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Consumer Behavior Towards Sustainable Product Manufacturing

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ABSTRACT

In recent years, manufacturing and design process has get great attention in manufacturing industries. Nowadays, sustainability is a significantly important requirement for human activity, making sustainable products and to develop manufacturing process environment friendly. This review paper present various investigations made by researchers in different stages and highlight their importance of integrating sustainability with manufacturing and design, and sustainable product development. In addition, the paper briefly reported how we can develop and produce more sustainable products and also highlight an environmental impact which is affected by population and economic growth.

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INTRODUCTION

Manufacturing is a huge process of industrialized society. From product, to processes developing product life cycles, to enterprises – across more than 23 sectors – manufacturing process occurs (Garner, S. and C. Earl, 2004). In addition, sustainability has been applied to various activities such as engineering, manufacturing and design. Manufactures are becoming increasingly concerned about social, economic and environment impact. So there are some factors that help to achieve sustainability of the products which are less environmental impacts and reach high quality products level. The review paper describes sustainable manufacturing, some of the environmental impacts and sustainable products developments.

Sustainable Manufacturing is the pathway to reestablishing manufacturing as the main activity in the future cleans economy, built on the principles of sustainability. Understanding and applying sustainable manufacturing is important to have knowledge of sustainability and indicators for it (Huang, C.C., A. Kuasiak, 1998). First of all, we have to realize what sustainability is. Sustainability can be used in various meaning and defined in many ways such as "sustain" latest meaning was "support", "keep into being" (Yuan, C.F., W. Wang, 2013). According to the World Commission on Environment and Development (WCED) states that "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" Sustainability can be included three contexts: environmental, economic and social condition. Economic, social and environmental problems are rapidly developing. Economic growth affected by globalization. Furthermore, beside globalization some challenges are dramatically arising such as climate change, ageing population, public health, poverty and social exclusion, loss of bio-diversity, increasing waste volume, soil loss and transport congestion (Gershenson, J.H., 2004).

2. Sustainable Manufacturing:

Sustainable manufacturing process requires less environmental impacts and to reach high quality products level. For instance, manufacturing organizations need to consider profitability, productivity and environmental stewardship. Marc and Hossam (Ulman, G.D., 2003) stated that important factors of sustainable manufacturing are improving environmental stewardship and sustainability, profitability and productivity as well as sustainability is increasingly viewed as strategic goals of manufacturing companies. Also, Jovane and Yoshikawa proposed based on the reference which is "The World Commission on Environment and Development declaration" that ''sustainable

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development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with the future as well as present needs''.

2.1 Manufacturing, competitiveness and sustainability:

Manufacturing can be studied in three levels. There are macro level, micro and field levels.

-Macro level consider macro economics,

-Field level consider for products, manufacturing processes, giving services and business strategy. As mentioned above, Manufacturing is a fundamental knowledge or opportunity of Sustainable Development, which is related to economy, society, environment and technology (Tseng, H.E., 2008).

Competitiveness might be dealt with customer satisfaction. Competitiveness is as based on the productivity of companies' productions.

Competitiveness *at meso level* may be as an ability and performance of a supply paradigm to respond to a demand paradigm.

Competitiveness *at field level* may be defined as a comparative concept the ability and performance of an actor (firms, universities, institutes and research centers, etc.) to respond to a "customer demand" better than anyone else.

Sustainability is a huge concept and it is concerning three factors, economy, society, environment (Maxwell, D., 2003).

Sustainability *at macro level* would dependent on environment, requiring economy, as the enabling tool to aim at the social dimension.

Sustainability *at meso level* is concerning products and services, processes and business models that meet the economical, social and environmental conditions. Sustainable manufacturing must respond to

Sustainability *at field level* products must be safe and less environmental effect throughout their life cycle,

-as appropriate, designed to be durable, repairable, readily recycled, compostable, or easily biodegradable;

-produced and packaged using minimal amounts of most environmentally friendly materials and energy (Houe, R., B. Grabot, 2009).

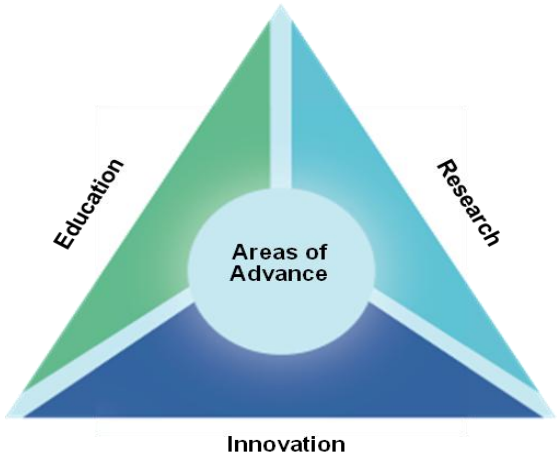

Fig. 1: Knowledge triangle (Ness, B., 2007).

Knowledge triangle (K-T) refers influence of three categories each other, which is research, knowledge and innovation. So competitiveness and sustainability should be achieved by developing and implementing new High Value (HV), knowledge (K)-based products and services, processes, companies and business model 4] (Fig 1).

2.2 Manufacturing and Environment:

Sustainable development is a broad concept, which is included three domains: economy, society, environment, and their interactions, as shown in (Figure 3).

Indicators of Sustainability help to address the challenges and problems of economical, social and environmental conditions. Sustainable manufacturing must respond to:

-economical challenges, by producing wealth and new services ensuring development and competitiveness through time;

-environmental challenges, by promoting minimal use of natural resources (in particular non-renewable) and managing them in the best possible way while reducing environmental impact;

-social challenges, by promoting social development and improved quality of life through renewed quality of wealth and job (Chichilnisky, Graciela, 1996).

Fig. 2: Fundamentals of sustainable development (Evans, S., 2002).

Relations between social, environmental and economic parts of sustainability, and some of the factors that comprise them such as (social) health, poverty, education, (environment) natural resources, (economic) productivities, efficiency, competitiveness. (Figure 2)

Nowadays, the manufacturing organizations are increasingly developing due to globalization. Also manufacturing organization need to concern serious environmental impacts because of a world with limited resources. Lennart Y. and Ljungberg's (2006) investigation highlight major causes of environmental impacts. They said unsustainable life style leads to serious environmental problems. Un-sustainability is caused by the rapid technical developments and global situation. There are today at least four basic problems, which are still unsolved (Barber, J., 2007):

- Over-consumption.
- Resource utilization.
- Pollution.
- Over-population.

Over- consumption:

According to the Robert U Ayres (Baldwin, J.S., 2005) stated that in the developing countries during the last centuries, the population grows steadily. As a result in increase the consumption of natural recourses. In addition, products can be produced one single or many different components and mixed materials. All those combination require and consume generally higher energy around the world.

Resource utilization:

A lot of energy and material is for example lost during production and transportation, which includes waste material and emissions, especially for non recycled products.

Pollution:

Even if all companies reach zero emissions right now, the earth would still be seriously affected by the emissions so far

Over-population:

The world could have more than ten billions inhabitants by 2025. It is clear as to how this situation will lead to less sustainability with more and more environmental impact. For instance, environmental impacts are not possible reduce to zero, even though; many products have become environmental friendly over the world.

Reducing environmental problems have investigated and many methods used by researchers. In addition, environmental marking systems have been developed recent years. Customers can identify the product whether the products are environmentally friendly or not. For example, there are some examples, it can help to identify for it: EU *sign* (a flower with 12 stars), the Energy Star (Emidast) Environmental Protection Agency in the USA, the TCO *sign* (Tjanstemannens Centralorganisation) in Sweden, Svanen (Standardiseringskommisionen i Sverige), *Umweltzeichen* (in Germany) or Environmental choice (in Australia) (Baldwin, J.S., 2005). These kinds of markings are voluntary for the companies and can be used when a product fulfils certain requirements from the specific organization. For instance, general customers are not easy understanding the demand of environmentally friendly.

3. Sustainable Product Development:

Sustainable product is that should be low environmental impacts, economical friendly and less consumptions of energy to produce goods and services. Although, sustainability of the products has been achieved by using various methods. According to the H. Kaebernick, S. Kara, and M. Sun reported that product development in manufacturing companies are still predominantly using traditional cost/profit models. Traditional model desires that achieving high quality of a product at low cost and high profit. The traditional method does not include any environmental aspects in the development process. However, the integration of environmental requirements is mainly considered every stage of product development as well as improves the stage of

a product's life cycle from design through manufacture (Baumann, H., 2002).

Three examples of methodologies that have recently been developed (Maguire, M., 2001). The manufacturing strategy for environmentally friendly products involves a design process which accounts for environmental impacts over the life of the product. Most of the significant stages of a product's life cycle, which have an influence on its environmental performance (Marshall, C. and G.B. Rossman, 1999).

They are:

- Introducing environmental awareness to customer requirements (CR);
- Assessing environmental performance as a design objective;
- Performing life cycle assessment (LCA) during the design process; and evaluating the product's potential for reuse and recycling (Asheim, Geir B., 1994).

Conclusion:

The paradigm of sustainability is growing as the benefits of new stage of product's life. Sustainability must be considered for environmental impacts and relationship between economic, social and environmental context. Also, the environmental requirements must be related to the traditional requirements of cost and quality as a relative. The availability of these methodologies and tools has improved the product productivity, quality and safety. Although some of the methodologies mentioned are still not widely used, with newer studies and researches in this area, there will be more commercialized versions of the technology in the near future. Furthermore, sustainability helps to address the challenges and problems of economical, social and environmental conditions. The paper briefly reported and included with importance of sustainability, manufacturing sustainability, and some other causes of environmental impacts.

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