A novel approach to assessing manufacturer progress toward sustainability

This item was submitted to Loughborough University's Institutional Repository by the/an author.


Additional Information:

- This is an Open Access Article. It is published by Elsevier under the Creative Commons Attribution 4.0 International Licence (CC BY). Full details of this licence are available at: https://creativecommons.org/licenses/by-nc-nd/4.0/. This paper was presented at the 6th CIRP Global Web Conference “Envisaging the future manufacturing, design, technologies and systems in innovation era”, Shantou University on the 23-25th October 2018.

Metadata Record: https://dspace.lboro.ac.uk/2134/34964

Version: Published

Publisher: © The Authors. Published by Elsevier

Rights: This work is made available according to the conditions of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) licence. Full details of this licence are available at: https://creativecommons.org/licenses/by-nc-nd/4.0/

Please cite the published version.
6th CIRP Global Web Conference  
“Envisaging the future manufacturing, design, technologies and systems in innovation era”

A novel approach to assessing manufacturer progress toward sustainability

Hana Trollman\textsuperscript{a}\textsuperscript{*}  
\textsuperscript{*}Loughborough University, Loughborough, Leicestershire, LE11 3TU, United Kingdom

\textsuperscript{a} Corresponding author. Tel.: +44-150-922-5414. E-mail address: H.Trollman2@lboro.ac.uk

Abstract

A new means of considering the progress of a manufacturer towards sustainability is presented as a tool for strategic decision makers such as top level management. All three of the sustainability dimensions are considered simultaneously. Initially, the current state in each of the three sustainability dimensions is determined and fitted into the proposed hierarchy. In the next step, stakeholders are considered to identify the sustainability dimension that represents the most impact for progress up the hierarchy. Global Reporting Initiative (GRI) sustainability report data is used to rank a sample of manufacturers on the proposed hierarchy. Results are compared to those given by the GRI materiality matrices of the selected manufacturers.

© 2018 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (https://creativecommons.org/licenses/by-nc-nd/4.0/)

Selection and peer-review under responsibility of the scientific committee of the 6th CIRP Global Web Conference “Envisaging the future manufacturing, design, technologies and systems in innovation era”.

Keywords: sustainability; strategy; systems approach; organisational level; manufacturer

1. Introduction

The challenge of assessing progress towards sustainability is in capturing a diverse set of issues that affect a wide variety of stakeholders. Models that evaluate sustainability performance should be balanced, capture interrelations and sufficiently consider the subjectivity of qualitative criteria inherent to sustainability indicators [1].

A problem with current corporate sustainability reporting tools is the lack of standardization with respect to both methodology and criteria [2]. The most widely used performance measurement system is the Balanced Scorecard [3], but it is constructed as a tool for monitoring and controlling rather than improvement.

The Global Reporting Initiative (GRI) guidelines are the most well-known and universally applicable corporate sustainability indicators, but findings [4] suggest that sustainability reports highlight the positive and obscure negative outcomes due to their elastic and uncertain application. GRI reporting was evaluated [5] based on the main criteria for corporate sustainability and found insufficient to answer the question of how sustainable a company is, or how quickly it is approaching sustainability. A recent assessment model for manufacturing organizations [6] provides no clear definition of sustainability and the focus is on improving indicators. Existing sustainable value-added methods either rely on benchmarks that are not clearly defined and do not consider stakeholders [7] or stakeholders are considered only to minimize resources [8]. Metrics in the social dimension are usually limited compared to other dimensions [9]. The research gap that this paper addresses is how a manufacturer can take meaningful steps toward sustainability that incorporate stakeholders through materiality considerations.
Sustainable value is created when the satisfaction of different needs is based on evaluation criteria that are social, environmental and economic together with the improvement of productivity of the necessary resources [9]. Maslow [10] postulated his Hierarchy of Needs which has been linked to organizational performance and social responsibility [11]. The evaluation of needs from a multidimensional perspective has been presented [12] so that personal and organizational needs are coordinated with the objective of facilitating sustainability. This research extends the consideration to the three dimensions of sustainability, complementing the resource-based view (RBV) of the firm [13] and dynamic capabilities from a manufacturing perspective.

2. Hierarchies of Sustainability Dimensions

All domains of sustainability may be considered social as social sustainability encompasses all human activities [14]. Manufacturing is a human endeavor, and as such should balance environmental, economic and social objectives.

A fundamental paradox of business is that it may cause the destruction of its own natural and/or social capital. Existing economic and social indicators do not take this into account.

The proposed needs-based hierarchies are inherently positive and in corporate self-interests. They are not a measure of absolute sustainability, but rather a form of relative sustainability, an example of which is eco-efficiency which can be both strong and weak. Initially an improvement is required in at least one dimension while performance in the others is held constant. The separation into three dimensions permits assessment on each individually to prevent deteriorating performance in one dimension to be offset by better performance in any other dimension. This avoids the problem of trying to integrate all relevant environmental and social impacts into one common unit.

Existing GRI materiality matrices will be used to provide an initial application and comparison with practice. This will aid manufacturers in understanding how their needs fit with the ongoing business process of achieving sustainable performance. The proposed hierarchies which manufacturers should follow to achieve sustainability through mutually supporting advances in hierarchy are shown in Figure 1.

2.1. Manufacturer Financial Needs

In market economies, economic sustainability is usually defined as the ability to persist durably on the market under competition constraints. The following hierarchy of financial measures is proposed:

Although there has been a transition away from tangible assets (Property, Plant and Equipment (PPE)) to intangible assets [15], PPE remains fundamental to manufacturing. Capital investment facilitates the acquisition of tangible assets. These can be separated into manufacturing assets such as machines, tools, material and control systems [16], and product assets. Overall tangibility has been found to be positively related to debt level [17].

Working capital is a necessary prerequisite for enabling a manufacturer to finance the day to day manufacture of products, governing tangible capital assets such as manufacturing assets and product assets. Research has concluded that working capital management is essential for corporate profitability [18].

Intangible assets can be defined as immaterial resources (not financial assets/financial capital or physical resources such as tangible assets) that, as a factor of production, play a fundamental role in the value creation process of a manufacturer and enable them to compete successfully [19]. Intangible assets provide new sources of growth and opportunities for servitization as manufacturing enterprises are being challenged to transition from product-centered solutions to product-service systems (PSS) [20].

Capital investment refers to funds invested for the purpose of advancing business objectives which may include acquiring capital assets and/or equity stakes. The investment decision at its most fundamental level determines whether a company will grow in size, be relatively stable, or possibly shrink [21].

Companies exist to maximize or continually increase their value for owners/shareholders [22]. This requires balancing capital funding between investments that increase long term profitability and sustainability together with paying dividends to shareholders. Although some investors are satisfied with principal protection, most are looking for return. There are three different types of return measures: return on investment (ROI), return on equity and return on assets. Since ROI does not inherently account for the duration of the investment, in may be used in conjunction with Rate of Return and Net Present Value (to account for inflation) to make ROI calculations more precise.
2.2. Manufacturer Environmental Needs

Environmental management is positively positioned in only a minority of firms [23]. Yet separating economic growth from environmental issues may present opportunities for innovation and consequently competitiveness [24]. Although missions and values are generally well integrated with environmental sustainability, primary processes are not well aligned with such priorities [25]. The choice for manufacturers can be to either modify existing products, processes and technologies to be more sustainable, or to acquire new sustainable ones. Trends in environmental sustainability suggest the following hierarchy for manufacturers:

The demand for material is expected to double over the next 40 years, leading to unacceptable impacts unless the total requirement for material production and processing is reduced [26]. Minimizing the material input into production reduces the effect on the environment with respect to extraction of raw materials through mining or harvesting and the associated environmental impacts as well as conserving scarce resources such as rare earth metals for use in future production of products requiring these. Production and transport processes are also affected as the handling of less material will require less energy and resources, thus creating another cost saving to the manufacturer. Hence material efficiency is the fundamental consideration for manufacturers.

Process efficiency is the next consideration after material efficiency as it involves more complexity in implementation at its basic conceptual level. Faced with constantly rising prices, reducing energy consumption remains a key focus for manufacturers as it is relatively simple to define and measure.

Having reduced the demand for raw materials and resources such as energy and water, the next logical consideration for a manufacturer would be the elimination of unnecessary waste. In part this is due to the relative position of the current perceived cost of waste compared to that of materials and resources.

Eco-design is a means of holistically integrating material efficiency, process efficiency and waste reduction. Eco-design, also known as DfE (Design for Environment), Environmental Design or Sustainable Design, includes the principles of dematerialization, product-life extension, closing the product life cycle, enhancement in energy efficiency, improvements in product distribution, and reduction of environmental impacts. A commitment to sustainability usually requires an LCA at considerable cost of time and resources [27].

“A particular practice is neither sustainable nor unsustainable in isolation of wider economic and ecological systems.”[28] Manufacturers conducting their businesses within planetary boundaries are hence the ultimate current sustainability achievement, still requiring considerable research to become feasible [29].

2.3. Manufacturer Social Needs

The social interactions of a manufacturer take place via the manufacturer’s workforce. Current postindustrial society has led to changes in social structure: industrial society was labor-intensive whereas technology has led to a decrease in the number of manual manufacturing jobs. Knowledge has come to replace productive labor as the source of value for future profits [30]. The following hierarchy is proposed for this post-industrial paradigm:

Having a stable workforce is critical to a manufacturer's production capability. The history of Japanese metalworking machinery firms serves as an example of how the relative stability of the workforce contributed to their success [31].

An appropriately skilled workforce will prevent business from failing due to dissatisfied customers and suppliers, environmental and health and safety violations and various forms of mismanagement as well as maintaining competitive advantage in being able to implement new technologies. There is currently a push to upskill traditional line workers driven by the need to embrace digital manufacturing [32].

A workforce may be both stable and appropriately skilled, but without motivation a manufacturer may find issues with productivity and retention. The level of motivation an individual exerts in their work tasks can affect all aspects of organizational performance. Motivation may also be generational [33].

A collaborative workforce is one that is capable of working in such a way that not only high levels of internal efficiency are met, but also stakeholders such as customers, suppliers and the community are satisfied beyond normal expectations. This demands empowerment with a degree of cultural intelligence and identification with a collective identity not generally imparted by education or motivation alone. Research indicates that High-Involvement Work Practices (HIWP) can foster employee engagement which in turn leads to discretionary behaviors that enhance performance [34].

The current information society is not considered sustainable as the required context to convert information into knowledge is missing [35]. A knowledge society can be sustainable if the focus is on supporting active citizenship through empowerment and engagement. Successful manufacturers will be the ones that engage in continuous knowledge creation which provides value through learning and innovation to re-shape their business. An adaptable workforce will not only be able to create the science and technology that can provide the materiality of change, but also the understanding and evaluation of its social worth for implementation.

3. Stakeholder Considerations

From a sustainable manufacturing perspective, all related stakeholders should be considered instead of just customers and shareholders. It is also logical to give weight to the realistically achievable needs and wants of stakeholders. This generally implies that stakeholders cannot have expectations that are unachievable from the manufacturer's current position on any individual hierarchy.

For example, material efficiency is achievable using manufacturing strategies such as making longer-lasting products, dematerialization, remanufacturing and component re-use. Process efficiency through increased energy efficiency does not solve the material efficiency problem and instead
metrics that have benefits spanning all three dimensions of important part of waste management and resource efficiency. For example, recycling, remanufacturing and reuse are an important part of waste management and resource efficiency which should be considered prior to waste reduction. Trying to satisfy a stakeholder demanding fewer defective products at the material efficiency stage is reasonable, but a stakeholder wanting to decrease emissions from transports is unlikely to be sustainably satisfied – financial resources may have to be diverted to outsourcing the problem to LCA experts. None of the German companies investigated [36] minimize the material variety of their products to increase recyclability. Even though eco-design including product labelling for waste characterization is key to effective recycling, remanufacturing and reuse, drivers such as hazardous substance bans were often more effective than extended producer responsibility in promoting ‘eco-design’ [37]. This may indicate that governmental stakeholders aiming too high for eco-design actually support material efficiency. Similarly, a stakeholder demanding better customer service is unlikely to be satisfied if the manufacturer does not have a stable or motivated workforce.

4. Manufacturer Materiality Assessment

Management of an organization is tasked with determining material topics for the GRI materiality assessment. A materiality matrix may be used to visualize the significance of economic, environmental and social impacts and their substantive influence on the assessments and decisions of stakeholders.

The materiality assessment procedure is not dependent on metrics – it is based on a holistic approach so that a topic may be material if it is important to stakeholders irrespective of the level of impact on the economy, environment or society. This removes the issue that existing metrics may be insufficient and enables a holistic viewpoint for satisfying needs jointly. For example, recycling, remanufacturing and reuse are an important part of waste management and resource efficiency that have benefits spanning all three dimensions of sustainability: greenhouse gas reduction, energy and material savings, less damage to health and job creation [38]. The materiality matrix is used to determine the dimension with the most impact - the stakeholder with greatest impact is considered but also issues related to the position of the manufacturer on the hierarchies with respect to their competition, global trends and whether stakeholder demands are realistic. The manufacturer then undertakes a plan of action to progress from their current position to the next level in the corresponding hierarchy. The next iteration corresponds to the next (GRI) reporting period for which a new materiality assessment would be undertaken. If the material issue identified initially is unchanged, the matter is investigated. If a new material aspect of most impact is identified, a new action plan is developed to move up the relevant hierarchy.

Three manufacturers are considered from the GRI database. Of these, only the Epta Group CSR Report on materiality did not consider outside stakeholders but rather internal experts. Manufacturers are ranked in the proposed hierarchies based on the lowest aspect identified in their materiality. The top priorities identified from the materiality matrices in the GRI reports of the manufacturers (Epta Sustainability that Reflects Our Identity CSR Report 2017, Hasbro Playing with Purpose 2016 CSR Report, Eurosuole Integrated Report 2016) are shown next to the hierarchy rankings in Table 1.

5. Discussion

The three GRI reports vary considerably in detail provided and interpretations of materiality differ considerably. Manufacturers invent their own categories to try to reflect their perceived needs: Epta Group considers 'Market Place', 'Workplace' and 'Community' in addition to 'Environment'. According to the proposed hierarchies, some material aspects of 'Market Place' would be financial, others social. 'Investing in employee training' is classified in the hierarchies under 'intangible capital assets' and 'investment in technological manufacturing advances' would be classified under 'intangible assets' whereas these are both identified as 'Workplace relevant aspects' in the GRI report.

The Hasbro Inc analysis only added 'Good Business Practice Issues' to social, environmental and economic aspects. Eurosuole added 'Consciousness of Product', 'Active Society' and 'Human Rights of Employees' to environmental

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Environmental</th>
<th>Social</th>
<th>Economic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materiality</strong></td>
<td><strong>Hierarchy</strong></td>
<td><strong>Materiality</strong></td>
<td><strong>Hierarchy</strong></td>
</tr>
<tr>
<td><strong>Matrix</strong></td>
<td><strong>Matrix</strong></td>
<td><strong>Matrix</strong></td>
<td><strong>Matrix</strong></td>
</tr>
<tr>
<td><strong>Epta Group</strong></td>
<td>Material efficiency</td>
<td>Waste reduction</td>
<td>Stable workforce</td>
</tr>
<tr>
<td>(MNE, Consumer Durables, Italy)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hasbro Inc</strong></td>
<td>Material efficiency</td>
<td>Material efficiency</td>
<td>Stable workforce</td>
</tr>
<tr>
<td>(MNE, Toys, USA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Eurosuole</strong></td>
<td>Process efficiency</td>
<td>Eco-design</td>
<td>Stable workforce</td>
</tr>
<tr>
<td>(SME, Textiles and Apparel, Italy)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Manufacturer materiality assessment
and economic considerations. Two of the 'Consciousness of Product' aspects are environmental, and one, 'product quality, safety and innovation' would be classified as social in the proposed hierarchies.

There is the most agreement with the hierarchies in the economic dimension. The only discrepancy may be due to the interpretation of the meaning of 'financial strength' in Eurosoule's material aspects. Financial strength is measured by profitability, liquidity and solvency. If liquidity is the aspect, the ranking in the financial hierarchy would be 'working capital'. If profitability is the aspect, this would rank in the hierarchy as 'return on investment'.

In the social dimension, all three manufacturers rank at the bottom of the hierarchy whereas Hasbro Inc and Eurosoule envision considerably different workforce characteristics: Eurosoule presents itself as innovation focused whereas Hasbro is more customer-oriented. Various groups or teams making up a manufacturer's workforce may rank at different levels in the hierarchy. The respective R&D and sales teams could hence be farther up the hierarchy than shop floor employees, but for long term sustainability, the entire workforce should be considered.

In the environmental category, Eurosoule has the most ambitious view of their ranking (Eco-design). As indicated in [4], this may be for public relations or marketing purposes. Epta Group places the most emphasis on legislation compliance. As environmental legislation is usually aimed at limiting emissions, their ranking is 'waste reduction'. However, the identified 'Reducing environmental impacts of our operations' and 'Making written commitments to use of renewable energy and materials' aspects imply the 'material efficiency' ranking in the proposed hierarchy.

The stakeholders of greatest importance to Epta Group are their employees. Investing in their employees and achieving the goal of a stable workforce would have the greatest impact for them in the social dimension.

The stakeholders of greatest importance to Hasbro Inc are their customers who represent a broad range of society (children, parents, retailers). Consumer and retailer satisfaction will be facilitated in the environmental dimension by focusing on material efficiency. This is a recurring theme in their materiality aspects: 'natural resources use and conservation', 'plastics', 'chemical management', 'product quality' and 'safety and materials innovation'.

For Eurosoule, achieving the goal of circular economy when footwear recycling is in its infancy [39] would appear less realistic than 'financial strength'. The financial dimension would be of greatest impact: 'return on investment' to satisfy shareholders or, more importantly, 'working capital' to enable day-to-day operations.

6. Conclusion

This research represents current perspectives on sustainability. Sustainability is a discursive paradigm (driven by cultural evolution) so the understanding of what it means for a manufacturer to be sustainable will require revision of the proposed hierarchies in the future.

Even though our understanding of sustainability currently encompasses concepts that are difficult to quantify on an individual manufacturer level (e.g. planetary boundaries, knowledge society), many manufacturers are still struggling to achieve legislation compliance and a stable workforce. This does not mean that goals higher up the hierarchies should be disregarded, but rather there should be awareness that without an appropriate foundation, making true progress towards sustainability is less likely.

For proactive application of the hierarchies, manufacturers should rank themselves critically and work towards moving up the hierarchies, balanced against stakeholder demands with the most impact. When assessing manufacturers, it is important to consider the context in which information is presented to determine what is realistic.

A detailed examination of strategy formulation, strategic connection to stakeholders, indicators for the hierarchies and analysis of risks will be the subject of future work.

References


