Lean, but also standardized

“Lean Six Sigma for the optimization of production planning processes“

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Status: 01.11.2017

This article was originally published in German in the journal “Qualität und Zuverlässigkeit”:
Günther, S./ Müller, A. (2016): Lean Six Sigma: Schlank und doch standardisiert, in: QZ, 61. Jg., H. 12, S. 37-41.

Abstract

Lean Six Sigma is a widely used concept for process optimization in many companies. The application focus of this concept is on production and service processes. Regarding the improvements of planning and administration processes, only a few reports or case studies are available. In this respect it is interesting since the importance of planning and management processes is increasing, especially in global-linked industries. Does this mean that the application of Lean Six Sigma or the underlying project management cycle DMAIC is less successful or less relevant?

To answer this question, there was a research study conducted at HTW Dresden, including 16 case studies, which were analyzed and evaluated. During the evaluation, great variety was found in the project steps and tools. There are several reasons for these findings, starting with the project goals, followed by team structure, and ending with employee qualification. Nevertheless, the research team has been able to derive a generic DMAIC cycle based on the given case study data. This “best practice approach” was applied successfully at a internationally renowned semi-conductor company for the optimization of a production planning process.

1. Starting Situation & Problem Description

Ever day a lot of industrial processes are optimized by the Six Sigma concept or, alternatively, Lean Six Sigma. In order to maximize the productivity of production lines, it is necessary to minimize downtime and quality losses. The main causes are often arise from the 5M dimensions, namely HuMan, Material, Machine, Method and EnvironMent. Even if all potential causes are identified and optimized in advance, there are still instances of unplanned downtime and losses. These problems are usually caused by the production environment and support systems. In the first place we have the planning processes, e.g. for order quantities and start times, which occur weeks before the physical production process begins. Inefficiencies and the shortcomings of these administrative processes could have a significant impact on the above mentioned business goals. Therefore, there is a need to focus on the optimization of the production planning processes as well, e.g. by using Lean Six Sigma.

Six Sigma, Lean or Lean Six Sigma?

Even though we this topic is highly relevant for the optimization of production planning processes there is no specific optimization approach within Lean Six Sigma concept. Quite often the DMAIC-cycle is used as a basis, and it is then adapted for the given problem. This means in practice: Which tools have to be selected in order to achieve an effective and efficient application of the Lean Six Sigma project? So far, there are only a few publications addressing this question. This leads to the conclusion that no suitable concept for this application area has been found yet. Depending on the problem and the individual preferences of the project leader, this or that tool from the Lean or Six Sigma tool box is used in each project phase. For the process owner (sponsor) of the company the trial-and-error approach is not up-to-par.

2. Study Approach & Design

In order to derive an efficient DMAIC-cycle for the optimization of planning processes, a meta-analysis has been conducted at the HTW Dresden. For this research, several data bases were used, e.g. on the one hand overall data bases like Sächsische Landesbibliothek, Staatsbibliothek München, and on the other hand subject-related data bases likeDe Gruyter, Emerald Insight, Google Scholar. During research only the use of English terms was successful. In this context, the following terms were used, either alone or in combination with one another: Lean, Six Sigma, DMAIC, application, planning process, administrative process, business process.

The majority of search results yielded English publications. The first attempt resulted in more than 50 hits. After reviewing each single hit, less than 20 articles remained. We looked especially for publications that describe the application of the DMAIC-cycle for the optimization of planning processes in detail. Publications that mainly focused on the optimization of production processes were discarded. Since there were only very few articles left, we expanded the search – in a second attempt – to include planning and “administrative processes”.

3. Results of the meta analysis

16 relevant Case Studies identified

In total, 16 articles could be identified following this approach. All case studies focused on the application of the DMAIC-cycle regarding the improvement of administrative processes. 9 of these case studies can be found using the key word „Lean Six Sigma Project“, 7 using „Six Sigma Project“. Besides published articles in journals, many case studies are originally from presentations delivered at topic-related conferences. The articles that we researched are alphabetically listed in Table 1.

#	Authors	Year	Country	Sector	Optimization of	Concept	Cycle	# Tools
1	Capasso, V./ Johnson, M.	2012	USA	Health Sector	Administrative process	Lean Six Sigma	DMAIC	8
2	Chang, S.-I. et al.	2012	Taiwan	Semi-conductor	Production planning process	Six Sigma	DMAIC	9
3	Cheng, C.-Y./ Chang, P.-Y.	2012	Taiwan	Nonprofit-Organization	Service Quality & Lead Time	Lean Six Sigma	DMAIC	13
4	Furterer, S./ Elshennawy, A.K.	2005	USA	Local Government	Accounting system	Lean Six Sigma	DMAIC	17
5	Günther, S. et al.	2008	Germany	Health Sector	OP-Planning process	Six Sigma	DMAIC	14
6	Kumar, S./ Wolfe, A./ Wolfe, K.	2008	USA	Financial Sector	Credit approval process	Six Sigma	DMAIC	9
7	Laureani, A./ Antony, J.	2010	UK/Irland	Service	Staff turnover	Lean Six Sigma	DMAIC	10
8	Laureani, A./ Antony, J./ Dougla	2009	UK	Service	Callcenter-Process	Lean Six Sigma	DMAIC	12
9	Liu, Y.-N./ Li, K.	2011	China	Semi-conductor	HR Project Management	Six Sigma	DMAIC	14
10	Muhareb, Al T.M./ Graham-Jone	2014	Saudi-Arabia	Aerospace	Service Quality	Lean Six Sigma	DMAIC	18
11	Neufeld, N.J. et al.	2013	USA	Health Sector	Patient discharges	Lean Six Sigma	DMAIC	8
12	Panat, R. et al.	2014	USA	Semi-conductor	Configuration process	Lean Six Sigma	DMAIC	12
13	Rivera, A./ Marovich, J.	2001	USA	Medical Devices	Sales and Procurement	Six Sigma	DMAIC	20
14	Stoiljković, V./ Trajković, J./ Stoi	2011	Serbia	Medical Devices	Sample analysis Micro	Lean Six Sigma	DMAIC	9
15	Wei, C.-C. et al.	2010	Taiwan	Sales	Replenishment process	Six Sigma	DMAIC	11
16	Zhiying, W./ Jing, S.	2006	China	Financial Sector	Bank counter process	Six Sigma	DMAIC	12

Table 1: Case studies of Lean Six Sigma that focus on administrative processes

The case studies consider a broad spectrum of sectors, issues, and companies. They range from the optimization of the operational planning process in a hospital via the elimination of errors in the context of loan application process in a bank to the improvement of the quality of bureaucratic service in regional administration. Interestingly, there is only one publication that focuses on the production planning process. Chang et al. (2012) describe the application of Six Sigma DMAIC-cycle to analyze the process in a semi-conductor company.

55 different tools applied

While the DMAIC-cycle is the core characteristic shared by all documented improvement projects, the selection and application of tools vary. On average, 12 tools were used in the projects listed above; all 55 identified tools can be seen in Table 2. On the one hand this is surprising, since articles in reference books or manuals outline a more or less standardized tool box for the DMAIC-cycle. On the other hand, the tools or methods of Lean/ Six Sigma are well-known for their flexibility. That is to say they can be used depending on the specific problem and/ or situation of the company in order to achieve high efficiency. For professionals without extensive knowledge of the methods or tools, this situation is unsettling. They want a generic problem solving cycle with a standardized tool box.

Six Sigma	Six Sigma & Lean	Lean
ANOVA	5x Why Analysis	5S
Control Plan	8D-Report	7 Types of Waste
CTQ-Analysis	ABC-Analysis	Kaizen
Data Collection Plan	Questioning/ Observation	Kanban
Visualization of Data	Brainstorming	Layout Planning
Descriptive Statistics	C&E Matrix	Lessons Learned
Capability Analysis	Checklist	One-Piece Flow
FMEA	Flow Chart	Poka Yoke
Test of Hypothesis	Histogram	Product-Quantity Analysis
Cost-Benefit-Analysis	Ishikawa Chart	SMED
Gage R&R	Classification/ Selection	Total Productive Maintenance
Paynter Chart	Qualification of Employees	Value Stream Mapping
Pilot Testing	Pareto Chart	Visual Workplace
Priorization-Matrix	Process Visualization	
Project Charter	Stakeholder Analysis	
Process Simulation	Standardization	
Quality Control Chart	Scatter Chart	
Regression Analysis	SWOT-Analysis	
SIPOC		
Six Sigma Key Measures		
Spaghetti Chart		
Design of Experiments		
Voice of Customer		
Probability Distribution Chart		

Table 2: Lean & Six Sigma Tools in researched case studies

There are two strategies for accomplishing a best-practice approach as a result. Firstly, we could quantify the use of individual methods and tools in the single phases of the DMAIC-cycle in order to evaluate the relevance of them. Secondly, we could analyze the use of individual methods and tools in detail based on selected case studies. This qualitative analysis has the advantage that the input-output-relation between the applied tools can be determined. In the following study both strategies are used.

Six Sigma Toolbox has great significance

The three tools that are used most frequently within the single phases of the DMAIC-cycle (Top 3) are shown in Table 3. The quantitative analysis leads to the result that conventional tools from the Six Sigma Toolbox are mainly applied (60%). The other tools (40%) are used with both concepts, e.g. Lean or Six Sigma. In this context it can be pointed out that in the considered projects no “pure” Lean tools, e.g. Value Stream Mapping, appear in the Top 3. Thus, they seem to be less relevant for the optimization of administrative or planning processes than usually expected.

Phase	Tools (Top 3)	6S oder Lean	# Nennungen
Define	Voice of Customer	6S	10
	SIPOC	6S	10
	Project Charter	6S	8
Measure	Process Visualization	6S & Lean	6
	Capability Analysis	6S	5
	Descriptive Statistics	6S	4
Analyze	Ishikawa Chart	6S & Lean	7
	Test of Hypothesis	6S	6
	Pareto Chart	6S & Lean	5
Improve	Brainstorming	6S & Lean	13
	Process Visualization	6S & Lean	5
	Pilot Testing	6S	2
Control	Quality Control Chart	6S	9
	Standardization	6S & Lean	6
	Capability Analysis	6S	4

Table 3: Top 3-Tools per DMAIC-Phase according to frequency

For the qualitative analysis we closely analyzed the tool use of 4 out of 16 case studies (see Table 4). These 4 were chosen using criteria-based selection with the following items: “Similarity to target process”, “Implication of article”, Scope of project results”, and partly “Relevance of the branch”. It can be stated in advance that there is no definitive solution (gray zone). In the 4 projects described in the above mentioned case studies, 12 tools have been used on average. However there is less variety; in total, we can see 21 different tools in the project reports. In the single phases of the DMAIC-cycle the number of tools varies between 1 and 4. According to the quantitative analysis the conventional Six Sigma tools are dominant whereas Lean tools are rather rare.

#	Authors	Title	Define	Measure	Analyse	Improve	Control
1	Wei et al. (2010)	Using Six Sigma to improve replenishment process in a direct selling company	CTQ-Analysis	Process Visualization	ANOVA	Brainstorming	Control Plan
			Six Sigma Measures	Ishikawa Chart		Descriptive Statistics	
			Project Charter	C&E Matrix			
				FMEA			
2	Chang et al. (2012)	Applying Six Sigma to the management and improvement of production planning procedure´s performance	SIPOC	Test of Hypothesis	Test of Hypothesis	Brainstorming	Qualification of Staff
					Capability Analysis	Capability Analysis	Quality Control Chart
					Quality Control Chart		
3	Liu/ Li (2011)	Application of Six Sigma Methodology DMAIC in HR Project Management - A case study of Motorola	Voice of Customer	Descriptive Statistics	Pareto Chart	Brainstorming	Pilot Testing
			Project Charter	Capability Analysis	Ishikawa Chart	Process Visualization	Process Visualization
				C&E Matrix	Value Stream Mapping		Capability Analysis
				Data Collection Plan			
4	Günther et al. (2008)	Optimierung des OP-Planungsprozesses in der Klinik für Neurochirurgie, UKD Dresden, auf Basis des DMAIC-Zyklus	Projekt Charter	Capability Analysis	Ishikawa Chart	Brainstorming	Quality Control Chart
			SIPOC	Data Collection Plan	Process Visualization	Process Visualization	Qualification of Staff
			CTQ-Analysis	Six Sigma Measures	Test of Hypothesis		Control Plan
							Capability Analysis

Table 4: Applied tools within the Top 4 projects

4. A derived concept for Lean Six Sigma

Specifying the use of the tools within Lean Six Sigma projects in the area of Production Planning and Administration is possible by combining the quantitative and qualitative analyses. In this context, how frequently the tools in the 16 case studies are applied is just as important as how the project-specific tools are used and linked within the 4 benchmark projects. Phases, process-steps and methods of the derived Lean Six Sigma DMAIC-cycle are seen in Figure 1.

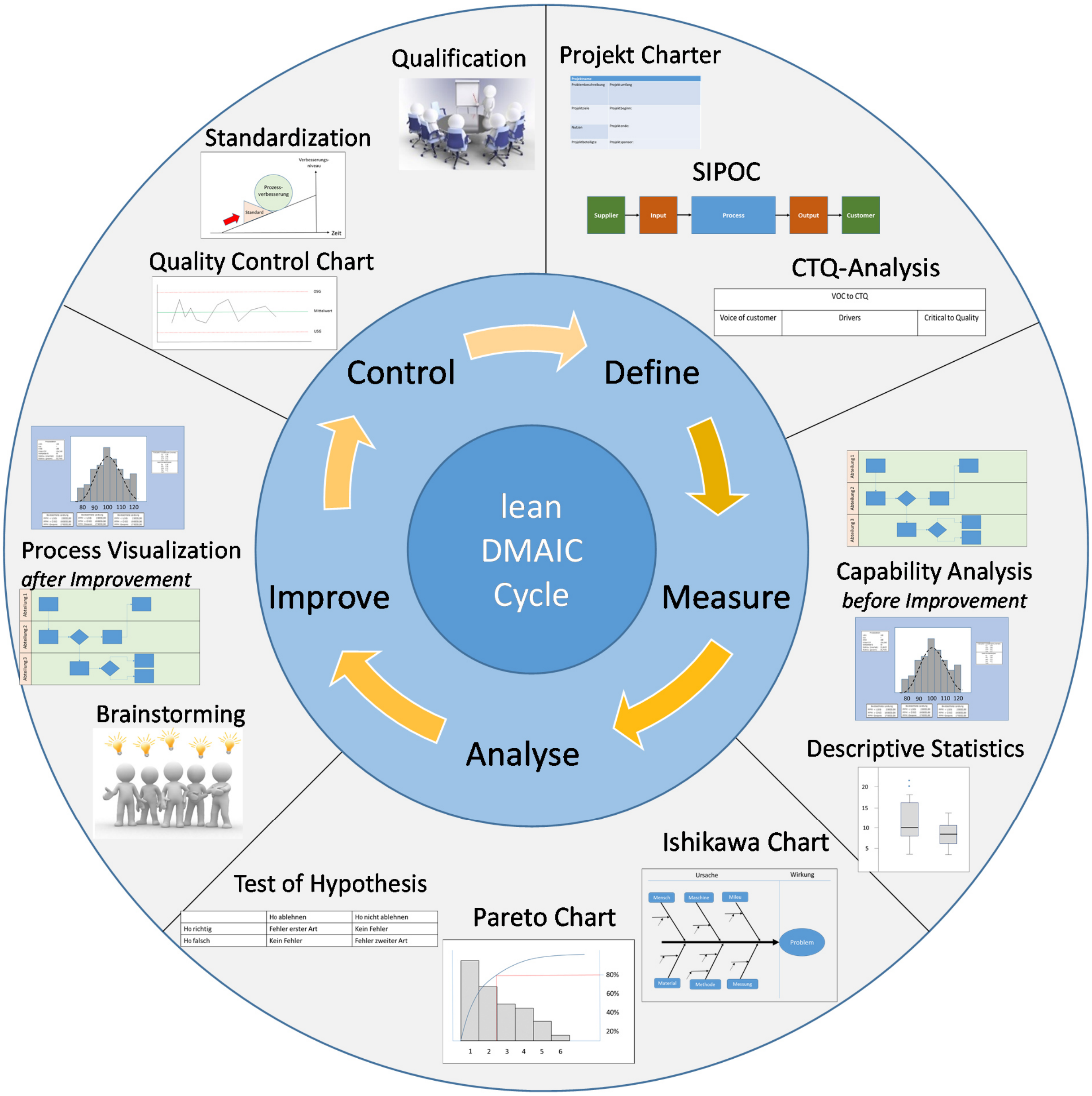

Figure 1: Derived lean Six Sigma DMAIC-cycle

According to the conventional Six Sigma approach, the following process-steps are conducted during the Define-phase: (1) Project Charter is created, (2) Process in question is described on “high level” (SIPOC), (3) the critical customer requirements (CTQs) are determined. Interestingly, the order of process-steps in the empirical findings varies although logic dictates that these 3 steps should be chronologically followed.

In the next phase, *Measure*, the actual process is defined in a quantitative and qualitative manner. On the one hand, detailed process flow charts, e.g. cross-functional charts, are mainly used to determine which areas can be improved and which non-value-added processes can be removed. On the other hand, actual data is collected to quantify the current performance of the process, e.g. by using a Process Capability Analysis. Additionally, the variation of the process is determined with the help of common statistical tools, e.g. Boxplot.

In the *Analyze-phase*, the causes of process errors and deviations are analyzed in detail. The following process-steps are usually followed: (1) A Fishbone-diagram (Ishikawa) is created in order to identify potential root causes. (2) A Pareto chart is drawn up to confirm and prioritize these causes according to the 80/20-rule. (3) In the case of insufficient or unclear results of the frequency statistics, advanced statistical tools have to be applied, e.g. t-test or ANOVA.

Based on the analytical results, concrete ideas for improvement are generated in the *Improve-phase*. In this context, Brainstorming is the most often used tool. After the improvement ideas have been implemented, a second measure phase is conducted to ensure that the targeted results have really been achieved. In this case, the standardization of the optimized process can be started.

This standardization work is already part of the last phase of the DMAIC-cycle, called Control. By introducing or renewing standard operation procedures, deviations from the target process should be avoided at all costs. Resorting to “old behavioral patterns” must be avoided too. Therefore, an effective communication strategy as well as comprehensive training of employees are necessary. True to the motto “Better safe than sorry!” the process performance has to be continuously controlled

5. Conclusion and Outlook

From a scientific perspective the chosen approach is a kind of trade-off between methodical rigor and practical relevance. The tools that are used within the DMAIC-cycle should help to achieve the project goal. In this context we have seen “less is more!” At the same time the investigated projects abide by the main principles of Lean Six Sigma, especially in terms of project definition and procedure:

1. Problem as to be clearly defined at the very beginning
2. Improvements are based on facts, analyses and data
3. Tools are interconnected and build upon each other
4. Root causes have to be confirmed based on data
5. Root causes are isolated and checked one after another

The empirically derived DMAIC-cycle for the optimization of production planning processes can be characterized by the following five points. In this way, a lean, but standardized problem solving process is achieved and comes close to the expectations of quality managers:

1. Limited to a maximum of 15 tools
2. Includes tools proven by practical application
3. Statistics: Streamlined to the bare minimum
4. Focused on visual aids and charts
5. Projects can be conducted by Green Belts

A first application of the derived DMAIC-cycle took place at a semi-conductor enterprise (Infineon Technologies) in the first quarter of the year 2016. During the 10-week project the operational production planning process of the wafer production was optimized at a German site (Dresden). The short-term changes of the production plan were identified as a major loss. At the beginning of the project, the so called "Changes of Request (CoR)" were over 50%. Despite the standardization of the planning process and conducting several optimization projects within the scope of "Lean Planning, the CoR was not significantly decreased in the past five years. It was only through the Lean Six Sigma project that a more than 30% reduction of the key figure was made possible.

Authors

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