions of competitive advantages. Kumar et al. (2012) describe green marketing strategy as the application of different marketing tools that satisfy organizational and individual goals, though at the same time upholding preservation, protection and conservation of the physical environment.

GMS is not an isolated strategy that will simply help organizations to address ecological issues, but instead it covers all those activities that are aimed towards meeting customer's expectations of both greener products and services, as well as creating a more sustainable and ethical company behavior (Fraj et al. 2011). Green marketing strategies can also be seen as a way of conducting business while

avoiding harm to people and the planet (Cronin et al., 2011). GMS is said to lead firms to improve their profitability, mostly due to the fact that process-oriented activities like eco-design, reverse logistics, and the use of cleaner materials in both products and packaging, seem to contribute to improve efficiency and at the same time, cut costs. The scope of GMS involves much more than simply selling and promoting more environmentally friendly products aimed towards green customer segments. The strategy also involves other areas such as: production, logistics, and administration departments within firms. The essence of GMS is to include proactive environmental actions that aim to respond to various environmental concerns in society. GMS is about the desire to “do the right thing”, and make the right choices, and therefore being able to show consumers that the organizations are aware of the environmental impact of their actions. (Fraj et al., 2011).

### **3. GREEN SUPPLY CHAIN MANAGEMENT**

Green Supply Chain Management (GSCM) can be described as Supply Chain Management with an environmental friendly or green component incorporated into every aspect of the supply chain. It covers a product’s whole life cycle from sourcing, design, product development, manufacturing, packaging, storage and transportation to disposal, recovery and post sales services including end-of-product life management. Therefore it can also be seen as “closing the loop” (Min and Kim, 2012; Ahi and Searcy, 2013). Ahi and Searcy (2013) analyzed several definitions of GSCM and Sustainable Supply Chain Management (SSCM) and compared them against each other. Their analysis shows that the two concepts are close to each other, but that definitions for SSCM were broader, while definitions of GSCM showed an emphasis on the environmental level of sustainability. Moreover, they claim that SSCM can be regarded as an extension of GSCM. The authors eventually define SSCM as: “The creation of coordinated supply chains through the voluntary integration of economic, environmental, and social considerations with key inter-organizational business systems designed to efficiently and effectively manage the material, information, and capital flows associated with the procurement, production, and distribution of products or services in order to meet stakeholder requirements and improve the profitability, competitiveness, and resilience of the organization over the short- and long-term” (Ahi and Searcy, 2013).

Opetuk and Dukic(2014) identify three main reasons why companies implement the environmental friendly GSCM strategy into their corporation:

- Legislation - they have to comply with the environmental regulations,
- Marketing - addressing the environmental concerns of their customers,
- Ecological awareness - mitigate the environmental impact of their production activities (Opetuk and Dukic, 2014).

Companies with a green supply chain (GSC) need to have very strict partner selection and performance evaluation processes (Wu and Barnes, 2016). When choosing the most appropriate partners for developing a GSC, a company has to consider contemporary environmental issues, as well as traditional economic factors in order to keep profitability high (Wu and Barnes, 2016). Wu and Barnes, 2015 describe four clusters that need to be considered when operating a green supply chain (GSC): cost, pollution control, quality and resource consumption. Keeping the costs at a minimum is an important goal for any supply chain, also a GSC. Pollution control is important in order to keep the negative environmental impact due to different kinds of waste to a minimum. High product quality and good customer service are essential also for GSCs. With the goal to minimize the negative environmental impact, the consumption of resources also needs to be minimized in a green supply chain (Wu and Barnes, 2016).

### **4. SUSTAINABLE DEVELOPMENT**

With the fast growing of global economy, the issues on resources and the environment, which become the key bottlenecks of sustainable economic development. How to challenge the conflicts between economic growth and high energy consumption as well as environmental deterioration is considered a deal around the world (Juan, 2011). Indeed, sustainable development is progressively being proposed as a desirable social and cultural aspect of manufacturing (Holden et al., 2014). It has been defined three dimension for SD: 1. safeguarding long-term ecological sustainability, 2. satisfying basic human needs, 3. promoting inter- and intra-generational equity. The sustainable development space is in adaptation with the literature that develops and investigate the sustainable indicators.

## **5. GREEN MANUFACTURING**

In the past few decades“ un-preceded growth in population, economy, and industrialization causes massive use of natural resources to meet customer demands resulting in pollution of environment and decrease in natural resources. Since the last decade corporate companies are getting interested in environment protection and customers are demanding environment friendly products (Walley and Bradley, 1994). Companies try to reduce their emission and resource utilization to prevent polluting environment through managing their activities in their supply chain (Hart, 1995; Corbett and Klassen, 2006). The consequences of production wastes on climate were described in a report by Intergovernmental Panel on Climate Change (IPCC) states that (IPCC, 2007a, p.5): "Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. Discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes, and wind patterns."

## **6. GREEN MANUFACTURING CONCEPT**

Green Manufacturing is commonly defined as “elimination of waste by re-defining existing production process or system” (Balan, 2008). This concept does not limits to address only the social and environmental impact of pollution-centric process but also process redundancy, ergonomics and cost implications due to inefficient methods of producing goods. Traditional production measures faster and cheaper are no longer success measures for manufacturing a product or evaluating an existing process line, but also other success factors such as materials used in manufacturing, generation of waste, effluents and their treatment method, life of the product and finally, treatment of theproduct after its useful life are important elements that are described by green manufacturing approach as success factors.

The Center for Green Manufacturing at Alabama University defines green manufacturing in their mission statement as: “To prevent pollution and save energy through the discovery and development of new knowledge that reduces and/or eliminates the use or generation of hazardous substances in the design, manufacture, and application of chemical products or processes”.

Balan (2008) states that all problem solving approaches and innovative techniques towards effective environmental solutions that result in cost savings from reduced work handling, effluent control, and process automation or other environmental and operational benefits can be named as applications of green manufacturing.

The issues that green manufacturing is mostly addressing on a process level according to the objectives of green manufacturing can be stated as follows (Pal, 2002),

- Provide a cleaner source of energy through new technology or approaches.
- Decrease energy consumption in processes by implementing new technology or approaches.
- Convert pollutants and wastes into byproducts and promote their use and recycling along with that of the product in order to reclaim the energy expended in the process and conserve resources.
- Maximize yield and minimize waste effluents via process improvements, such as by tailoring feedstock selection, selecting proper fuel mix, automation, and establishing control strategies via sensors with real-time feedback loops that control process parameters.

## **7. KEY ELEMENTS OF GREEN MANUFACTURING**

### **1) Eco Audit**

An Eco Audit can be defined as a management tool comprising a systematic, documented, periodic and objective evaluation of the performance of the organization, management system and processes designed to protect the environment with the aim of (1) facilitating management control of practices which may have impact on the environment, and (2) assessing compliance with company policies. (CEC, 1993). On a detailed level it can be explained as an integrated resource use analysis that identifies opportunities to reduce environmental impact, increase performance and save money.

According to Friend (2009), Eco Audit holds a broad area of resource use examinations which includes “climate control”, “lighting”, “motors and appliances”, “load management” and “Water” in

facilities and equipment usage area. Most significantly, when processes are taken into consideration additional usage of examinations can be specified as “equipment use”, “waste and recycling” and “material”. Friend (2009) asserts that equipment usage has to be rightly operated, and an organization’s waste is defined through its purchases and he expresses the importance of manipulating or controlling of waste and recycling activities along with Environmental Preferable Purchasing in an organization. These essential process elements can be handled and greened by Eco Audit systematic assessments.

## 2) Carbon

Carbon can be described as an indicator or tool to monitor greenhouse gases in manufacturing processes, carbon emission through transportation, energy efficiency and fossil fuels. “A carbon footprint is the measure of greenhouse gases (GHGs) produced by a given activity, product, business, or supply chain, expressed in tons of carbon dioxide equivalents (the standard unit for describing carbon dioxide emissions)”. Identifying and knowing corporations of carbon footprint leads to (Anastas and Zimmerman 2003);

- Identification and prioritization of efficiency improvements regarding carbon usage
- Evaluation of GHG reduction scenarios and strategies
- Availability of organization’s carbon position
- Developing strategies for green process design, environmental impact management and having better carbon footprint position through reduction.

## 3) Design for the Environment (DfE)

Design for environment can be described as an innovative approach which manufacturing organizations utilize to make traditional business decisions along with environmental impacts considering the cost and performance. It is developed by Environmental Protection Agency (EPA, 2011) as a voluntary program which works directly with the organizations in order to adapt environmental and health considerations in their business decisions into design and resining of products and processes.

DfE program enables organizations to design or redesign products, processes and management systems by making them cleaner, more cost-effective and safer for workers, public and environment. The main objective of DfE programs while working along with industries and organizations is to compare the human health and environmental risks, performance, and costs associated with existing and alternative technologies or processes (EPA, 2011).

EPA specifies the main elements of Design for the Environment program to achieve a successful green business design as following (EPA, 2011):

- Evaluation of the human health and environmental impacts of its processes and products
- Identification of what information is needed to make human health and environmental decisions
- Conducting an assessment of alternatives
- Considering cross-media impacts and the benefits of substituting chemicals
- Reduction of the use and release of toxic chemicals through the innovation of cleaner technologies that use safer chemicals
- Implementation of pollution prevention, energy efficiency, and other resource conservation measures
- Making products that can be reused, refurbished, remanufactured, or recycled
- Monitoring the environmental impacts and costs associated with each product or process
- Recognizing that although change can be rapid, in many cases a cycle of evaluation and continuous improvement is needed.

## 8. PRINCIPLES OF GREEN ENGINEERING

The development of modern day technology leads to the new designs of sustainable waste treatment processes. The Principles of Green Engineering will help coordinate the development of green

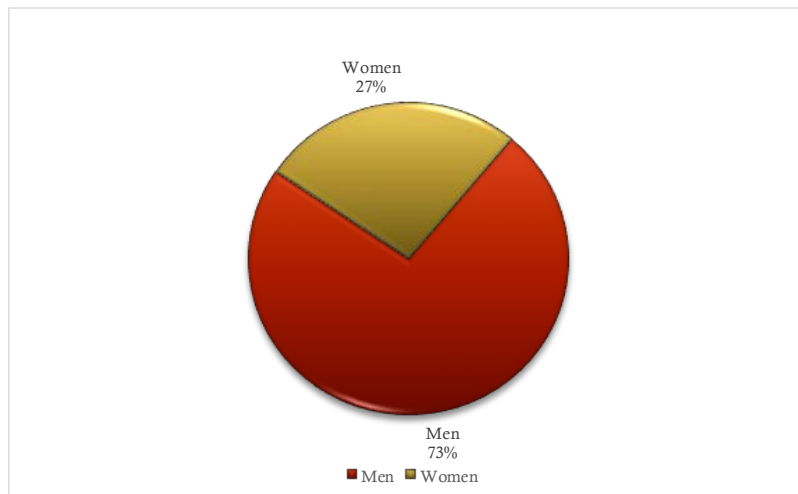
designing process that is sophisticatedly combine from the small decompose process of molecules, materials, product to the overall complex systems (Anastas and Zimmerman; 2003).

The green engineering methods are not just a set of rules; instead they are like set of methods which can be adopted to succeed in implementation of sustainable design process. Optimization of an unsustainable production line is important to eliminate the problem that has caused to the logistics, economic and institutional system. To overcome the problems old process should be changed to new green one, by reconstructing the whole logistics system. The green principles should be implemented from top to bottom in order to get impressive effect. The principles can be stated as follows (Anastas and Zimmerman; 2003).

**9. METHODOLOGY**

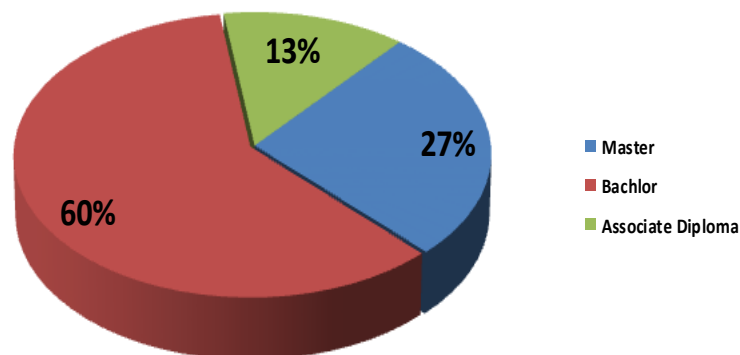
Kani Faravaran Mining Engineering Company is selected as a case study; because the use of sustainable oriented green initiatives and strategic green performance measurement in this sector seems so important. In this study, data gathering is via a structured likert scale questionnaire. Questionnaire valid indexes are all gathered and approved through library researches and Delphi consensus technique. The population in this study comprised in mining industry, the sample is 75 expert of Kani Faravaran Company. Having said that, the sample is a subset of the main population, which has the features of the population.

From the total number of 75 responders of questions, 20 persons (27 percent) were female and 55 (73 percent) were male as depicted in Chart (1).



**Chart1. Gender**

In the population, 20 persons (27 percent) are postgraduate, and 45 persons (60 percent) have undergraduate education. Furthermore, 10 persons (13 percent) are in the associate Diploma and at the highest level, undergraduate have a sample population make up to 60, as depicted in Chart (2).



**Chart2. Education**

**10. DESCRIPTIVE ANALYSIS**

**Table1.** Summary of sociological information society

		Quantity	Cumulative Percent
Gender	Women	20	27
	Men	55	73
<b>Total</b>		<b>75</b>	<b>100</b>
Education	Master	20	27
	Bachelor	45	87
	Associate Diploma	10	13
<b>Total</b>		<b>75</b>	<b>100</b>

**11. HYPOTHESES**

1. Eco Audit facilitates the trend of green manufacturing in Kani-Faravaran Company.
2. Annoy elements Foot printing facilitates the trend of green manufacturing in Kani-Faravaran Company.
3. Design for the Environment facilitates the trend of green manufacturing in Kani-Faravaran Company.
4. Green manufacturing increases the company’s efficiency.

**12. ANALYSIS**

- Eco Audit facilitates the trend of green manufacturing in Kani-Faravaran Company. ( $H_1$ )
- Eco Audit does not facilitate the trend of green manufacturing in Kani-Faravaran Company. ( $H_0$ )

**Table2.** Output first and second hypothesis based on Friedman test

Friedman Test		Test Statistics	
Mean Rank	Question	N	75
2.53	Q <sub>1</sub>	Chi-Square	82.254
1.77	Q <sub>2</sub>	df	3
3.40	Q <sub>3</sub>	Asymp. Sig.	0
2.29	Q <sub>4</sub>		

Based on the analysis Table (2) can be obtained stating that because the test statistic is much larger table hypothesis is accepted, ie  $H_0$  is rejected and  $H_1$  accepted to be placed; in other words, eco audit facilitates the trend of green manufacturing in Kani-Faravaran Company.

**13. SECOND HYPOTHESIS**

- Annoy elements Foot printing facilitates the trend of green manufacturing in Kani-Faravaran Company. ( $H_1$ )
- Annoy elements Foot printing does not facilitate the trend of green manufacturing in Kani-Faravaran Company. ( $H_0$ )

**Table3.** Output first and second hypothesis based on Friedman test

Friedman Test		Test Statistics	
Question	Mean Rank	N	75
Q <sub>5</sub>	2.24	Chi-Square	28.934
Q <sub>6</sub>	2.13	df	2
Q <sub>7</sub>	1.63	Asymp. Sig.	0

Based on the analysis Table (3) can be obtained stating that because the test statistic is much larger table hypothesis is accepted, ie  $H_0$  is rejected and  $H_1$  accepted to be placed, in other words, annoy elements foot printing facilitates the trend of green manufacturing in Kani-Faravaran Company.

**14. THIRD HYPOTHESIS**

- Design for the Environment facilitates the trend of green manufacturing in Kani-Faravaran Company.
- Design for the Environment does not facilitate the trend of green manufacturing in Kani-Faravaran Company.

**Table4.** Output first and second hypothesis based on Friedman test

Friedman Test		Test Statistics	
Question	Mean Rank	N	75
Q <sub>8</sub>	1.51	Chi-Square	43.328
Q <sub>9</sub>	2.07	df	2
Q <sub>10</sub>	2.41	Asymp. Sig.	0

Based on the analysis Table (4) can be obtained stating that because the test statistic is much larger table hypothesis is accepted, ie H<sub>0</sub> is rejected and H<sub>1</sub> accepted to be placed, in other words, design for the environment facilitates the trend of green manufacturing in Kani-Faravaran Company.

**15. FOURTH HYPOTHESIS**

- Green manufacturing increases the company’s efficiency. (H<sub>1</sub>)
- Green manufacturing does not increase the company’s efficiency. (H<sub>0</sub>)

**Table5.** Output third and fourth hypotheses based on Friedman test

Friedman Test		Test Statistics	
Question	Mean Rank	N	75
Q <sub>11</sub>	1.67	Chi-Square	16.892
Q <sub>12</sub>	1.33	df	1
		Asymp. Sig.	0

Based on the analysis Table (5) can be obtained stating that because the test statistic is much larger table hypothesis is accepted, ie H<sub>0</sub> is rejected and H<sub>1</sub> accepted to be placed, in other words, green manufacturing increases the company’s efficiency.

**16. QUESTIONNAIRE RELIABILITY**

Cronbach's coefficient alpha for the variance must first questionnaire scores of each domain questions and will calculate the total Variance. Then, using the following formula we calculate the coefficient alpha.

$$r_{\alpha} = \frac{J}{J - 1} \left( 1 - \frac{\sum_{j=1}^n s_j^2}{S^2} \right)$$

Where:

J= Number of questionnaires or tests, S<sub>j</sub><sup>2</sup> = J I have the following variance test and S<sub>2</sub> =Total variance or test questionnaire.

Therefore, in order to measure reliability, Cronbach's alpha method and software using SPSS furrows. Using data obtained from questionnaires and statistical software to help SPSS confidence coefficient calculated using Cronbach's alpha is equal to the number obtained in 0.9516 is reliability.

**17. CONCLUSION**

On the basis of the investigation process, approaches and analysis, it is to declare that eco audit, annoy elements foot printing and eventually green manufacturing indexes facilitate the trend of green manufacturing in Kani-Faravaran Company. Implementing sustainable development variables in manufacturing process. Besides, customers increasing awareness of environmental approaches is considered as a prominent market demand strategy. Preserving green procedure is also another policy that reinforces the performance of company in acquiring green manufacturing standards.

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