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ASSESSMENT OF THE LEAN PRODUCTION EFFECT ON THE SUSTAINABLE INDUSTRIAL ENTERPRISE DEVELOPMENT

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Abstract. Most of the industrial enterprises, aimed at perfection through continuous improvement of their competitiveness and sustainability, deeply analysing the existing opportunities, focus their attention mainly on efficiency improvement. Taking into account this fact, in the present article more attention is paid to the evolutionary approach for enterprise development and the lean idea. Having in mind the results of analyses concerning the use of lean production as a step to sustainability and the sustainability reporting practices of the leading industrial enterprises, a short set of indicators is offered for assessing the lean production effect on the sustainable industrial enterprise development.

Keywords: lean production, sustainability, sustainable development, industrial enterprise, performance measurement, improvement.

1. Introduction

In the beginning of the new millennium there are different management approaches trying to support the industrial enterprises in the pursuit of competitive power and economic success. During the last decade there is also a visible trend to combine these approaches with respect to environmental and social issues. Most of the largest industrial enterprises are trying to implement sustainability management into their activity and especially some of them are making serious efforts to have an open dialogue with their stakeholders [1]. Therefore, for many industrial enterprises all over the world, the main task is to ensure sustainable business development, combining economic, social and ecological aspects. The main challenges in front of the management of industrial enterprises aimed at perfection are linked with achievement of production that is [2]:

- defect-free – with high quality outputs, inputs, and processes; low external failure (defects that escape the factory undetected), and low internal failure (defects discovered and fixed inside the factory);
- fast – in terms of manufacturing lead-time or turnaround time, or order processing time;
- lean – eliminating any non-value added activity and waste;
- flexible – satisfying more and more varied market requirements, as soon as the need or market demand arises;
- environment-friendly – with waste and pollution – free processes; producing goods designed for the protection and preservation of the environment (recyclable, repairable, re-manufacturable, re-usable, or biodegradable); practicing good and thorough housekeeping; ready to deal with external and internal emergency situations and accidents (like fire, earthquake, explosion), to serve as a model for good corporate citizens in the community and so on.

In order to cope with these challenges, the industrial enterprises are looking for safe ways for development.

2. Ways for industrial enterprise development

There are two different approaches for development, achieving success and handling with the modern challenges: reengineering and continuous improvement [3]. They find expression in Business Process Reengineering (BPR) and Kaizen.

BPR is the fundamental rethinking and radical redesign of business processes to achieve tangible or dramatic improvements in vital and contemporary measures of performance, such as quality, cost, speed, service [4]. It is being fulfilled by business organisations seeking to avoid impend-

ing difficulties, passing through rather a difficult period or anticipating difficulties [5]. It includes a few stages [6]: preparation, identification, vision, solution, transformation.

Kaizen is an approach of sustained continuous improvement focusing on waste elimination in all systems and processes of an organization, starting from the work place (place where value is created (Gemba)). The strategy of such a development starts and ends with people and improving their ability to meet the expectations of high quality, low cost and on-time delivery, it ensures the organizational success.

They both are striving for better quality and higher productivity but the first one relies on revolutionary changes and the second one relies on evolutionary changes [7, 8]. Some experts and researchers [7, 9, 10] think that, with the aid of these approaches, a sustainable development can be achieved. The growing pressure to become efficient, effective and competitive global players is the reason for many organisations to implement a variety of techniques, operate according to a variety of philosophies and utilise a variety of approaches. These external pressures have included the need to raise quality, reduce costs, shorten the lead time, increase flexibility, lessen variability and so on. Many organisations have reacted to these drives by implementing tools and techniques that allow them to become lean and introduce leaner methods of working [11], i.e. to support the evolutionary approach which was coined to the idea of "Lean Production (LP)", pursuing multiple competitive priorities simultaneously.

3. Lean production and sustainability

Womack, Jones, and Roos coined the term "lean production" in their 1990 book "The Machine that Changed the World" [12] to describe the manufacturing paradigm established by the Toyota Production System. This system is based on systematic identification and elimination of non-value added activity and waste from the production process: defects, waiting, unnecessary processing, overproduction, unnecessary movement, unnecessary inventory, unused employee creativity, and unnecessary complexity. It is based on long-term philosophy; continuous process flow; "pull" systems; workload levelling out; getting quality right the first time, standardization; visual control; reliable, thoroughly tested technologies; leaders who thoroughly understand the work, live the philosophy, and teach it to others; exceptional people and teams who follow company's philosophy; respect for the extended network of partners and suppliers by challenging them and helping them improve; close look; slow decision-taking, thoroughly considering all options, rapid decision-implementation; continuous improvement.

The practice shows that the achieving of multiple competitive priorities simultaneously is possible (Toyota [12], GÅ [13]) and a more careful and profound look at the theory shows that this doesn't contradict to the idea for focusing – it looks at this idea in different and untraditional ways [14]. The simultaneous pursuit of different challenges, demanding the use of different methods and techniques, to some extent determines the appearance of hybrid approaches, a fact which can be seen in the literature and in some software packages (IFS [15], SAP [16]). Therefore, more and more environmental and social issues find their place especially in the lean idea [10, 17–22]. Rothenberg, King and Lenox found high levels of advanced pollution prevention among firms with lean manufacturing systems [23, 24]. The scope of LP adoption is broadening and spreading over more and more industrial sectors and in some business organisations LP is combined with environmental improvement [7, 18, 20, 21, 25–31]. Some of the researches indicate that lean implementation typically produces resource productivity improvements ranging from 30 to 70 percent, substantially reducing the amount of raw materials, water, energy, non-product output associated with production processes, and lean produces – and requires for its success – a robust, systemic, continual improvement-focused waste elimination culture. On the other hand, environmentally sensitive processes can be difficult to lean; there is a tendency for focusing on the middle part of the product/service value chain, missing the very early and late material flow stages; lean also appears to pay limited or no explicit attention to the environmental risk of the materials and transformation processes used to produce products, or to the environmental risk of the product's use and ultimate disposition – "blind spots" that sustainability initiatives focus on quite explicitly. The key factors that slow down the adoption of sustainability are: treating the sustainability initiatives like investments, producing positive net present value (NPV) results, but probably not the most profitable ones and reluctance to disrupt production or redesign products and organisation – difficulties that lean can handle well. Examining the strengths and weaknesses of lean manufacturing and sustainability initiatives produces an encouraging conclusion that they are potentially perfect complements that, effectively linked, hold the potential to vault sustainability synergistically forward [18]. The use of lean methods can lead to realization of benefits for the environment and society but also there are potential problems which have to be avoided [3]:

- potential benefits: identification and elimination of non-value added activities and wastes, and therefore: material and energy savings, floor space reduction, easier implementation of suggestions offered by the employees, reduction of the production process's complexity and elimination or streamlining of environmentally and socially sensitive process steps, reduction of the product designs' complexity and the number and types of materials and consequently facilitation of the disassembly and re-

cycling; realization of quick, sustained results without significant capital investment; quick identification of spills and leaks; risk reduction; higher employees' awareness about Environmental, Health and Safety (EHS) issues (such as waste handling/management procedures, workplace hazards, and emergency response procedures); increased longevity of equipment and decreased need for replacement; decreased number and severity of accidents; focus on reducing the conditions that result in accidents, spills, and malfunctions; improvement of product durability and reliability and consequently increasing product lifespan, reducing environmental impact of meeting customer needs; use of the nature as a design model; magnification of environmental and social benefits of lean production through diffusion across the network.

- potential problems: adoption of practices that do not satisfy applicable EHS regulatory requirements; improper waste disposition or lost opportunities for reclamation or recycling as a result of a failure to involve the environmental personnel in the decision-making process; underestimation of environmental and social risk, disregard of valuable pollution prevention and sustainability opportunities and even adoption of initiatives with worse environmental and social impact as a result of a failure to integrate the environmental and social factors, aspects and impacts in the decision-making process; increased use of chemicals (paints, solvents, cleaning substances), part of which can be dangerous for the environment; rise of a need for equipment change; increased transport burden in case of improper planning; failure to reduce or eliminate overproduction and associated waste if the products have large and/or unpredictable market fluctuations; decreased effectiveness of the approach in case of lack of technical capacity for effective use of tools; shift the burden onto suppliers if the approach does not cover the whole supply chain.

4. Critiques and development of the lean thinking

In spite of some voices of discontent to the adoption and ultimate effectiveness of lean production, many case examples exist to demonstrate how business organisations are changing their production methods and management practices to become leaner and fitter. Indeed, lean manufacture has been extended to encompass the whole spectrum of activities such that world-class business organisations are seeking to become lean enterprises [32]. Leanness is perceived as an ideal to be pursued, not as a system to be implemented, a journey rather than a fixed position and one with no final destination due to emphasis on continuous improvement. Therefore, this notion of leanness is presented as a dynamic system, requiring modification and change, and also as a fragile system, working close to the limits of organisational tolerance [11]. If these limits are crossed it is possible to reach a state of "corporate anorexia", which together with the possible loss of autonomy and excessive work intensification, lack of strategic view and enough ability to cope with variability is one of the dangerous traps in which an organisation, striving for leanness, can fall into. This state can be described using analogies with the human body; concept of elasticity or journey [11] but in all of them, the central point is that if you don't know where and when to stop you can miss the optimum position.

Lean is one of the most influential new paradigms in manufacturing, which has expanded beyond the original application on the shop floor of vehicle manufacturers and component suppliers in the auto industry, ranging from "heavy" industries such as primary metals to aerospace businesses. In particular when applied to sectors outside the high-volume repetitive manufacturing environment, lean production has reached its limitations, and a range of other approaches to counter variability, volatility and variety have been suggested.

As the concept is changing, some of the critiques are not problems of the present day. It is clear that new critiques are emerging, for example linked with the integration with other concepts and mixing of techniques and instruments. For some experts the excessive integration may lead to problems, but for others there is untapped value in this. Among the best tries for profound description of the toolset of lean manufacturing and Toyota Production System are these, made by Monden [33], Shingo [34] and Bell [35]. Today, the lean toolset maybe is not so clear, but it becomes more and more rich, incorporating tools from different concepts, for example [10]: Kaizen, 5S, Total Productive Maintenance, Cellular Manufacturing, Just-in-time, Six Sigma, Production Preparation Process, Lean Enterprise Supplier Networks. According to Bell [35], the toolset can change and it is important not to try one and the same tool for fixing different problems. He recommends analysing the problem first and then objectively determining what tool is needed.

With roots in Total Quality Management (TQM) and Group Technology (GT), influenced by contemporary concepts, as Agile Manufacturing and Six Sigma, the approach is still changing and developing [36]. The terms "Lean Enterprise" and "Lean Network" are launched to describe the extension of the lean approach outside of the organization's boundaries. An explanation of this trend is the fact that in the era of globalisation the industrial enterprise has to pay more attention to its supply chain. A good example of the possibility to realise serious competitive advantage through the use of advanced supply chain management is the "Retail Link" system of Wal-Mart.

The lean concept is very popular all over the world. Derived from the Japanese practice, it is well accepted by a lot of American producers. Hundreds of business organisations across multiple industry sectors are implementing lean production systems to varying degrees. The Lean Production suits well to most of the main challenges mentioned at the beginning [36]. Key misconceptions regarding lean management are that lean means layoffs, works only in certain environment and is for manufacturing only [37]. In fact, sometimes such problems can occur but layoffs are more typical for time of radical changes and restructuring; sector limitations are avoided through integration with other concepts and it can be really useful also outside the manufacturing field, especially concerning changes in administrative processes.

5. Indicators for assessment of the lean production effect on the sustainable industrial enterprise development

Taking into account the results of profound analyses [1, 3] a set of indicators is offered for assessing the lean production effect on the sustainable industrial enterprise development (Table). It consists of indicators which can give really useful information and are widely used in the practice of the leading industrial enterprises. The accent is on efficiency indicators because with their aid it is easy to compare the results for different periods and enterprises. Using them it is possible to make a profound benchmarking survey and uncover some problem areas and directions for improvement. But in fact, they are not enough to draw general conclusions. First of all because better efficiency doesn't mean better results in general. It is important to take into account the total volumes as well. An efficiency improvement is possible even with lower volumes of production, sales and profit. On the other hand, sometimes, an efficiency improvement can lead to higher volumes of production, sales and profit but also to higher resource consumption, waste generation and emissions, worse social performance and so on (so-called "rebound effect").

Another problem in front of making general conclusions is linked with the fact that the best solution (to find way to improve all these indicators) usually is almost impossible and there is a need to find a balance. Of course, there are different studies trying to offer a way how to do this but still there is a need for deeper study on this topic. One of the most popular opportunities is to use Balanced Scorecard

Indicators for measuring the progress to sustainability

Economic
Value added to resource costs
Value added to waste costs
Change in retained earnings at end of period
Labour productivity
Debt to production ratio
Contribution to GDP (ratio of value-added to GDP)
Employment contribution (number of employees relative to the total number of people employed in a certain region or a country)
Human capital investment as percentage of profit
Social
Share of suppliers monitored on their social performance
Share of environmental and social criteria in suppliers' selection process
Illness & disease reduction (illnesses avoided, mortality reduction)
Safety improvement (reduction in lost-time injuries, reportable releases, number of incidents)
Share of employees covered by collective bargaining agreements
Gender profile, percentage of apprentices, employees from minorities, disabled employees, workforce diversity, management diversity
Average hours of training per year per employee
Share of hours of training relative to the total hours worked
Change in the number of employees receiving job skills training
Share of employees surveyed who agree that their workplace is safe and comfortable
Share of pre-tax earnings donated to the community
Environmental
Resource consumption per unit of production / sales/ employee…
Intensity of resource use
Resource consumption reduction
Ratio of renewable raw materials used to total material flow
Share of the weight of products sold that is reclaimable at the end of the products' useful life and percentage that is actually reclaimed
Distance travelled per unit of production / sales/ employee…
Waste per unit of production / sales/ employee…
Waste reduction
Emissions per unit of production / sales/ employee…
Emissions reduction
Contribution to greenhouse gas emissions
Contribution to ozone depletion

(BSC) or even Sustainability Balanced Scorecard (SBSC). However, as the first step, it is useful to reach a set of indicators, as shown in Table, which can give profound information about the enterprise performance.

6. Conclusions

To achieve excellence, perfection, and sustainability in the modern dynamic and global world is a serious challenge. The industrial enterprises, aimed at dealing with this challenge, strive for better performance with respect to quality, cost, lead-time, flexibility, customer service, environmental impacts. The general indicators, suggested by Prof. R. Domingo, are a good starting point for study, but in the spirit of striving for sustainable development, the last "star" can be named "sustainability", with which to achieve bigger thoroughness [36].

Usually, the industrial enterprises look for safe ways for improvement. They are moving forward really carefully, exploring the ground, step by step, focusing their attention mainly on efficiency improvement. It is difficult to start changes only because of the need for environmental or social performance improvement. The industrial enterprises more often than not will avoid such changes without serious stakeholder pressure or clear and significant economic incentives. Of course, the attitude differs in different countries but basically the nature of business enterprises is to look for profit. This is the reason to put the accent on the possibilities to use lean production as a step towards sustainability. Therefore, more and more environmental and social issues find their place in this concept. The problem is that the accent only on economic growth and adoption of those concepts and techniques, which are useful for profit maximization, where environmental and social benefits are a side effect, not the targeted goal, is not sustainable strategy because it does not reach deep enough. It works within the same system that caused the problem, slowing it down at the best. For destructive systems, it is not enough [36]. Therefore, the use of set of indicators for measuring the progress on the road to sustainability can be a kind of solution to these problems. Thus, it is possible to keep the accent on economic progress together with environmental and social performance improvements. A problem of research is how to build a comprehensive system of indicators for monitoring and control of the progress towards sustainability. Using the results of the analyses of the possibilities to implement lean production as a step to sustainability and the usage of sustainability indicators by 100 leading industrial enterprises, in order to retain only indicators which can give really useful information and to skip these which are really rarely used, a new short set of indicators for measuring the progress on the road to sustainability is offered. This set of indicators tries to respond to the modern trends of performance of measurement system development – multidimensionality, inclusion of indicators looking beyond the traditional financial and operational measures, accent on the relationships with different stakeholders and so on. The best solution (to find way to improve all these indicators) usually is almost impossible. So, the main problem is how to find a balance. There are different studies trying to offer a way how to do this but still there is a need for deeper study on this topic. It is also important to find the root causes of the problems and then to take the right measures. There are different ways to do this and some of them are part of the lean toolset.

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GAMYBOS APIMČIŲ SUMAŽĖJIMO POVEIKIO TVARIAJAI PRAMONĖS ĮMONĖS PLĖTRAI ĮVERTINIMAS

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Santrauka

Dauguma pramonės įmonių, orientuotų į ilgalaikę veiklą bei konkurencingumo didinimą, daug dėmesio skiria rinkoje egzistuojančioms galimybėms analizuoti ir gamybos efektyvumui analizuoti. Straipsnyje nagrinėjama, kaip gamybos apimčių sumažėjimas veikia įmonės evoliuciją. Autoriai nagrinėja gamybos sumažėjimo ir įmonės veiklos tvarumo sąryšį. Sudaroma rodiklių sistema, leidžianti įvertinti veiklos tvarumą ir nustatyti gamybos apimčių sumažėjimo įtaką veiklos vystymui perspektyvoje.

Reikšminiai žodžiai: gamybos apimtys, tvarioji plėtra, pramonės įmonė, veiklos įvertinimas.

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