Development and assessment of methods for defining, monitoring and controlling KPIs for sustainable production processes

Sustainability is an important issue in manufacturing. The consortium partners of the FoFdation project are aware of this importance and have developed methods to define, monitor and calculate the sustainable performance and impact of the manufacturing process.

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Definition of sustainability by Brundtland Commission)

The four year FoFdation project aims to develop "Smart Factory" architecture and implementation without neglecting the sustainability of the factory and its processes. For this reason the partners working in WP5 are researching potential solutions in the fields of:

- "Manufacturing sustainability and metrics", which clarifies the meaning of sustainability on an individual basis and determines which metrics should be used to evaluate sustainability on various application levels.
- "Data collection for sustainability evaluation", which specifies how the relevant data can be evaluated and measured on different application levels, and
- "Production and sustainability analysis", which explains what can be done with the revealed data to find solutions/a solution for optimization and awareness.

The objective of the first part of work package 5 (Task 5.1) was to define sustainability in the FoFdation context and to develop means to evaluate how sustainable the single manufacturing processes as well as the whole production are. Furthermore, it reviewed a variety of methods to define, monitor and calculate the sustainable performance on different levels.

The triple-bottom-definition of sustainability which compromises social-, economic- and environmental factors reveals a large field of research. To assess the sustainability of a factory and enterprise the partners of work package 5 defined three major application- and analysis levels:

- Strategic and management level
- Company and operational level
- Factory and shop floor level

In the following section a short review of each level will be given:

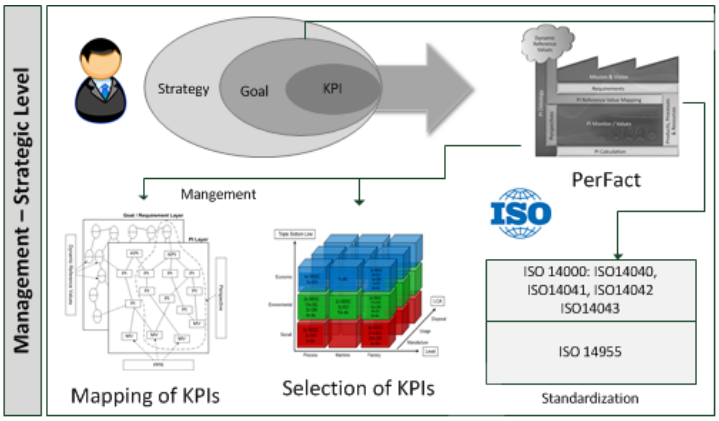

Figure 1: Overview of the Strategic Level

Strategic and management level

The strategic level has to declare which strategic goals the company should follow and which key performance indicators should be measured and calculated. In this approach state of the art and state of the play elements were reviewed and combined. For example the theoretical management approach PerFact was used to provide a general overall performance measurement on the company level. All strategic decisions have to follow current legislation- and standardization procedures. For

this reason several standards, e.g. ISO14000 and current legislation, e.g. SRI, in the field of sustainability were reviewed. Under consideration of the given Use Case of FIAT the major result at this level revealed a multilayer complexity of KPIs, performance indicators (PIs) and Measurement values (MVs). KPIs are versatile and already available but needed to be individually adjusted to the strategic goal of the enterprise. With the given sustainability report of CRF those goals are declared and are further enhanced by FoFdation with additional sustainability manufacturing measurement frameworks (SMMF) such as the sustainability value.

Company and operational level

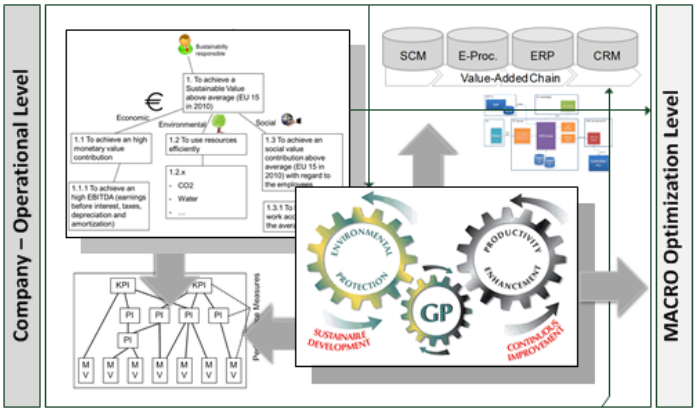

Figure 2: Overview of the Operational Level

The literature research in the operational level has revealed a large field of different approaches. Further this level enables optimization activities compared to the strategic level as it only focuses on evaluation and awareness. Two approaches were chosen at this level, firstly the Sustainable Value (SV) and secondly the Green Productivity (IGP) approach. Both approaches have the ability to acquire measurement data from the shopfloor and are further enhanced with additional data, e.g. ERP. The Sustainable Value offers an approach for the external benchmarking of a company, whereas the IGP evaluates the internal sustainability state at the operational level.

Factory and shop floor level

The factory and shop-floor level, as the initial point for measurements, uncovers multiple optimization opportunities. The calculation of KPIs originates from this level. The partners of FoFdation have developed sensor architecture on the machine level that enables micro optimization at the initial machine tool level, calculates and displays PI on the machine tools HMI for awareness and supplies further information on machine status and consumption of electricity and compressed air for the SMES and operational level. This approach represents the basis for the calculation of the given KPIs mentioned above and enables the user to realize activity based on where the consumption arises as well as the root of its cause. Until now this view was only possible with major investment into sensors or generalized on aggregate system levels.

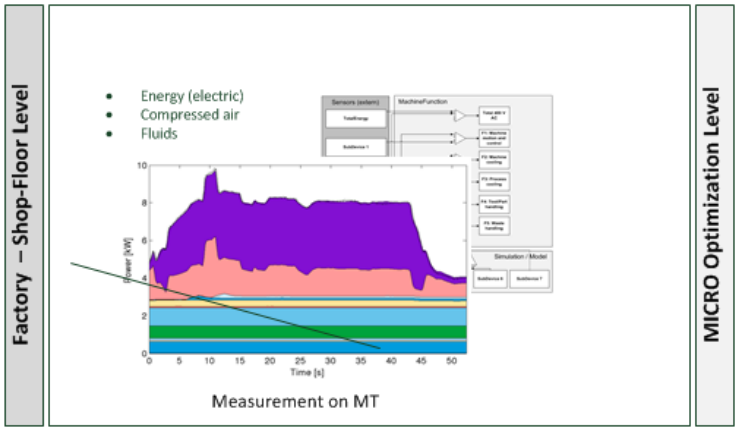

Figure 3 Overview of the Shop-Floor Level

In conclusion, the first part of work package 5 has uncovered different ways to approach the topic of sustainability, proposed various approaches at each system level and led to a more practical approach at the shop-floor level for the following work packages.

For more information about the FoFdation project visit **http://www.fofdation-project.eu** and the project's social media pages, including Facebook (#fofdationproject) and Twitter (@FoFdation).

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For further information please visit:
http://ec.europa.eu/research/industrial_technologies/factories-of-the-future_en.html