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Cost driven Green Kaizen in pharmaceutical production – Creating positive engagement for environmental improvements

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Abstract

A case study of green kaizen is presented demonstrating results of how to engage operators and management in environmental improvements on the shop-floor by utilizing a method, the Green Performance Map, in a pharmaceutical manufacturing company. The method involves identification of improvement possibilities, an input-output model for visualization (to reach consensus), and a cost saving approach for prioritization of actions (to attain force to take the step). The paper sets out to demonstrate how operationalization is needed to change behaviour, and points at the advantage of utilizing cost as a driver for environmental change.

Keywords: environmental improvement; kaizen; green kaizen; change management; opex; cost driven; lean; sustainability

1. Introduction – green transformation is needed

We are in an extra ordinary situation with a global environmental and climate situation that is alarming. We know now from the latest report of Intergovernmental Panel on Climate Change [1] that the difference between keeping the global warming to 1.5 degrees vs 2.0 degrees is huge when it comes to climate change effects, and that time is very limited to make the necessary changes. These climate gas emissions are due to environmental issues such as the use of energy and material, emissions to air, soil and water.

The industrial sector worldwide is obviously a part of the problem with about 2/10 of global direct emissions and a significant amount of indirect emissions (such as electricity and transportation used by the production system) as reported by [2]. However, the industry is clearly also a part of the solution towards achieving a more sustainable production of B2B and B2C products. It means that extensive changes are required by the manufacturing industry as well as of all other producing industry like steel, mining, chemistry, forest, food and the pharmaceutical.

The changes needed are tremendous and have already started. In combination with the exponential development driven by new technology and the overall digitalization, we find the producing industry entering a transformation mode. It is even said by some, that this is the first time in history we are aware of that we are designing an industrial revolution as we go.

There are, however, large differences in possible transformation speed of production depending on each company's preconditions of working with new green-field factories vs with existing factories, i.e. brownfield. When designing a new factory or e.g. a new production line, best-available technology (BAT) could be used in order to create the most energy- and resource-efficient solutions, utilizing also the new digital options available. When, on the other hand, updating an existing factory is based on normal levels of annual capital expenditure (CAPEX), the transformation will rely more on the operational excellence (OPEX) and continuous

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improvements (CI). The probably most cost-efficient way for production to improve towards increased sustainability is through green lean operation management [3]. However, many fail, and exploring new efficient mechanisms that trigger and maintain focus on lean and green kaizen in daily operations is necessary [4]. As stated by Cherrafi et al. [4], there is a lack of green lean approaches that are developed by practitioners and then applied in research as case studies. The other way around is more often the case, i.e. researchers develop methods which are in some cases tested in real-cases in industry.

As a base for development of the green kaizen approach applied in this study, the Green Performance Map (GPM) has been used. The authors originally developed the GPM-method (both at that time working in the automotive industry) in a joint collaboration between industrial practitioners and academy, as reported in e.g. [5, 6]. The GPM was applied in the participating manufacturing companies within the Swedish automotive industry. Later, it was of interest to investigate whether applying the method in other industry sectors like the pharmaceutical production industry (from now on called pharma industry) could be successful. Pharma production implies specific quality and cleanliness requirements, operationalized through e.g. cleanrooms and tough restrictions and regulations of how to design and operate the production. This may be challenging when implementing a lean type CI [7]. Both the environmental, time and resource efficiency have been increasing within the pharma industry. Good manufacturing practice demands a quality product produced with a reliable process using risk management to identify potential hazards for the final customer [8].

Here, a pilot was performed, testing the GPM-method at two production lines within a pharma-company. In addition to the focus on how to facilitate environmental improvements on shop-floor level, the cost parameter was highlighted to increase attention on management level for approving resources for green kaizen. This paper reports on the results from the pilot and sets out to demonstrate how operationalization of environmental strategies is needed in order to change behaviour, and points at the advantage of utilizing cost as a driver for environmental change in the production context.

2. Frame of reference

The pharma industry is devoted to providing their customers with longer, healthier lives and wellbeing. How-ever, environmental sustainability in general is crucial as a base for human health and wellbeing. Green Engineering has, therefore, for a long time been equally important to cost and quality control in the pharma industry [8]. Today, many companies have operationalized their sustainability work into SHE, i.e. Safety, Health and Environment, as a collective operations management strategy for their company-wide and cross-functional tasks. It is relevant to note that still, it is often experts (dealing with e.g. legislative compliance and sustainability reporting) that drive much of the environmental work in industry. It means that environmental CI has not yet been integrated within operations management in the same way as have kaizen related to resource efficiency (for increased productivity).

Lean production with its focus on process quality, CI and learning organization [9] could be recognized as the perfect fit for the pharma industry. In spite of this, Garzia-Reyes et al. [7] mean that lean implementation among European pharma manufacturers is immature. The main reason being that enabling support in HR, leadership, customer and supplier relations, including also process planning and control are not always in place. The researched company in our pilot has, however, shown considerable progress in their lean transformation between 2007-2017 [10]. To succeed with long term lean transformation, companies need to assure training, commitment, a long-term vision and the willingness to allocate resources to implementation of lean tools and methods [11].

Lean production can be integrated with sustainability or green visions [3, 12]. We find that environmental management systems aligned with ISO 14001 involves similar elements as in lean production [13]. Furthermore, integrating lean and green requires aligning management on visionary and strategic level as well as in use of operative tools and performance measurements [13, 14]. One approach mentioned is the adaption of lean analysis tools to support also green lean implementation, which the environmental value stream map is an example of [4], but few tools are designed specifically to support production teams in their environmental CI efforts. Two factors indicating level of environmental integration in the daily operations is: 1) whether it is part of the daily meeting structure, and 2) if environmental improvements are made as part of kaizen work on all levels. Synergies between lean and green has been researched and can be seen for example in integration as part of strategies or management systems and with performance indicators capturing environmental and social sustainability dimensions [14, 15].

However, for producing industry to take full responsibility of its environmental and climate impact, creating an operations culture of continuous environmental improvement, green kaizen, is a necessary way to go. On operation level this is demonstrated in e.g. [5, 16], and results from using the GPM method were previously reported on in e.g. [5, 17-19]. The method builds on the approach of engaging every employee in improving her/his own working place and has demonstrated power to work well within a real manufacturing/production context in discrete manufacturing and operated in the automotive industry. The method helps reducing the environmental impact by identifying, visualizing and prioritizing environmental aspects, as illustrated in a visual and easy-to-use input-output model, see figure 1, where aspects are noted in eight different categories and prioritised in red. The working procedure is based on an adapted PDCA-process in 5+1 steps comprising:

0: Preparation, check company env. policy and reports
1: Identification of environmental aspects by team
2: Prioritization of environmental aspects (red in fig.1)
3: Action plan for prioritised aspects, (ca. 1-3 months)
4: Implementation of improvements
5: Evaluation of results.

The GPM-method is based on the lean principles and possible to use within the frame of ISO 140001. While it creates employee engagement for green kaizen it also supports decisions by reducing complexity in the environmental work.

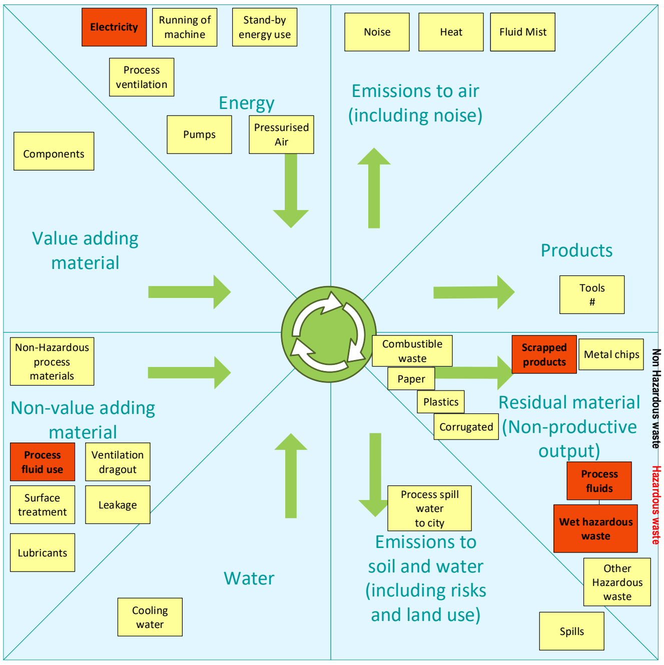

Fig. 1. Example of Green Performance Map utilized in a company case [18].

Policy and standards are typical drivers to reduce negative environmental impact, but market needs, making profit, and capitalizing on the new opportunities are becoming more and more important as positive environmental drivers. Dummett [20] lists drivers for companies to embrace sustainability such as; government legislation or threat of legislation, cost savings, market advantage, protection or enhancement of reputation and brands, avoiding risk, or responding to accident or environmental threat, a ‘champion’ within the organization, pressure from shareholders, pressure from consumers, pressure from nongovernment organizations, and societal expectation. To be noted, cost savings are here listed as a driver for environmental change.

While lean practices in some cases support and improve sustainable performance, some challenges remain [7]. The green lean approach is far from being fully developed and applied within manufacturing industry, despite the evident opportunities in combining resource efficiency and environmental improvements. The tools and methods developed for supporting green kaizen in manufacturing industry are seldom applied in other industry sectors, as for example demonstrated by the lack of published empirical green kaizen cases in the pharma industry.

3. Method and case description

The research presented in this paper is based on a case performed at a pharmaceutical production company. The company is working with lean production since about 15 years and have a structure and organization for implementation of lean and kaizen in production operations. Their environmental work belongs to the SHE-organization, combining central experts with local SHE-coordinators supporting on shop-floor level.

An action-oriented approach was practiced while introducing and testing the pre-developed GPM-method at the pharma company. The case study methodology was used including selected suitable techniques for data collection and analysis. The GPM-method was piloted at two production lines being of similar character to discrete manufacturing, both semi-automated and operating in two-shifts. Empirical data was collected and documented over a period of six months from late 2017 to spring 2018. Data was collected through participatory workshops, observations at the production lines, discussions in the teams, interviews in teams and individually, and by studying documentation. Data was also collected during project meetings with operators, supporting functions and production leaders participating. Energy specialists initiated and collected energy measurement data at selected production equipment. The research study was complemented with a master thesis project as part of the pilot [21], and some of the results from the thesis work comprising mainly the cost parameter of green kaizen is presented in this paper.

The pilot study was initiated by an introduction of Green Kaizen to local management and CI experts (lean managers and environmental managers), a training session was performed, and the first pilot was planned together with environmental and lean support personnel. In the pilot, the GPM tool was used according to its predefined process in 5+1 steps, and a number of environmental improvement potentials were identified as a result (step 1). These were prioritized (step 2) and the team started implementing some of the solutions in a KATA inspired CI [22] while also investigating others (step 3 and 4). The CI coordinators brought the learnings from the first pilot into a steering committee consisting of change managers, responsible for both lean and SHE improvements. As a result, interest for a second pilot was demonstrated. A GPM pilot for a new production line was planned and applied according to the same process as in the first pilot case. After performing the two pilots, they were evaluated and found successful by the steering committee. A long-term plan was then set up for how to standardize the GPM-method in order to be included as a tool in their existing lean toolbox.

4. Empirical findings

The case company initiated their lean program during early 2000 in order to enhance their operational excellence. Initially, factors like production engineering and design of production equipment were emphasized, and typically lean tools like 5S, visual management and lean leadership were implemented. The first selected production lines for the pilot test was considered a lean front-runner since early stages of their lean journey with successful improvements of quality, productivity, lead-times and cost. Over the years, standardization within operations was made, building process stability as part of the lean house. One of the take-aways when standardizing working procedures concerned the importance of involving operators and management in the improvement work. Standard operating procedures (SOP) were developed during the following ten years as part of this standardization work in order to secure a reliable production.

For organizing CI activities in the company, the classical PDCA cycle was used. Lean improvements were mostly driven at team level by working with daily visual management and weekly PDCA improvement meetings. Improvements were driven by using lean tools like 5S combined with Good Manufacturing Practices and TPM. Typically, tools and practices were run as pilots before rolled-out on a broader scale. Regarding environmental improvements, these could typically be integrated in the kaizen initiative. However, according to several of the respondents, no extensive attempts had been made to highlight continuous environmental improvements in the same way as "classical" lean kaizen before 2018. On the other hand, the company had successfully improved their environmental sustainability by other means, and it was an important part of their new sustainability strategy.

The green Kaizen was initiated in October 2017 and the pilot was followed until June 2018. After forming and training the steering committee comprising of support functions and line managers, the first pilot team of 8 operators and the team leader was selected. Two workshops with an interval of one week were performed in accordance with the GPM procedure. In the first workshop, the team made a self-assessment of their maturity on sustainable operations and team-based CI, which was further discussed. Then, the team was divided into three smaller groups with three line-personnel and one coach in each group to identify operative environmental aspects in each part of the production line. In about 30 minutes (27 + 17 + 58) aspects were identified, summing up to, 84 different aspects in total. A summary of the aspects sorted into categories is presented in table 1.

Table 1. Summarized identified environmental aspects gathered from the input-output model.

Results from the GPM-phase 1
Productive material: One product component (A) sometimes sorted as waste (due to process complexity, not product waste restrictions), and tree types of paper and packaging material, labels and glue.
Energy: Compressed air (also idle) and energy use of machine (operations and idle), lighting, screens, scanners, transporters, lifts, ventilation, heating and moisture control etc.
Water: Only for cleaning.
Process material: Administrational material, high consumption of gloves with packaging. Ethanol and paper tissues, lubricants,
Emissions (air, noise): Heat from some of the machines, noise specifically from one machine, smell from ethanol.
Products: High production volume of the specific product.
Residual material: Different packaging: plastic material paper and cardboard material, component A sorted out; for recycling. A lot of printed material for security combustion and cotton gloves, small amount mixed waste for energy recovery. .
Emissions (water, ground): Water from cleaning is sent to wastewater treatment.

Findings were reported in the large group, and the most important ones were identified for further investigation until workshop No.2, one week later. The prioritized aspects were such that they could be improve by the team themselves and had relevant improvement potential. Four issues were set for investigation: high use of gloves due to work practice, one product component sometimes being unnecessarily wasted due to process complexity, production equipment with large amount of stops causing energy and work loss at standby, and unnecessary packaging on disposable gloves.

In workshop two, a recap was made, and the team of 11 people went out on the shop-floor to look into each of the four proposed environmental aspects to collect data for the cost estimation. The use of gloves was 60 pair/48hr (6 working shifts) or 5-6 pair/operator and shift instead of the required 3 pair on the station which was operated by 2-3 persons rotating. Measurement and SOP-check showed a deviation from the SOP requirements. The improvement of saving almost 50% gloves, by changing behaviour was implemented directly by the team. Also, the overused gloves previously sent to energy recovery could be avoided as waste and showed a cost saving potential of 25-50% implying about 225 kg cotton, with large scale-up options in several operations. In addition, a long-term proposal to waste management to investigate recycling of cotton gloves externally was made.

The next environmental aspect prioritized was a plastic component wasted due to process complexity within the automated production equipment. In a specific point of the line, rejected (fallen) components were sent to recycling although the quality was not altered. The quick fix was to feed back the components manually into the production line while ensuring non-contamination, the medium-term solution was a proper automatic installation saving 100% of wasted material at that point of the line. A large number previously being sent to material recycling could thus be avoided (plus adding the same number to the Right-First-Time (RTM)-volume. However, the solution involved changing the SOP and the maintenance department to be involved. The solution had scale-up options in some more lines.

The third aspect concerned a production equipment (not a bottleneck) with extensive unplanned stop time, 3,9 hours unplanned logged stop-time (stops > 5min) in addition to the changeover time. In addition, the stops created standby energy and wasted packaging that had to be sent to secrecy combustion due to labelling issues. The team hence initiated a stop time analysis and an energy measurement was ordered. It was found later that the equipment used 70-80% of the regular energy during standby. As a result of the pilot, a quick fix was to send wasted packaging to secrecy-recycling instead of secrecy combustion. The operators also became aware and started to engage further in regular TPM activities reaching further long term solutions.

The fourth aspect was the use of an overpackaged disposable glove (single packaging not regulated by SOP) resulting in extensive packaging disposal to energy recovery. The quick fix was to collect the packaging as recyclable material, while the long-term change was to investigate (in co-operation with the purchase department where hence the cost savings could be made) if new standard gloves without individual packaging could be used. The operators decided to start measuring the amount of packaging. The third and fourth improvement was put on hold until the second solution was implemented, in line with Lean Kata where a team should focus on one improvement at the time [22]. However, the support functions started to investigate the business cases of all four aspects. The team also continued avoiding several of the 80 less prioritized aspects.

After a steering group review of the two hours workshops and the improvement results, the second pilot was initiated in April 2018 in another production line at the company. The self-assessment was performed as a group discussion with 6 participants. The same procedure was followed as the first pilot, but in 30 minutes less time as a test to see how time efficient the GPM could be performed without losing quality. The team identified over 30 aspects and prioritized to continue working with wasted packaging material (which was a big issue at the line together with equipment disturbances).

5. Analysis

Previous automotive manufacturing use of the GPM-method indicated the importance of demonstrating cost savings of environmental improvements to get management attention and commitment, in line with [20], but also to be used as a parameter when prioritizing. Cost savings were, therefore, the main evaluation parameter in the pharma- pilots. As part of the cost (and value added) focus, it was also requested by the case company to test the limit of the shortest time needed for applying the GPM-tool without losing quality and results. The second pilot was possible to run within 2 x 1½ hour, which was found sufficient in a smaller group. This was of value to the planning of an upscaling of green kaizen, using the GPM tool over the whole production site.

The estimated implemented annual (short-term) ***direct green cost savings*** of the prioritized green actions were ca 8,4 k€, or around 50% of the identified loss-cost (around 17k€ in pilot A). Due to the duplication of production lines, total annual ***scale-up green cost savings*** were estimated to a quite extensive level eleven times higher (92k€). Rough estimations made of ***indirect green cost savings*** related to proposed changes (such as cost for handling, transportation and purchasing) indicated an interesting long-term cost saving potential to be further looked into. Besides, other spill-over effects from working with the GPM-method to e.g. their regularly lean-work were indicated, demonstrating that there were also ***qualitative green improvement parameters*** to consider as result of making environmental improvements, see fig. 2. Qualitative parameters are often difficult to calculate in monetary terms on a short-term basis (although they tend to end up in the KPIs eventually). However, making a rough estimation is still better than no estimation – since zero is still a very exact number (i.e. not considering the qualitative parameter means de facto setting zero cost savings).

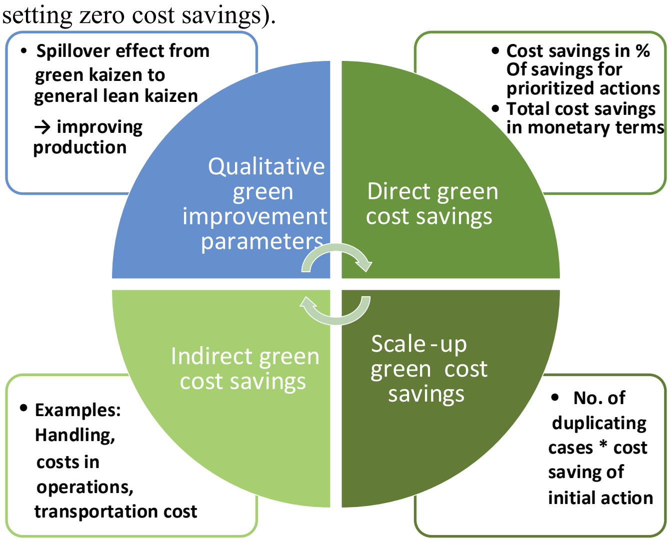

Fig. 2. A model illustrating four cost saving categories of making environmental improvements.

When prioritizing among the identified environmental aspects, a general rule communicated was to be aware of not to pick those aspects where more resources were needed for measurement and analysis of the improvements than what could be gained from executing the changes. A quick estimation of resources vs gain could often be enough (if no investments is needed), for considering change of behaviour or small consumption costs. Some general guidelines when using the GPM-method could be summarized as follows:

- The success factor is to prioritize and act on only a few green actions. Create no long lists, it reduces motivation rather than the opposite.
- For simple green actions: "*Just do it*"
- Integrate green kaizen into the existing structure for continuous improvements, create no new system
- Help all involved to understand their own environmental role – everyone could contribute
- For every suggestion you ask others to support, you should do 3 actions by yourself
- Prioritize actions in the following order: 1) operator or team action, 2) support needed by functions like maintenance, production engineering or energy, 3) actions needing large investments
- Document and measure at the right level and extent, do not over-do
- Do not put in more resources than the value of the change
- Do not crease measurement procedures that cost more than the improvement potential

6. Discussion and conclusions

The pilot demonstrated a practical and easy-to-use method to operationalize environmental strategies in a pharmaceutical producing company by using and slightly adapting a green kaizen method that was originally developed by and for the automotive industry. Improving the environmental sustainability cannot only be made by new green investments. It is clear that a lot of improvements can be made by changing behaviour in operations in the production context, see fig. 3.

Fig. 3. The goal is to create the positive improvement circle.

The goal is to create a green positive improvement circle, that a) creates practical environmental improvements on the shop-floor, resulting in b) cost savings and c) best practice sharing and scale up of successful cost saving solutions, gradually building d) a more sustainable organization with growing green competence and engagement, and e) eventually integrating the use of a green kaizen tool in the lean toolbox, which further standardizes and facilitates a learning culture of making continuous environmental improvements.

Utilizing green cost savings as a driver both on shop-floor level when prioritizing among identified improvement solutions, and on management level to get their commitment and engagement, is demonstrated to be a successful way to go in order to increase speed of change when it comes to environmental improvement work in production. Hence, it is advantageous to think in terms of making business cases for the proposed green changes, i.e. the costs should be worth the economic benefits. Especially important when there are scale-up effects of identified cost savings. Moreover, green improvements might challenge existing production standards (and SOP) which could imply even broader positive scale-up effects in the pharma industry.

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References

[1] IPCC. *Global Warming of 1.5°C. Special Report* 2018 [cited 2018 2018-12-30]; Available from: https://www.ipcc.ch/sr15/.

[2] EPA. *Global Emissions by Economic Sector 2010, (Based on IPPC 2014)*. 2018 2018-12-30]; Available from: https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

[3] Zokaei, K., I. Manikas, and H. Lovins, *Environment is free; but it's not a gift.* International Journal of Lean Six Sigma, 2017. 8(3): p. 377-386.

[4] Cherrafi, A., et al., *A framework for the integration of Green and Lean Six Sigma for superior sustainability performance.* International Journal of Production Research, 2017. 55(15): p. 4481-4515.

[5] Romvall, K., et al., *Green Performance Map – An Industrial Tool for Enhancing Environmental Improvements within a Production System*, in *the 18th CIRP International Conference on Life Cycle Engineering, 2011*. 2011: Braunschweig, Germany.

[6] Bellgran, M., et al., *Green Performance Map - HANDBOK [in Swedish].* 1 ed, ed. I. IPR. 2012, Eskilstuna, Sweden: Mälardalen University. 20.

[7] Garza-Reyes, J.A., et al., *Lean readiness–the case of the European pharmaceutical manufacturing industry.* International Journal of Productivity and Performance Management, 2018. 67(1): p. 20-44.

[8] Jiménez-González, C., et al., *Key green engineering research areas for sustainable manufacturing: a perspective from pharmaceutical and fine chemicals manufacturers.* Organic Process Research & Development, 2011. 15(4): p. 900-911.

[9] Yamamoto, Y. and M. Bellgran, *Fundamental mindset that drives improvements towards lean production.* Assembly Automation, 2010. 30(2): p. 124-130.

[10] Birkie, S.E., et al. *Implementation Challenges Affecting the Environmental Improvement Performance in Pharmaceutical Production*. in *IFIP International Conference on Advances in Production Management Systems*. 2018. Springer.

[11] Netland, T.H., *Critical success factors for implementing lean production: the effect of contingencies.* International Journal of Production Research, 2016. 54(8): p. 2433-2448.

[12] Bergmiller, G.G. and P.R. McCright. *Lean Manufacturers' Transcendence to Green Manufacturing*. in *Proceedings of the 2009 Industrial Engineering Research Conference*. 2009. Miami, Florida: Institute of Industrial Engineers.

[13] Kurdve, M., *Development of collaborative green lean production systems*, in *School of Innovation, Design and Engineering*. 2014, Mälardalens Högskola.

[14] Carvalho, H. and V. Cruz-Machado, *Integrating lean, agile, resilience and green paradigms in supply chain management (LARG_SCM)*, in *Supply chain management*, P. Li, Editor. 2011, InTech: New Delhi. p. 27-48.

[15] Leon, H.C.M. and J. Calvo-Amodio, *Towards lean for sustainability: Understanding the interrelationships between lean and sustainability from a systems thinking perspective.* Journal of Cleaner Production, 2017. 142: p. 4384-4402.

[16] Pampanelli, A.B., P. Found, and A.M. Bernardes, *A Lean & Green Model for a production cell.* Journal of cleaner production, 2014. 85: p. 19-30.

[17] Petersson, L., L. Swanström, and M. Bellgran. *Green KPIs as drivers for environmental improvements on shop floor level*. in *PERSPECTIVES ON MANAGING LIFE CYCLES–: Proceedings of the 6th International Conference on the Life Cycle Management*. 2013. Chalmers University of Technology, The Swedich Life Cycle Center.

[18] Kurdve, M. and M. Wiktorsson. *Green performance map: visualising environmental KPIs*. in *Published in Conference roceedings EurOMA 2013*. 2013. Dublin.

[19] Shahbazi, S., M. Wiktorsson, and M. Kurdve, *Using the Green Performance Map: towards material efficiency measurement*, in *Operations Management and Sustainability*. 2019, Springer. p. 247-269.

[20] Dummett, K., *Drivers for corporate environmental responsibility (CER).* Environment, Development Sustainability, 2006. 8(3): p. 375-389.

[21] Hanna, R., *Kostnadsdrivet förbättringsarbete inom miljö: En fallstudie på AstraZeneca*, in *School of industrial engineering and management*. 2018, KTH.

[22] Rother, M., *Toyota Kata: Managing People for Improvement, Adaptiveness and Superior Results*. 2010: McGrawHill.