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Sustainability performance indicators at shop floor level in large manufacturing companies

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Abstract

This article investigates sustainability in the performance measurement systems of Swedish manufacturing companies. It builds on a previous study that documents relatively few direct environmental indicators at shop floor level, which raises questions about possible indirect links between existing indicators and the environment that could be used to improve the environmental aspect of company´s sustainability ambitions. A method for identifying and categorizing indirect links to sustainability issues was defined and used. The results suggest that at shop floor level 90% of the indicators have at least an indirect relation to one or more of the sustainability dimensions economy, environment and social, of which 26% are at least indirectly related to the environmental dimension. Despite the many indirect connections, participating companies perceive a need to improve sustainability indicators and some ideas are suggested.

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Keywords: Performance Measurement System; Sustainability; Sustainability Performance Indicator; Environmental management

1. Introduction

The field of Performance Management has evolved from revolving around financially-focused and static performance measures to strategic systems with a balanced approach in regards to measuring and managing performance [1]. Following the unparalleled spread of the Balanced Scorecard [2], manufacturing organizations today measure and manage performance from multiple aspects, such as customer, internal processes, learning and development, cost and revenue, quality, delivery, sustainability, safety and reliability.

The adoption of Performance Measurement Systems (PMSs) in the Swedish manufacturing industry seems to be almost 100%, at least among medium and large companies [3]. The Swedish industrial application and the wide spread of PMS is tightly connected to the adoptions of Toyota inspired lean manufacturing strategies and production system models [4], with focus on time efficiency and reducing lead time [5]. This includes using performance indicators (PIs) to align the operation to the company's strategic objectives and managing the daily operation to meet customer demands and other requirements.

In response to the growing sustainability concerns, manufacturing companies have to formulate measures to evaluate sustainable manufacturing performance, aiming at integration of sustainability aspects [6]. Many scholars have explored the mutual goals and tools of lean production on the one hand and sustainability on the other in order to gain a

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better understanding of the compatibility and impact of lean and green initiatives [7], [8]. Integration of sustainability management and operations management is seen as a way forward but is possibly hindered by a lack of sustainability metrics [9]. Although literature on sustainability is extensive and growing, and the companies' interest and focus on sustainability is generally increasing, the major body of knowledge concerns sustainability indicators and reporting at corporate level [10], [11], while few studies have empirically studied how sustainability is integrated at shop floor level in manufacturing operations.

The purpose of this article is to investigate sustainability aspects of the PMS at shop floor level in manufacturing companies. In the earlier study presented by Landström et al [3], a methodology for PMS present state analysis in large companies was introduced and thus provided a foundation for improving PMSs. With respect to sustainability, few indicators were documented as related to the environment, which in part is explained by the fact that the "documentation scope" was limited to indicators related to "production operation and the production support functions: quality, maintenance and internal logistics", found at work center or work unit level, see figure 1. For overall reporting purposes, and at site level, Landström et al. [3] found more indicators related to the environment. This raises the following research questions which will be explored in this article:

1. Which indicators at shop floor level in manufacturing have direct or indirect connections to the environment and sustainability?
2. Do the indicators identified make it possible for the companies to track and improve their goals related to sustainability? If not, which additional indicators are needed at shop floor level?

Since the research questions are related and their respective answers interdependent, they will be explored and discussed together. As society is not yet sustainable, it is assumed that there is a need for more, alternative, sustainability indicators [12] at shop floor level as well as on other levels.

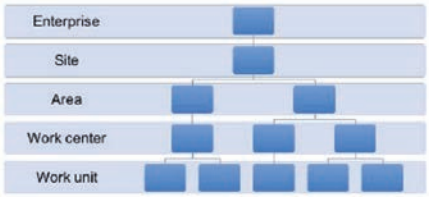

Fig. 1. Hierarchical levels according to ISO 22400-2:2014

2. Research Design

Research presented in this paper is mainly based on empirical data collection from seven large global manufacturing companies, see Table 1. Empirical data was collected in a larger context to investigate PMS. Based on an earlier study presented in [3], a methodology for PMS present state analysis in large companies was introduced. These results are briefly described in section 4. This paper however focuses on the sustainability aspect of the PMS. The data collection approach consists of a top-down interview and bottom-up observation and investigation of PIs in the meeting areas and production control measures on shop floor. The selection of companies was on basis of companies' involvement in a Swedish research project called "Sustainable and resource efficient business performance management systems (SuRe-BPMS).

Table 1 Information about the sites

Site	No. of employees	Product	Manufacturing process
A	1000	Machines and Tools	Machining, assembly
B	1200	Aero space components	Machining, welding, surface treatment, testing
C	270	Vehicle components	Machining, surface treatment, assembly
D	380	Machines and tools	Machining, heat treatment, assembly, surface treatment
E	1800	Machines	Machining, assembly
F	1000	Heavy vehicle	Machining, welding, painting, assembly
G	800	Heavy vehicle	Machining, welding, painting, assembly

The empirical data analysis consists of data reduction, data displays, and conclusion drawing and verification [13]. Afterwards, empirical results were analyzed in an iterative process in several meetings and workshops together with companies' representatives and academic researchers to validate the empirical findings.

3. Method

3.1. Sustainability frameworks

To answer the research questions, an understanding and definition of sustainability is needed that goes further than the original one of "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* [14].

The three dimensions of sustainability: environment, economic and social can be dependant and interrelate in different ways as shown in the figures below.

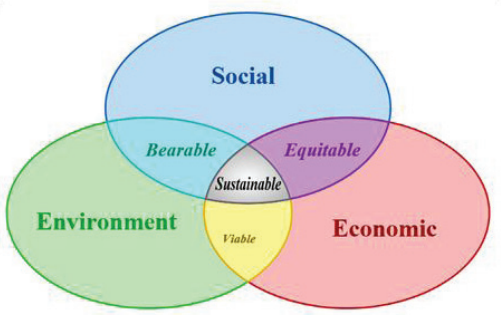

Fig. 2. Three dimensions of sustainability according to Cato [15]