The role of manufacturing in affecting the social dimension of sustainability

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ABSTRACT

Manufacturing affects all three dimensions of sustainability: economy, environment, and society. This paper addresses the last of these dimensions. It explores social impacts identified by national level social indicators, frameworks, and principles. The effects of manufacturing on social performance are framed for different stakeholder groups with associated social needs. Methodology development as well as various challenges for social life cycle assessment (S-LCA) are further examined. Efforts to integrate social and another dimension of sustainability are considered, with attention to globalization challenges, including offshoring and reshoring. The paper concludes with a summary of key takeaways and promising directions for future work.

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1. Introduction

Historically, decision-makers within the manufacturing enterprise have focused on technological and economic issues. Product engineers, for example, often use finite element, computational fluid dynamics, and heat transfer models (software technology) as part of the design process to develop new technologies. Manufacturing engineers focus on the technological challenges of machine tools, automation systems, robots, etc. to realize a given product for a specific cycle time and cost. Managers within a manufacturing facility are often tasked with economic-related issues, e.g., budgeting, financing, and ensuring adequate cash flow. What is all too often overlooked, however, is that people are vital to the manufacturing enterprise. As a manufacturing firm seeks to transform natural resources, monetary capital, and knowledge into products that serve a societal need, humans play a critical role in every aspect of the enterprise. With this in mind, this paper explores how manufacturing impacts humans or groups of humans (social groups). It does not consider how society drives changes within the manufacturing enterprise (via the influence of demographics, educational level, gender roles, etc.). Rather, it is

exclusively focused on the effect of manufacturing on society. In addition, this paper does not seek to make subjective or value judgments.

As evidence of its societal value, in 2014 industry was responsible for 31.1% of the $113.7 trillion global GDP [51], and much of this economic activity is attributed to manufacturing. As a result, manufacturers produced cars, refrigerators, mobile phones, televisions, clothing, food products, furniture, etc., all intended to meet the needs of and enhance the quality of life for society. In addition to meeting society's needs, manufacturing also provided employment for 22.3% of the 3.39 billion people within the global labor force [51]. Clearly, manufacturing plays a significant role in society around the globe.

The primary reason manufacturing exists is to provide the goods, services, and systems needed by society. To do so, manufacturing employs a large segment of society – and the money secured through this employment helps to support families and individuals. These are just a few of the positive social benefits of manufacturing. To further motivate this examination of the effect of manufacturing on society, let us briefly review some situations where manufacturing has negatively impacted social groups.

- From 2007 to 2015 there were numerous reports [30,138,197] of worker suicides at the Hon Hai Precision Industry (Foxconn)

plants in Zhengzhou, Chengdu, and other Chinese cities. It was suggested that these suicides were attributable to mental health challenges and stress exacerbated by the working environment. Rather than address the cause, Foxconn asked workers to sign an anti-suicide pledge and installed steel cages around dormitory balconies and netting below the factory windows to stop the workers from plummeting to their deaths [86,89].

- In 1984, a Union Carbide pesticide plant in Bhopal, India released nearly 30 metric tons of methyl isocyanate. Hundreds of thousands of people were exposed to the resulting toxic gas cloud, and thousands of people were killed. This disaster had a tremendously negative effect on the community surrounding the manufacturing facility. What might not be expected, however, is this event led to a significant negative impact on competing chemical companies and supply chain partners [31,65,174,222, 238,247].

- Nike has continually found itself criticized for its social responsibility performance. During the 1990s, there was a global boycott of Nike owing to accusations related to the labor practices (sweatshops) of its subcontractors. The boycott, driven by the actions of consumers and NGOs, deleteriously affected Nike's bottom line [43,79,151,216]. In response to the boycott and the associated stockholder uproar, Nike sought to transform its business practices and began monitoring the social responsibility of its supply chain partners [168].

In each of the above examples, manufacturing had an effect on individuals and stakeholder groups (Foxconn: workers, Union Carbide: local community, chemical industry, supply chain, Nike: supply chain, stockholders). Such examples begin to explain why firms are increasingly interested in social issues. This is evidenced through the increased attention to such issues as CSR (corporate social responsibility), triple bottom line, brand reputation, EPR (extended producer responsibility), outsourcing/reshoring, transparency, and the social dimension of sustainability.

Often a basic discussion of sustainability will begin with some form of the Brundtland definition [39]: meeting the needs of the present without jeopardizing the ability of future generations to meet their needs. Sustainability discussions also cover the need to embrace three dimensions: environment (or ecological), economic, and society. Fig. 1 offers a framework on how these dimensions interact with one another. Often, these three dimensions are referred to as the triple bottom line or 'people, planet, and prosperity.' Much has been written about the economic and environment dimensions, but far less has been contributed regarding the social dimension of sustainability. This paper seeks to summarize the work that has been done with respect to the effects of manufacturing on the social dimension of sustainability, with the goal to expand the knowledge of the manufacturing research community in terms of understanding the social dimension of sustainability, and in particular the role of manufacturing in affecting social groups.

In terms of effects on social groups, we may define social impact as 'changes in physiological states and subjective feelings, motives

and emotions, cognitions and beliefs, values and behavior,' that occur in an individual or social group as a result of the presence or actions of an entity [161]. Current research on social impacts focuses on changes within human interactions, organizations, relationships, and culture as a result of public or private actions. These changes can be physical, environmental, emotional, or intellectual, and further, can affect the way people live, work, play, connect to one another, unite to meet their needs, and generally survive as members of society [211,260]. From a manufacturing perspective, social impacts may be thought of as the direct or indirect effects felt by stakeholders due to a manufacturing enterprise.

The interconnectedness of our world is clearly visible in the modern supply chains of manufacturing companies, and the influence that manufacturing has across the supply chain (Fig. 2). Over the last several decades, companies have seized the opportunity to source materials and products internationally in order to reduce their bottom line cost. Such an outsourcing/ offshoring practice has often had detrimental effects on the local economies from which production was removed, and resulted in concomitant social disruptions. As might be expected, offshoring has generally had positive effects on the economies to which manufacturing has been newly located, and social consequences have also resulted. While globalization is motivated by economic issues, including the use of local resources for some products, manufacturers increasingly recognize that they must understand how local groups of people impact and are impacted by decisions. As people are often the most significant asset a company can cultivate, attention to the needs and characteristics of local groups is becoming a higher priority for companies.

Recently, the United Nations (UN) issued sustainable development goals [257], several of which include social impacts. As might be expected, the UN goals are focused on the measurement of social performance at a national level. While such national measures are important, they often provide little insight to a manufacturing enterprise that is endeavoring to improve its social performance. And, perhaps, this begins to get at the heart of the matter with respect to social performance. It is increasingly the case that there are tools that a manufacturer may use to reduce their environmental impact. Life cycle analysis (LCA), for example, asks a user to inventory their inflows and outflows for a given product across the life cycle to calculate the corresponding environmental impact. Methods such as 'design for the environment' and 'green supply chain design' may be utilized to reduce the environmental footprint of a product. So, what are the corresponding methods available to manufacturers from a social impact perspective?

The foregoing discussion motivates several questions. For example, what social effects are relevant to a manufacturing firm? What stakeholders are relevant to a manufacturing enterprise? How do we measure social impacts? What types of actions (or inactions) within an enterprise result in corresponding societal impacts? Are there tools that we can employ to quantify the total social impact across the life cycle? How do we simultaneously consider the three dimensions of sustainability: environmental, economic, and societal? This paper seeks to
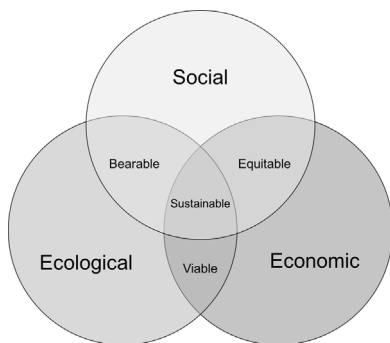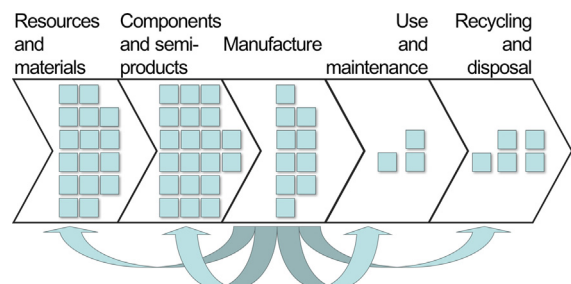

Fig. 1. The sustainable development framework including intersections (bearable, equitable, and viable) of the three pillars (ecological, economic, and social).

Fig. 2. The company designing and producing products exerts influence on large parts of the value chain [107].