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An Empirical Analysis of the Factors That Support the Drivers of Sustainable Manufacturing

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Abstract

Manufacturing businesses have been contributing to energy consumption, pollution and resources consumption. Alongside governmental legislations, there are many drivers of Sustainable Manufacturing such as social and market pressures which are growing as awareness about environmental issues increases. These drivers have been extensively researched as evidenced in the literature. However, this study goes beyond the drivers themselves to unveil the factors that underlay each driver. For example, customer demand is a driver that depends on factors such as the importance of environmentally-friendly products to win orders and the bargaining power of customers. Thorough understanding of these factors will provide the knowledge economy with the information required to advance manufacturing and the environment. In this study we analyzed ten factors that underlay the drivers: Market pressure, Competitiveness and Supply Chain pressure. Using data collected from 36 manufacturing companies, factors were ranked based on their importance. The results show the ranking of ten factors. Further analysis of the factors revealed some interesting characteristics of Sustainable Manufacturing.

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Keywords: Sustainable Manufacturing; Drivers; Environmental Sustainability; Lean; Six Sigma

1. Introduction

Efforts to reduce the impact on the environment have been increasing in the last decades as awareness of environmental issues extended beyond the scientific community and into the public domain. Politicians now regard environmental sustainability as a priority and use governments' power to impose it. The manufacturing industry is particularly responsible as the most energy consuming industry and because of its waste and emissions [1-2]. A lot of research has been conducted to explore the requirements for manufacturers to become sustainable. Kashmanian et al. [3] identified these requirements and classified them into stages that a company progresses through to transform to an environmentally sustainable company. During this transformation, some drivers play an important role in enabling manufacturers to integrate environmentally friendly practices in their management system, while at the same time, other factors hinder the transformation process and act as barriers to change. This study reviews the literature to identify the significant drivers for the environmental side of sustainable manufacturing and then uses data collected from 36 manufacturing companies based in the UK to analyze the factors that make up some of these drivers.

2. Literature Review

Research on the drivers of Sustainable Manufacturing (SM) has been very active in the last two decades. The most influential driver prior and during the 1990s was governmental regulations [4]. However, as companies started to look beyond legal requirements for various reasons, such as pressure by non-governmental bodies, cost savings and customer demand, the strategy of these companies shifted

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from being merely in compliance to beyond compliance; beyond fence line; and beyond footprint [3]. As a result, research in this area has grown rapidly to cover in greater details the influence of various drivers that facilitate the pursuit of better environmental performance.

A study by Mittal and Sangwan [5] into the drivers of SM supports the view that the importance of drivers is changing. They developed a fuzzy TOPSIS method to rank 13 drivers and concluded that four drivers are the most important for adopting SM, these are; 'Competitiveness' between companies; 'Incentives' given by governments; 'Organisational resources' and 'Technology'. Table 1 shows the drivers in their ranking order and some examples. However, ranking the drivers depends on the type of industry, region and the maturity of the market. For example, Zhu et al. [6] found that the most important drivers for the Chinese Automotive Industry were regulatory requirements and market pressure. Therefore, this study takes a different approach to the evaluation of SM drivers, by considering the factors that underlay these drivers.

The success of SM depends on the above mentioned drivers, and these drivers in turn depend on factors that determine the strength of each driver. For example, the driver 'Supply chain pressure' depends on factors such as the 'Bargaining power of suppliers', the 'Level of supply chain integration' and others. The review of the literature on SM did not produce a single study analyzing these factors. The authors acknowledge that the data available from the survey is limited and allows only for the study of few factors that support some drivers. The following is a review of the drivers we aim to study and their underlying factors.

2.1. Supply Chain Pressure

In the area of Green Supply Chain Management (GSCM), the drivers to change are similar to those found in single manufacturing companies. Walker et al. [7] found that studies of GSCs tend to focus on drivers rather than barriers due to the desire to focus on positive aspects of GSC research. They also found that large organisations, in the private and public sectors, are likely to hold the power to influence the suppliers to respond to the environmental agenda. This makes the size of a company a very important underlying factor for the driver 'Supply chain pressure' and, indeed, an important underlying factor of other drivers.

Another important factor is the 'level of supply chain integration'. Growing evidence suggest that the higher the level of supply chain integration with suppliers and customers the greater the potential benefits [8].

In addition to the above mentioned factors, the 'bargaining power of suppliers' is very important in increasing, or decreasing, the pressure of the supply chain to adopt SM.

2.2. Market Pressure

Zhu et al. [6] used the term Market Pressure in their research to cover market related drivers such as 'Customer demand', 'Peer pressure' and 'Public image'. The market associated with environmentally-friendly products has been researched for more than a quarter of a century. Welford and Gouldson [9] reported that in the year 1990 the size of the market for "environmental improvements" was estimated at $200 billion worldwide and expected to grow rapidly. In 2011, in the UK alone, the green goods and services sector was worth £122 billion [10].

The findings of the Global Corporate Social Responsibility (CSR) study [11] illustrate that there is a rapid shift in global markets towards environmental products and activities. The study covered more than 10,000 citizens from 10 of the largest countries by gross domestic product (GDP). An important finding of the study is that customer awareness of social and environmental issues is a significant cause of this change. An important accelerator of this awareness is social media where bad or good news about a company could change its reputation and consequently its market share.

On a global level, the CSR study found that more people tend to shop for products and services that provide social and environmental benefits. In addition, consumers use their purchasing power to protest against irresponsible products. Nine out of ten global participants would boycott a company if they learned of its irresponsible practices. In fact, more than half (55%) have done so in the past 12 months according to the same report. The factors available for us to study the driver of 'Market pressure' are: 'Market competition' and 'Market concentration'. The two factors differ in nature as in some markets the competition is fierce even if the number of competing companies is small. Markets of new technologies are an example of this type of markets. Whereas in other markets, a large number of companies may work in a low competition environment.

The 'Bargaining power of customers' and the 'Importance of environmentally-friendly products to win orders' are also factors that affect the driver 'Market pressure'. Customers such as large companies and government units in countries that tackle climate change, strongly demand for products and services of low ecological impact [1].

2.3. Competitiveness

Making most out of resources is an important approach to win competition. Manufacturing companies learned a key lesson from the Japanese car maker Toyota as the company practiced its Toyota Production System, also known as Lean Manufacturing, to achieve better process performances, higher product quality and higher efficiency, which are the underlying factors that support the driver 'Competitiveness'. Moreover, Lean Manufacturing provides a strong base for SM as it reduces the consumption of resources and wastes [12].

Six Sigma is another important management system that has been adopted very successfully in the manufacturing industry. Similar to Lean Manufacturing, Six Sigma improves quality, delivery time and flexibility to promote competitiveness. Lean and Six Sigma, therefore, are considered in this study as factors supporting the driver 'Competitiveness'.