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The Millennium Development Goals and Production Engineering training

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Abstract

Purpose – *The search for a more sustainable society depends on more sustainable organisations and, as such, Production (Industrial) Engineering may contribute to this process through the training of professionals with a greater social and environmental consciousness. The purpose of this paper is to present arguments in favour of the integration of Production Engineering and the Millennium Development Goals and evaluate the potential of Production Engineering subareas in contributing to the Millennium Development Goals.*

Design/methodology/approach – *This work is conceptual and integrative in order to provide an original framework. A Brazilian perspective on Production Engineering has been adopted.*

Findings – *A framework is proposed to guide this integration process by providing suggestions for an agenda of opportunities for academics and practitioners in favour of a more sustainable society.*

Originality/value – *This work presents a new framework integrating Production Engineering and the Millennium Development Goals in order to promote a more sustainable training in Production (Industrial) Engineering field of research.*

Keywords Education for sustainable development, Sustainable development, Industrial/Production Engineering, Millennium Development Goals, Training for sustainable development

Paper type Conceptual paper

1. Introduction

In the context of Education for Sustainable Development (Leal Filho, 2010), although a great variety of social sectors, such as the mainstream media, the government and the academy in general are discussing eventual advances, stagnations or retractions with regard to the construction of the Millennium Development Goals, there has been little debate on this subject within the Production (Industrial) Engineering and Operations Management (Sarkis, 2012) community both in Brazil and abroad. However, among the studies published in both prestigious international journals and emergent journals, representing the efforts of both junior and senior researchers, significant possibilities for the creation of more fruitful links between Production Engineering and the Millennium Development Goals still appear to exist. In general, more research on the relationship between engineering and society is required (Downey and Lucena, 2009). This is because training is fundamental for sustainability applied to production issues (Dubey and Gunasekaran, 2015).

The importance of the Millennium Development Goals is at least twofold. First, it is relevant because of its emergence from the summit of over 180 heads of state, who ratified the United Nations (UN) Millennium Declaration, one of the most relevant contemporary World treaties (Nelson and Prescott, 2003). Second, but no less relevant, the Millennium Development Goals deserve attention because they emphasise the primary concerns of a humanity that wishes to travel the path to more sustainable development, which will grant future generations economical growth, environmental quality and social justice.

As indicated by Sarkis (2012), the knowledge fields that permeate Production Engineering (such as, e.g., operation management, economic engineering and mathematical modelling) may certainly contribute to the improvement of the quality of life in society by integrating into their scientific foundation concern with the most critical topics for humanity, such as the improvement of environmental and social conditions. Additionally, according to Brawner *et al.* (2012) Production Engineering has many characteristics of social factors. However, research performed in a scientific manner in the most traditional Brazilian Production Engineering journals reveal that to date, the Millennium Development Goals have barely been incorporated into the agenda of this scientific community. In international journals, there is a clamour for more “humanised” “Production Engineering/Operation Management”, which is evident in the effort of the prestigious *International Journal of Production Economics* in its publication of a Special Issue on this subject (Sarkis, 2012).

In the face of this context, in which the Millennium Development Goals is a sine qua non condition to achieving more sustainable development, arises the question that motivates this research: How can the Production Engineering field contribute to the effectuation of the Millennium Development Goals as an integrative proposal for sustainable development? To guide reflection on this question, this paper intends to perform the following:

- present arguments in favour of the integration of Production Engineering and the Millennium Development Goals with a focus on a more sustainable society;
- evaluate the potential of Production Engineering subareas in contributing to the Millennium Development Goals;
- elaborate a framework so that Production Engineers and other interested professionals may act in favour of the Millennium Development Goals within the organisations in which they act; and
- suggest a research agenda to strengthen the relationship between these two knowledge areas, making contributions to a more sustainable society.

To reach these goals, the present study is structured in the following manner: Section 2 – conceptual foundations – presents a conceptual background on Production Engineering and on the Millennium Development Goals; Section 3 – integrating the concepts – presents proposals to integrate the previously explored concepts; finally, Section 4 presents the central ideas in this research in a systematic manner, along with their implications for a theoretical-practical agenda.

2. Conceptual background

This paper has as theoretical axes the areas that comprise Production Engineering in Brazil according to the Brazilian Association of Production Engineering (ABEPRO) and the eight Millennium Development Goals according to the United Nations (UN, 2012).

2.1 Production Engineering in Brazil: an examination of its subareas

Brazil, the world’s fifth largest country, with a population of nearly 196.5 million and with the 7th largest economy. It is per definition a developing country, that is part of BRIC (Brazil, Russia, India and China) group. Production Engineering is formally considered a knowledge area in Brazil. This knowledge area encompasses projecting, implanting, improving and maintaining integrated production systems, which involve men, material and equipment, as well as specifying, predicting and evaluating the results produced using these systems. For this purpose, Production Engineering uses specialised knowledge originating from mathematics, physics and the social sciences, along with the principles of engineering and analysis and design methods. Production Engineering is composed of ten fields of knowledge (Associação Brasileira de Engenharia de Produção (ABEPRO), 2012):

- operations engineering and production processes, which involves the technique and practice related to the management of production systems and operations, production planning and control, maintenance, factory design and layout planning, among other aspects;

- logistics, which addresses questions related to transportation, movement, stock and storage of inputs and products and aims for cost reduction and client satisfaction;
- operational research, which involves the resolution of real problems by means of optimisation and decision making with the support of mathematical and computational models;
- quality engineering, which addresses the planning of quality certified or uncertified management systems, in addition to quality and continuous improvement practices;
- product engineering, from the conception to the release of a product and its eventual withdrawal from the market, accomplished through the contributions of various parts of the corporation;
- organisational engineering, or the application of strategic, tactical and operational concepts related to the management of organisations;
- economic engineering, or the formulation, estimation and evaluation of economic results for decision-making;
- labour engineering, concerned with projects, improvement, implantation and evaluation associated with the activities and tasks necessary for the full operation of production systems, with respect to ergonomic foundations and the man-machine interface;
- sustainability engineering, concerned with the efficient use of natural resources in production systems, as well as the adoption of social responsibility principles; and
- education in Production Engineering, which involves the content and format of Production Engineering courses, at both the undergraduate and the graduate levels.

Each area of Production Engineering in Brazil is composed of subareas and subjects of interest. The next section presents the Millennium Development Goals to verify the possibilities of integrating the Millennium Development Goals.

2.2 Millennium development goals

In the year 2000, after analysing the greatest dilemmas and problems of humanity, the UN established eight substantial goals that society must pursue for development and society to become more sustainable. Sustainable development is a special form of development in which current society may reach full development in social, economical and environmental terms without compromising future generations' possibilities for their own full development (Hart and Milstein, 2003).

These eight goals may be described as follows:

1. eradicate hunger and poverty;
2. universal education; Provide quality basic education for all;
3. achieve gender equality and women's empowerment;
4. child health, reduce child mortality;
5. improve maternal health;
6. combat AIDS, malaria and other diseases;
7. environmental sustainability; and
8. global partnership; ensure that everyone works towards development.

3. Integrating the concepts in search for a sustainable training

For Production Engineering in Brazil to effectively contribute to more sustainable development in Brazilian society, it is assumed that it must establish an interface with the Millennium Development Goals. Although until now, such an interface has been scarce in not only the BRIC countries but also in research performed by developed countries (Sarkis, 2012), exploratory research efforts must be made.

Although in an explanatory manner, this study presents a picture of the integration of the Production Engineering areas, as defined in Brazil, and the Millennium Development Goals. Methodologically, this integration attempt obeys the following principles:

- the ten areas of interest with regard to Production Engineering, which are described in Section 2.1 and defined by ABEPRO (2012), are considered;
- the eight Millennium Development Goals, according to Section 2.2, are considered; and
- the possibility that each of the Production Engineering areas of interest may contribute to compliance with the Millennium Development Goals, according to Table I, is considered.

Generally speaking, the field of knowledge related to production operations and processes may contribute to the design of production systems, as well as to production planning and control and product and system maintenance. Addressing the problems presented by the Millennium Development Goals in light of a production system (inputs-processing-outputs) may be useful with regard to adequately understanding the complexity involved in these product and service provision systems. Specifically, this area may contribute production systems and services to the poorer portions of society, also known as the pyramid's base.

Logistics are particularly useful with regard to guaranteeing reliable storage, transportation and distribution of products and services to which the Millennium Development Goals refer. This area is also particularly relevant to advancing discussions on logistics and environment by means of reverse logistic concepts and green supply chain management. In addition, logistics offers knowledge that is fundamental to the development of humanitarian logistic systems or logistic systems subjected to natural disasters and wars.

Operational research may allow more efficient manners of making decisions to resolve the dilemmas presented by the eight Millennium Development Goals to be discovered through the use of computational models and optimisation techniques.

Quality engineering may contribute concepts and practices that can be used to reach the Millennium Goals. Concepts such as the P-D-C-A (Plan-Do-Check-Act) Cycle and continuous improvement may be relevant, along with the notion that production systems should aggregate other variables (equality and the inclusion of employees, environmental management, etc.) to actually offer quality products.

Product engineering offers a series of relevant concepts, such as reference models for the development of these items, which may be used in a variety of contexts, from drug production to the design of services for society.

Organisational engineering may contribute to the Millennium Development Goals through its fundamental strategic, tactical and operational concepts, which can be applied to the design of production systems and of services provided for society. For example, a literature on agile project management already exists; however, its application in social problem solving is still limited.

Economic engineering is fundamental to adequate cost-benefit analysis of decision-making related to actions that prioritise the Millennium Development Goals. The economical and financial sustainability of a project is also a fundamental part of the sustainability concept and must be respected.

Labour engineering is dedicated to work organisation, ergonomic improvements, prevention and the reduction of labour risks and is therefore directly related to the operationalisation of projects and actions that aim to comply with the Millennium Development Goals. These projects must be guided by the principles of labour engineering, or they will be counterproductive from the social point of view.

“Logistics are particularly useful with regard to guaranteeing reliable storage, transportation and distribution of products and services to which the Millennium Development Goals refer.”

Table I Areas of production engineering and the millennium development goals

Areas of production engineering	Millennium development goals							
	End poverty and hunger	Universal education	Gender equality	Child health	Maternal health	Combat AIDS, malaria and other diseases	Environmental sustainability	Global partnership
Operations engineering and production processes	Production systems for the pyramid's base	Quality education as a production system	Inclusion of women in this work market	Children health treatment as a production system	Pregnant women's health treatment as a production system	Apply techniques to the production of medicine fighting neglected diseases	Include the reduction, reuse and recycling of materials	Multidisciplinary
Logistics	Humanitarian logistics	Efficient educational material logistics	Inclusion of women in this work market	Guarantee access to medical service at the ideal time and drug delivery	Guarantee access to medical service at the ideal time and drug delivery	Drug delivery	Reverse logistics	Integration of project partners
Operational research	Optimisation and context simulation for food production/hunger reduction	Optimisation and context simulation for more efficient resource allocation	Inclusion of women in this work market	Optimise medical care in the context of scarce resources	Optimise medical care in the context of scarce resources	Optimise medicine production in the context of scarce resources	Optimisation, simulation and mathematical models for sustainability	Optimise variables of different natures in search of more consensual decisions
Quality engineering	Application of quality principles and practices to food production	Application of quality principles and practices within educational systems	Equality as the basis of quality management systems	Continuous improvement to reduce mortality	Continuous improvement to improve the health of pregnant women	Application of quality principles and practices in the development of new medicine and procedures	Integration of the concepts of environmental management and quality in the work regime	Application of principles and practices that aim for collaborative work, such as continuous improvement sessions and PDCA cycles
Product engineering	Development of food product for the pyramid's base	Development of educational and institutional products, particularly for the pyramid's base	Inclusion of women in this work market	Application of service development concepts for continuous improvement	Application of service development concepts for continuous improvement	Application of principles and practices of development for products/drugs	Design for environment, the reduction of waste, reuse and recycling	Skill integration for the development of products that comply with all stakeholders
Organisational engineering	Application of the principles of planning, organisation, direction and results control; verify existent good practices	Application of the principles of planning, organisation, direction and results control; verify existent good practices	Inclusion of women in this work market and applying practices of human resource management	Application of the principles of planning, organisation, direction and results control; verify existent good practices	Application of the principles of planning, organisation, direction and results control; verify existent good practices	Application of the principles of planning, organisation, direction and results control; verify existent good practices	Including themes such as quality of life and environmental management in organisational planning	Integration of multiple stakeholders into the process of planning and establishing actions and aims
Economic engineering	Verify the viability of investments considering social and environmental costs	Verify the viability of investments considering social and environmental costs	Inclusion of women in this work market	Verify the viability of investments considering social and environmental costs	Verify the viability of investments considering social and environmental costs	Verify the viability of investments considering social and environmental costs	Verify the viability of investments considering social and environmental costs	Search for more wide-spanning methods of economic evaluation; collaborative work to verify the viability of investments considering social and environmental costs

(continued)

Table I

Areas of production engineering	Millennium development goals							
	End poverty and hunger	Universal education	Gender equality	Child health	Maternal health	Combat AIDS, malaria and other diseases	Environmental sustainability	Global partnership
Labour engineering	Adequate work methods and ergonomics for food, agroindustrial and rural organisations	Work methods and ergonomics applied to teaching-learning environments	Equality and inclusion as bases in work environments	Adequate work methods and ergonomics for health organisations	Adequate work methods and ergonomics for health organisations	Adequate work methods and ergonomics for organisations involved in combating neglected diseases	Work methods and ergonomics as bases for quality of life at work	Work methods and ergonomics for collaborative work
Sustainability engineering	Development of strategies and practices for the pyramid's base and the reduction of poverty	Mapping of stakeholders and a pursuit of economical, environmental and social balance in educational systems	Inclusion and management of diversity in this and other related areas	Social impacts of child mortality	Social impacts of the improvement of pregnancy conditions	Analysis of the sustainability of production and the distribution of medicine for neglected diseases	Application of principles and practices for the social and environmental management of organisations	Sustainability as a multidisciplinary theme that exercises collaborative work
Production engineering education	Inclusion in the disciplines of Ethics and citizenship and transversally in others, in addition to undergraduate studies	Inclusion in the disciplines of Ethics and citizenship and transversally in others, in addition to undergraduate studies	Inclusion in the disciplines of Ethics and citizenship and transversally in others, in addition to undergraduate studies	Application of real cases and problems in academic studies	Application of real cases and problems in academic studies	Planning of Production Engineering activities that address these subjects. Discuss the related ethical problems	Address subjects such as quality of life at work, sustainable development and environmental management	Present to the students and perform research activities that strengthen collaborative and team work inside and outside the classroom

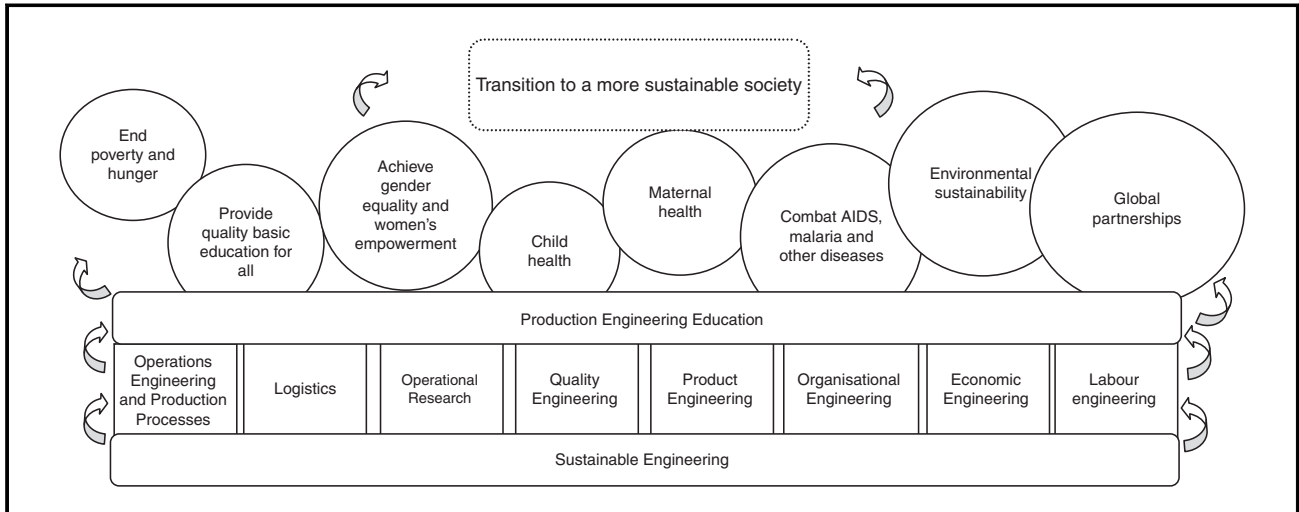
Sustainability engineering is the area capable of establishing the largest quantity of direct links to the Millennium Development Goals. The identification of stakeholders that is aimed towards social management and environmental management may be particularly useful in Production Engineering. However, sustainability engineering must act in a multidisciplinary manner that is transversal to the other areas to be effective.

Finally, education in Production Engineering must allow for the development of methods, experiments and practices that will guarantee the effective inclusion of the Millennium Development Goals in the Production Engineering field of knowledge. Similarly to sustainability engineering, education is a means by which the other Production Engineering areas may establish relations and projects that consider the Millennium Development Goals.

It is believed that the interrelation between Production Engineering and the Millennium Development Goals is possible and useful in the pursuit of a more sustainable society. A framework was produced (Figure 1) to illustrate this interrelation. The sustainability engineering aspect of Production Engineering would be the base from which to seek adaptations in the other Production Engineering knowledge areas in such a manner that production systems consider the economical, social and environmental aspects of their projects, implantation, improvement and maintenance. As a consequence, to achieve the Millennium Goals, these concerns must be incorporated into aspects of the academic formation of production engineers, who will be responsible for guiding organisations towards a more sustainable society.

“Sustainability engineering is the area capable of establishing the largest quantity of direct links to the Millennium Development Goals.”

Figure 1 A framework to understand the interrelation between Production Engineering and the Millennium Development Goals



4. Conclusions

As this paper has tried to demonstrate, the interface between Production Engineering and the Millennium Development Goals should be pursued both by scholars and for engineers involved in organisational practices. This applied to Brazil, but also to other developing countries. In this context, it is important that universities assume their role as leaders in the creation and diffusion of knowledge to potentialise this interface. Therefore, academics and universities are expected to perform the following tasks:

- Take into account the Millennium Development Goals in their teaching activities at the undergraduate and graduate levels. Ideally, this insertion is performed in a transversal manner by reaching all of the existing disciplines.
- Incorporate topics related to the Millennium Development Goals into their research and extension groups and activities.
- Adopt practices and actions related to the Millennium Development Goals in their administrative activities.

In addition, the following suggestions may be made to practitioners acting within organisations:

- include topics on the Millennium Development Goals in the organisations' strategic planning; and
- develop in each of the corporations' areas – production, marketing, finances, human resources, etc. – specific projects to strengthen some or all of the objectives.

As a consequence of the previous suggestion, propose goals for the functional areas to achieve the Millennium Development Goals. It is also important to gather and systematise all of the sustainability and social responsibility actions around the eight Millennium Development Goals and prepare a report to share with stakeholders.

Finally, it is worth noting that the integration of Production Engineering and the Millennium Development Goals suggested in the present study has an exploratory character and is intended to catalyse this integration. This integration is already occurring and being suggested with regard to other areas of knowledge; for example, the combination of medicine-related knowledge and the Millennium Development Goals has been suggested (Travis *et al.*, 2004). However, the search for a more sustainable society depends on more sustainable organisations and, as such,

“[...] the integration of Production Engineering and the Millennium Development Goals suggested in the present study has an exploratory character and is intended to catalyse this integration.”

Production Engineering may contribute to this process through the production of professionals with a greater social and environmental consciousness, the application of related knowledge to organisations' administrative processes or the preparation of research and extension agendas at universities.

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