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Evaluation of Lean Business Process Improvement Methodology

Niclas Måren
GKN Aerospace Norway
niclas.maaren@gmail.com

Gerrit Muller
University of South-Eastern Norway
gerrit.muller@usn.no

Elisabet Syverud
University of South-Eastern Norway
elisabet.syverud@usn.no

Abstract. Industry trends such as lean manufacturing have proven to work effectively in removing waste and improving the efficiency and effectiveness of production processes in manufacturing companies. The business processes within some manufacturing companies tend to lack the same attention as the production processes, however. This research explored the value of using the GKN lean business process improvement (BPI) methodology for improving business processes at GKN Aerospace Norway (GAN), an aerospace manufacturing company located in Norway. The method aims to identify and reduce waste by mapping the current state of a selected process, suggest a future state with less waste, generate an action list for changes, and a plan for implementation of the proposals made. During this study, the method showed to be successful at improving the efficiency in 7 out of 8 of the processes adopted. The research also found that employees at GAN respond favorably to BPI initiatives but that better preparation prior to each BPI workshop could further improve the effectiveness of the method.

Introduction

Background. GKN Aerospace Norway (GAN) is a Norwegian manufacturer of complex jet engine components for military and civilian aero-engine programs. GAN has more than 40 years of experience in manufacturing high-quality mechanical parts for the aerospace industry. The company's product portfolio consists of rotary and static components made from exotic superalloys, such as Inconel and Haynes. The manufacturing of components created from these materials requires high precision machines, manufacturing knowledge, and stable manufacturing processes. In a continually changing market with high customer expectations, being the customers' preferred supplier is integral to securing new contracts and surviving in an industrial high-cost country such as Norway. On-time delivery, high-quality production, and acceptable costs are enablers ensuring a good reputation for being a reliable supplier in the aerospace industry.

To boost the operational efficiency of the organization, GAN introduced lean in 2012. The goal of this incorporation was to reduce activities that add cost without adding any value, often referred to as *waste* in the lean terminology. Given the organization's limited lean experience at the time, problems in production seemed to be the most rewarding to approach first. These problems are often visible, measurable, and directly affect the company's ability to deliver products on time to the customers. Therefore, the company introduced *lean manufacturing* as the first lean initiative to boost operational efficiency and satisfy customers.

Focus areas for improvement. For a long time, lean has been a market trend for manufacturers. Companies worldwide establish and implement lean as a strategy to reduce cost and enhance the

efficiency of their production lines (Welo & Næss, 2013). Statistics indicate that lean manufacturing has shown to be a prominent contributor for improving the efficiency of production lines at GAN by reducing waste (GKN Aerospace, 2018). However, the competitive advantage is declining as the number of companies within the same market segment who are implementing lean has increased. This implies that lean manufacturing in itself is not sufficient to remain competitive, as new production technology and lean manufacturing are gradually becoming a standard for manufacturing organizations (Welo & Næss, 2013).

Studies conducted at several GKN sites indicate that 70% of wastes in the manufacturing sites are in non-shop floor areas. The studies also indicate that implementing efficient business processes is a significant success factor for ensuring success at the site (GKN Aerospace, 2018). Research from the industry supports the argument that investing efforts into improving business processes has a positive impact on productivity and saving cost (Bakotic & Krnic, 2017).

Several employees at GAN have stated that inefficient business processes hinder them in meeting the expected progress in their daily tasks. In an attempt to address the expressed concerns, the company introduced a new approach to Business Process Improvement (BPI) in 2016. The BPI methodology aims to identify and remove waste in processes and improve performance. The methodology builds on the Plan-Do-Check-Act (PDCA) cycle and can be broken down into eight steps. Since 2016, the employees at GAN have completed less than ten BPIs.

The Continuous Improvement (CI) department initiated three BPIs in 2018 to determine the potential for improvement of GAN's business processes. The goal of these initiatives varied based on each process' objective, but a common goal for most BPIs is to improve the efficiency and effectiveness of the selected processes to better support production. The consequence of inefficient business processes is that the lead-time for simple tasks is so high that process stakeholders lose productivity and flow. When the performance of the business processes is low, they become bottlenecks for the value streams that they support. Several employees claim that an average improvement of 50% in the process efficiency is realistic if the process stakeholders invest time and effort in ensuring such change. This research aims to evaluate the GKN lean BPI methodology at GAN by answering five research questions:

RQ1: In general, how successful is the GKN BPI methodology in improving the efficiency of business processes?
RQ2: Do the workshop participants believe that it is worth investing their time in a BPI before attending, and what do they think after completing the BPI?
RQ3: What are the most common sources of waste that the BPI methodology identifies (based on GAN's definition of eight types of waste)?
RQ4: What is the expenditure, in general, to conduct a BPI?
RQ5: What are the success factors for completing a BPI workshop efficiently, and what are the pitfalls that may reduce the workshop's efficiency?

The GKN lean BPI methodology shares several similarities with other BPI methodologies that are available to the public. Therefore, this research aims to add value to other organizations that might consider adopting similar BPI methodologies to boost the efficiency and effectiveness of their business processes. The answers of RQ1 to RQ4 depends on several factors that are specific to each organization, while RQ5 aims to inform external readers about success factors and pitfalls that are worth considering before the implementation of BPI in an organization.

Literature

Recent changes in the economic environment such as globalization processes, economic crises, and customer demands that exceed the production capacity are creating pressure on companies and their performance (Bakotic & Krnic, 2017). To remain competitive, business processes require continuous

improvement to adapt to the changes since the lack of efforts aimed at improvement will provide competitors or new actors willing to enter the market a competitive advantage (Andersen, 2007).

Several definitions of the term "business process" are available. Hammer & Champy have proposed one of the most widely used definitions: "A business process is a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer" (Hammer & Champy, 1993). In many cases, the company performing the process is the customer of the process' outcome. In these cases, the business process adds value to the company and contributes to the customer of the company only indirectly. Business processes are instrumental to every company's performance and influence their capability to implement business strategies effectively. Business processes are also important to ensure the company's growth and development (Bakotic & Krnic, 2017).

Lean business process improvement is a structured approach for improving business process performance to generate more value with fewer resources and in a more cost-effective manner (Veyrat, 2015). The process stakeholders can achieve such improvements by eliminating waste within their processes and by enhancing functionality to make the processes more flexible and increase the quality of the process outcome. Bjørn Andersen, in his book "Business Process Improvement Toolbox," states that the performance level of business processes tend to decline over time if efforts are not made to improve them (Andersen, 2007). His research also indicates that in order to secure improvement and renewal, efforts beyond pure maintenance are essential. Figure 1, retrieved from his book, illustrates the effect time has on the performance level of processes based on the efforts made to improve them.

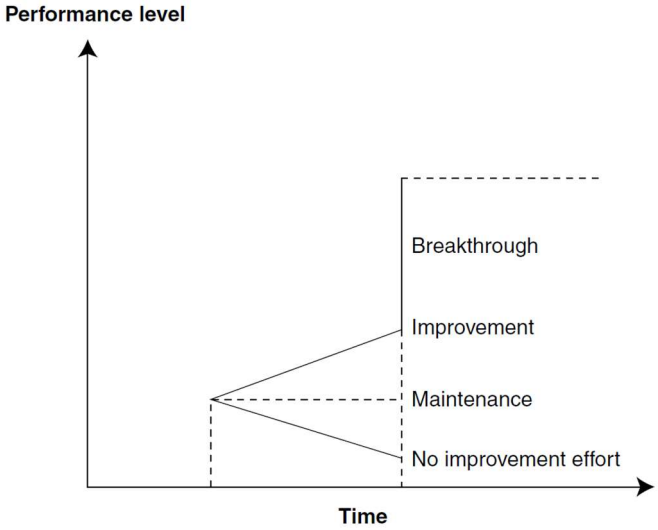


Figure 1. Performance over time based on improvement efforts (Andersen, 2007)

When the performance level of a process decreases over time, some employees adopt workarounds to circumvent their obstacles (Ventura Marttins & Zacarias, 2017). Researchers define these workarounds as "informal temporary practices for handling exceptions to a normal workflow" (Lund-Jensen, et al., 2016). Such temporary methods often turn into permanent workarounds to survive in everyday life with an increasing workload and outdated processes. In the end, this leads to lower process performance due to the process users' behavior and lack of improvement effort. Several researchers speculate on the reasons behind the low improvement efforts of process users. Some of the suspected reasons are lack of improvement culture, lack of resources, lack of leadership, and lack of knowledge or methodology (Radnor & Bucci, 2008) (Andersen, 2007).

With the daily production being the priority in most manufacturing organizations, there is often a limited amount of resources available for improvement initiatives (Andersen, 2007). Therefore, it is instrumental that the top management in organizations carefully considers where to invest their limited amount of improvement resources. With an in-depth understanding of the organization's strategy

and its position in the market, they are the most informed with respect to selecting processes that can strengthen the organization's position among competitors.

Several researchers have conducted studies to identify success factors for the implementation of continuous BPI in organizations. As a foundation, Dr. Zoe Radnor and Giovanni Bucci in their literature review of BPI methodologies identified that ensuring a company culture that focused on improvement, understanding customer needs, and the value within the organization are key to initiate BPIs. They also determined success factors such as strong leadership, visible support from the top management, effective communication strategies, appropriate training, development, providing resources and adequate time for improvements to occur, and using external expertise and support (Radnor & Bucci, 2008).

The GKN BPI Methodology

Currently, there exists a broad range of methodologies for lean improvement of business processes in companies. Furthermore, GKN has curated its own methodology. The GKN methodology builds on the PDCA cycle, developed in Japan. Using W. Edwards Deming's work with the Deming wheel as inspiration, the Japanese developed the PDCA cycle with the intention of applying it in problem-solving situations (Imai, 1986). The PDCA cycle is unceasing to enable continuous improvement. With a constant need to adapt to a changing market and new customer demands, GKN used the PDCA cycle as a basis and applied several pre-existing tools to create a structured approach to improve business processes. Figure 2 is an illustration of GKN BPI methodology.

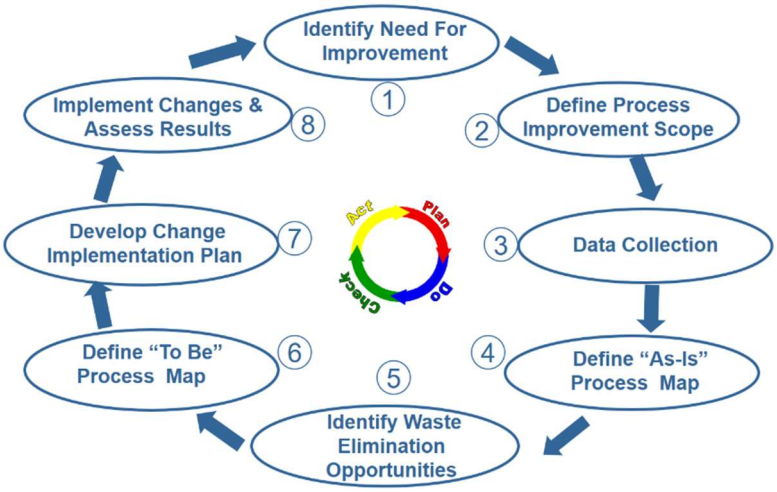


Figure 2. GKN's BPI methodology (GKN Aerospace, 2018)

The objective of each BPI may vary from process to process, but some of the most common goals are as follows:

- Improve efficiency to eliminate activities that do not add any value to the company or the customer.
- Enhance functionality to increase flexibility, eliminate Single Point of Failure, and ensure that each process delivers the desired output.
- Increase data quality to enable other initiatives or add value to the customer.
- Adapt processes to changing markets and customers' needs.
- Increase overall employee and customer satisfaction.

The steps of the methodology in Figure 2 are:

1. **Identify Need for Improvement**. The Continuous Improvement (CI) department, with input from the rest of the organization, will undertake this activity. The CI department will write

down all processes that require improvement on a list of potential BPI candidates. When the CI department or other employees with BPI training have the available capacity to conduct a BPI, a site steering committee (SSC) can use a Pugh matrix to select the process that will have the most significant impact on the site's business needs. If an SSC does not exist, the methodology recommends approval from a sponsor who can provide the human resources needed to conduct the BPI.

2. **Define Process Improvement Scope**. After the SSC has selected a process for improvement, the facilitator must fill out a scope document. The scope document defines the scope of the process, key performance indicators (KPIs) to measure changes, the improvement goals, the resources required, and the period for which the BPI needs the resources. After gaining approval of this document from the SSC, the facilitator can commence the BPI by inviting all participating stakeholders to a workshop where they reiterate the provisions of this document to ensure that there is common agreement on the scope and goals.

3. **Data Collection.** In this step, the participants collect historical data to define the current state of the KPIs that will later be used to measure improvement.

4. **Define "As-is" Process Map.** This step is important since it is instrumental to understand the current state of something that requires improvement. Here, the facilitator together with the participants creates a model of the current state of the process. In the GKN BPI methodology, four-field mapping is used. This is similar to a regular cross-functional flowchart (Andersen, 2007). A cross-functional flowchart is a business process-mapping tool used to articulate the steps and specify the stakeholders of a given process (Reynard, Sue, 1995). Discussions and disagreement among participants often occur during the "As-is mapping." These discussions are valuable, as each person might have made assumptions over the years that could affect how they perceive the process. If the group discovers any problems or issues with the process while making the map, the group should list these out.

5. **Identify Waste Elimination Opportunities.** After completing step 4, the group should complete the list of issues by analyzing the "As-is" map. After the list is complete, the group should analyze the identified problems with a 3C analysis. A 3C analysis is a practical problem-solving tool used to identify the root cause of waste and to determine the countermeasures that the group can adopt to remove the waste (Mann, 2005). The tool separates waste caused by the process and waste caused by the process users. Figure 3 is GAN's definition of waste types. After the analysis is complete, the group must select the problems that they want to address in the next step of the BPI.

Figure 3. GAN's eight categories of waste (GKN Aerospace, 2018)

6. **Define "To-be" Process Map.** This step aims to define the future state of the process using the same cross-functional flowchart template as in step 4. To define the future state, the group uses the problems that they have opted to address to ensure a future state with less waste and better quality.

7. **Develop Change Implementation Plan.** First, the group will create an action list to define the required measures to achieve the future state of the process. Subsequently, they should analyze these actions in a force field analysis. A force field analysis is a tool used to analyze forces that drive change and forces that resist change (Mind Tools content team, 2018). This analysis makes it easier for the BPI group to approach actions that are feasible to implement. Following this, the group must perform a cost/benefit analysis to determine if implementing the feasible actions is profitable. When all these documents are completed, the group must consolidate them into a report for the steering committee or sponsor to seek their approval for implementing the changes.

8. **Implement Changes & Assess Results.** Finally, the group should initiate development if required, implement changes, and track progress. To encourage performance, the group should celebrate meeting or exceeding its goals.

Research Methodology

Review of prior BPI attempts. We reviewed data from five old BPIs to gather an overview of GAN's experience with BPI. In addition, we used these data to evaluate how successful the previous attempts of BPI have been. In the cases were the facilitator of the old BPI was still employed by the company, structured interviews were done to gather data regarding the BPI. Out of the five old BPI's, three of them had facilitators who were still employed at the company.

Ongoing BPIs. To gain a holistic view of the company's approach to BPI, we collected data on ongoing BPIs using three different methods:

- By being a passive participant in one BPI to observe.
- By being the facilitator of a second BPI.
- By interviewing the participants of a third BPI. The project group of this BPI executed step 1-7 without interference from participants of this research.

By being a passive participant in a BPI, we observed the methodology and the participating stakeholders from the sidelines. We gathered data regarding the BPI methodology, facilitator, and participants during all the workshops required to complete the BPI. To gain a deeper insight of the methodology and the participating stakeholders' behavior, we acted as the facilitator of a BPI from the stage where the process users reported the need for improvement to the stage where a list of actions was prepared for implementation. A non-biased facilitator with no interference from this research executed the third BPI. Statistical data was retrieved from the three BPIs up to, and including, step 7 of the methodology.

Interviews. When the three BPIs passed the stage in the process were BPI participants had created a list of actions to implement (step 7), we interviewed all the participating stakeholders. We used a structured interview consisting of 18 questions to gather data from the participants. The first one-third of the questions was prepared with the aim of collecting objective data that we could use to identify trends. The second one-third of the questions sought to collect the participants' subjective opinion regarding the initiative and BPI methodology. The remaining questions collected statistics on the BPI results from the BPI facilitators.

Measures. We gathered and used the data to answer each research question in the following way:

RQ1: The percentage process efficiency improvement is calculated using statistics from the "As-is state" and the estimated data from the "To-be state" of each process. In old BPIs were the project group had already implemented the changes, the actual recorded improvement was used. The improved performance in this research is limited to improved *efficiency*. The KPIs used to measure efficiency in this research are *lead-time* and *workload*.

RQ2: We gathered data from the participating stakeholders through structured interviews using a Likert scale. To gain a deeper understanding of stakeholder satisfaction, we conducted a net promoter score (NPS) analysis. NPS is a tool used to measure customer experience (NPS, 2019) and is useful in measuring employee satisfaction with an initiative. *Promoters* ("Strongly agree" on the Likert scale) are loyal enthusiasts who will continue buying/using and refer others, thereby fueling growth. *Neutrals* ("Agree" on the Likert scale) are satisfied but unenthusiastic customers who are vulnerable to competitive offerings. *Detractors* ("Strongly disagree" to "Neutral" on the Likert scale) are unhappy customers who can damage the brand and impede growth through negative word-of-mouth reviews (NPS, 2019). Figure 4 is an illustration of the NPS score level.

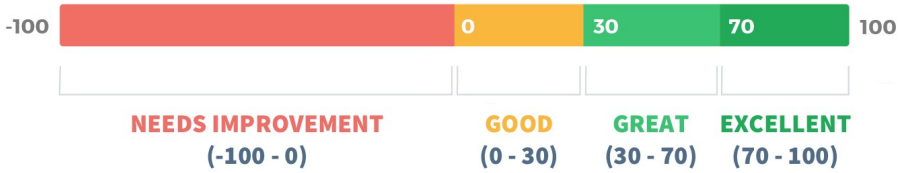


Figure 4. NPS score level (Grigore, 2018)

RQ3: We used structured interviews of the current BPI facilitators, and the three facilitators of the old BPIs, to list the types of waste that they identified and addressed in the BPIs. In the two cases were the facilitator had left GAN, We used the BPI documentation, made by the project group, to gather information regarding wastes identified and addressed in the BPIs.

RQ4: We used structured interviews of the BPI facilitators to gather data that enabled cost estimates of each BPI. We adopted the following formula to calculate the BPI cost, assuming P_{hc} = USD 85:

$$BPI\ Cost = P_a * W_a * W_l * P_{hc}$$

where:

P_a = Number of participants
W_a = Number of workshops
W_l = Length of each workshop (Hours)
P_{hc} = Average hourly cost per person per hour

RQ5: The BPI stakeholder's subjective opinions of success factors and pitfalls were collected using structured interviews. The authors grouped and counted the success factors and pitfalls as reported.

Limitations. This research has three limitations:

- The sample size of processes analyzed is small. Only eight BPI initiatives contained useful data for this research. 10-15 more BPIs would have helped to achieve near theoretical saturation in this research.
- Enough time was not available to define KPIs to measure *effectiveness* and calculate the improvement of quality after the BPIs.

- The limited time available for conducting the research excluded step 8 of the methodology from the three processes approached in this research. In the three cases where the implementation of actions (stage 8 of the methodology) was not completed, the project group estimated the KPI values of the future state based on the recorded values in the current state. The project groups estimated the improvements after completing step 7 of the methodology.

Case Study

After being the customers' preferred supplier, one of GAN's strategic goals is to be the Center of Excellence (COE) in the manufacturing of jet engine shafts within all GKN engine system sites. In addition to focusing on shafts, other products, such as low-pressure turbine casings, experience ramp ups within the Norwegian site. To meet the organization's strategic goals and satisfy customers with punctual and prompt delivery, the company frequently conducts improvement projects in production.

Improvement project in production. The first author of this research has been the project manager of one improvement project in production during the period of conducting this research. The goal of this project was to decrease the manual labor required for the deburring of several components in the product portfolio. To realize this goal, GAN must improve its in-house knowledge of deburring using computer numerical control (CNC) machines or robot cells. Furthermore, to enable the reuse of the knowledge gained, there is also in place a project for curating the best practice for deburring.

During their execution phase, improvement projects at GAN often meet resistance in the form of business processes with poor performance. In many cases, the business processes are not capable of handling the process users' requests within the deadline specified by the process users. This often leads to poor motivation among project participants. To boost motivation in the improvement project mentioned above, the project manager and the CI department manager offered to help the project participants to improve business processes that prevent them from achieving the progress they aim for.

At the beginning of the project, the project participants suggested improving the process used for the procurement of new tools and the process for registration of new tools in the enterprise resource planning (ERP) system. These processes significantly delay delivery and affect the schedules of the workers who use these processes. As a response to this request, this research initiated two BPIs with the goal of improving the efficiency of the processes and for gathering more information about the GKN BPI methodology. The first author was the facilitator of the BPI for registration of new tools and material in GAN's ERP system. The CI department manager was the facilitator of the BPI to improve the process for indirect procurement of tools and other resources. Both BPIs reached stage 8 in the BPI method, but none of them realized stage 8 within the period of this research. This was due to the long timeframes required for their implementation. Work intended towards realizing stage 8 is in progress even after the conclusion of this research.

During the execution of the BPIs, the scope was limited to the *improvement* of business processes since *breakthroughs* often require *Business Process Re-engineering* (BPR). While BPI relies on incremental changes to improve stable but inefficient processes, BPR is more comprehensive and often requires a redesign of the whole process. As most in company processes are rigid but stable, it does not seem reasonable to start with BPR.

Review of previous BPI attempts. In addition to the three BPIs initiated by this research, we reviewed previous and current attempts at initiating BPI at GAN. The goal of the review is to improve the quality of the data used to answer the research questions. We identified 11 BPIs (including the three BPIs in this research) that GAN has undertaken since the introduction of BPI in 2016. The status on the BPIs at the time of this research is as follows:

- Four are completed. The results of these BPIs are included in this research.

- Four have completed step 7 of the methodology but will complete step 8 soon. This research initiated three of these BPIs. The estimated results of these BPIs and the data gathered through the interviews are included in this research.
- Two are ongoing but with little progress. Performance data on these BPIs are not included in this research. Data collected through structured interviews are included in this research.
- The project group abandoned one BPI before completion. Data on this BPI is not included in this research.

Research Findings

This section seeks to answer the five research questions presented in the introduction. We drew the results from the raw data of 20 structured interviews of BPI participants and facilitators.

RQ1: Successfulness of the method. The data collected from the ongoing and completed BPIs at GAN indicate that there have been efficiency improvements in all BPIs who aimed to improve the efficiency. One BPI did not aim for improved *efficiency*, as quality (*effectiveness*) was the only concern. All BPIs who aimed to improve the efficiency have improved between 33% and 77%. Four out of eight have shown an improvement of more than 50%. The KPIs used to measure efficiency in this research are *workload* and *lead-time* of the business process execution. All improvements greater than 50% are improvements related to *lead-time*, while improvements less than 46% relates to *workload*. Figure 5 illustrates the "As-is state," the "To-be state," and the improvement in percentage of each process reviewed in this research.

RQ2: Stakeholder' satisfaction. In Figure 6, data collected from 20 BPI participants through structured interviews illustrates the stakeholder satisfaction for the BPI initiatives. We asked the participants, before and after the BPI, to state the extent to which they agreed with the following statement: "I feel/felt that it was worth investing my time in this initiative." Figure 6 also contains the NPS score before and after the initiative.

RQ3: Wastes identified. Figure 7 shows data collected through structured interviews of the BPI facilitators of eight BPIs. The plot illustrates the types of waste the BPI project groups identified and the types of waste they addressed after identification. As can be observed from Figure 7, d*efects* and w*aiting* are the most common types of waste identified at GAN, although all types of waste are quite common.

RQ4: BPI Cost. We collected BPI expenditure data through structured interviews with the BPI facilitators and calculated the average cost, the lowest recorded cost, and the highest recorded cost of conducting a BPI at GAN. Table 1 shows the recorded values for each category.

Table 1: RQ4 Results: BPI Cost

Highest cost of a BPI	$ 15 300
Lowest cost of a BPI	$ 4 590
Average cost of BPI	$ 9 903

The realization of step 8 in the GKN BPI methodology is not included in the cost since this stage falls outside the scope of this research. The average hourly cost per person at GAN was set to USD 85 in this estimate.

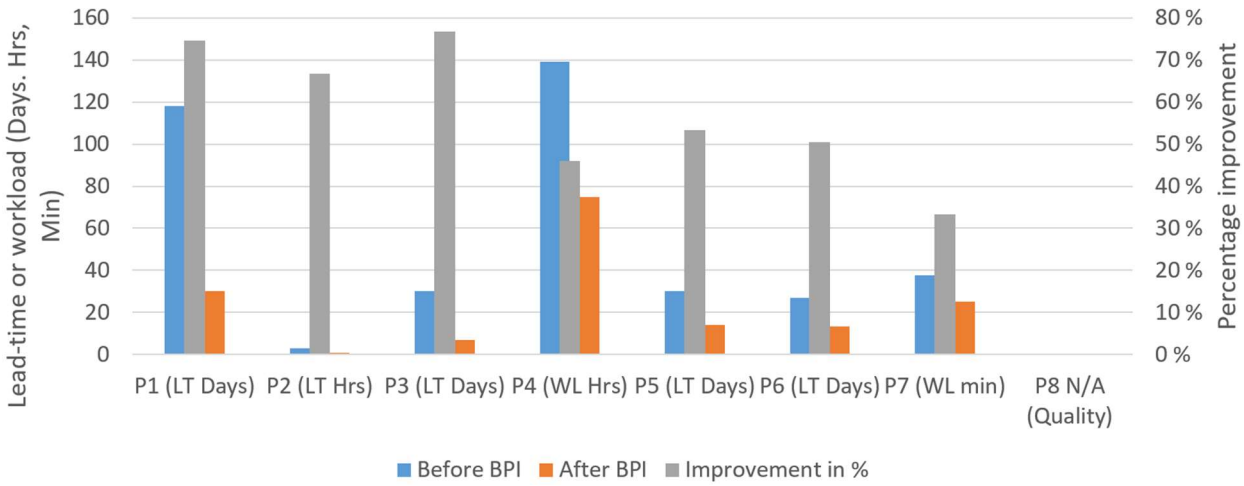
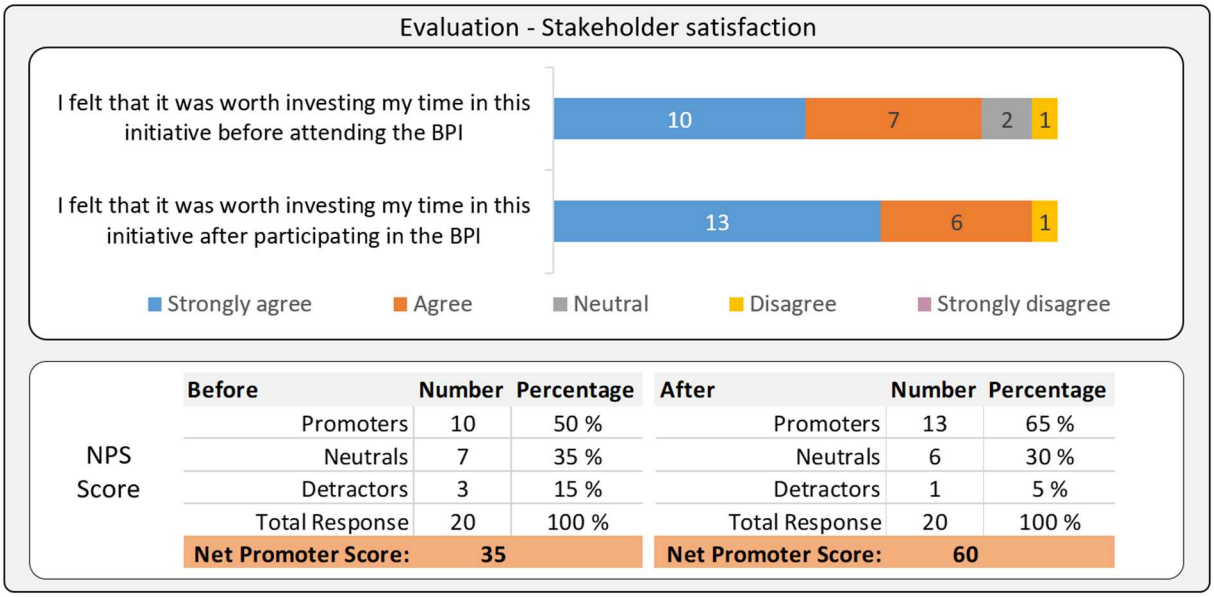


Figure 5. RQ1 Results: Effectiveness of the method



NPS Score	Before	Number	Percentage	After	Number	Percentage
	Promoters	10	50 %	Promoters	13	65 %
	Neutrals	7	35 %	Neutrals	6	30 %
	Detractors	3	15 %	Detractors	1	5 %
	Total Response	20	100 %	Total Response	20	100 %
	Net Promoter Score:	**35**		**Net Promoter Score:**	**60**	

Figure 6. RQ2 Results: Stakeholders' satisfaction

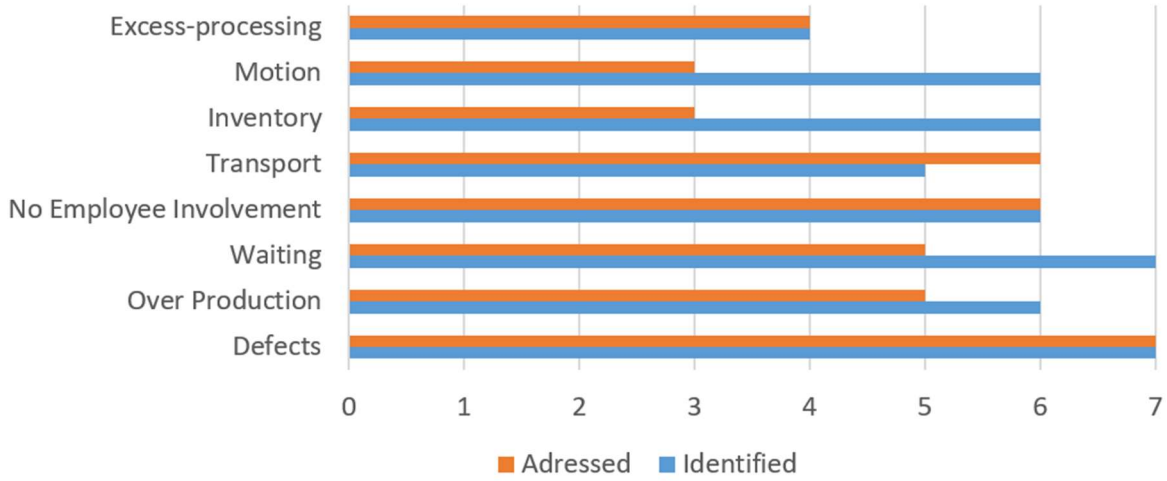


Figure 7. RQ3 Results: Wastes identified

RQ5: Success factors and pitfalls.
We used structured interviews of 20 employees who had participated in, or led, a BPI at GAN since 2016 to gather their subjective opinions regarding success factors and pitfalls in conducting a BPI. Figure 8 and Figure 9 show all the success factors and pitfalls that the interview subjects reported twice or more.

Success factor	Times reported
A structured and trained facilitator that keeps people focused and keeps discussions on topic	10
That all stakeholders are identified and are present in the workshops where they are needed	10
A clear agenda with goals for each workshop	5
That the participating stakeholders prioritize the initiative	5
That the stakeholders are positive to change	5
Prepared BPI participants (requires information from the facilitator in good time before the workshop)	5
Continuous evaluation/validation of the solution feasibility	4
Work on the problem often enough (at least one time per week)	3
That a sponsor approves and supports the initiative. (That the BPI participants have a mandate to make changes)	2
That there are not too many people in the workshops	2

Figure 8. RQ5 Results: Success factors

Pitfall	Times reported
That stakeholders are not present in workshops/ does not prioritize the initiative	5
That the participants or the facilitator are not prepared for workshops	4
That stakeholders or needs are not identified	4
Jump to a solution before the required time is used to understand the problem	3
No common agreement. Conflicting opinions	3
That participants does not see the need for change. Lack of improvement culture	2
Unrealistic scope	2
No sponsor	2
Fear of change	2
Poor leadership and weak management engagement	2
That there is no clear agenda for the meetings	2
That there is no visible progress after one or more meetings	2

Figure 9. RQ5 Results: Pitfalls

Discussion

This section is divided into five sub-sections. The five sections elaborate on the five research questions of this research. Additionally, information about the trustworthiness or limitations of the results has also been included.

RQ1: Effectiveness of the method. Based on the results of this research, the GKN BPI methodology has been successful at reducing waste and improving the *efficiency* of the reviewed business processes. The average improvement of the processes analyzed in this research was more than 50%, but some processes have experienced an improvement of more than 70%. One interesting observation from the results of RQ1 is that the BPI groups were only able to improve the *lead-time* of the processes with more than 50%. The BPI groups were not able to improve the workload more than 46%.

It is worth noting that improvements beyond *lead-time* and *workload*, which are the KPIs employed in this research, are realistic. They might even be the desired improvement for the organization. E.g., in one of the BPIs conducted at GAN, removing *defects* (from the eight wastes) was the only goal. Improving the flexibility, robustness, data quality, and so on can give good payoff, and even be necessary to stay compliant with the customer requirements. In other cases, improved data quality can

be a required enabler for other projects. However, it can be difficult to measure the actual savings from such improvements.

In more than half of the processes analyzed in this research, the BPIs realized improvements in the *effectiveness* of the process. The primary reason for the improved *effectiveness* was digitalization of initially manual documentation. This, however, is outside the scope of this research.

Since realization of step 8 of the methodology was not feasible for all BPIs within the given time for this research, the project groups estimated the *efficiency* improvement in four out of the eight processes (P1, P2, P3, and P6). The BPI groups aims to realize the performance improvements by automating manual tasks, or removing them completely. Therefore, the estimated improvement should be comparable to the actual realized improvement after the completion of step 8, since the value is easy to calculate based on the recorded values during the "as-is" mapping of the current process.

RQ2: Stakeholders' satisfaction. Without elaborating extensively on RQ5, we observe that stakeholder satisfaction is undoubtedly instrumental to succeed with new initiatives in the end. Our general impression of GAN employees, especially those who have worked there for several years, is that they are not positive to invest time in improvement initiatives. Therefore, it was surprising to note that the NPS score presented in the previous sections was positive both before and after executing the BPIs. The score scale in Figure 4 considers both scores as "great." The last score, however, is close to the "excellent" range of the scale. We expected the increased NPS score after the execution of the first BPI.

In the past, we made several observations regarding employees showing a general fear of investing energy unnecessarily on new initiatives. Some people, especially employees involved in production, can get frustrated because they were not necessarily involved in the improvement initiative and therefore do not feel ownership of the new process. Other factors can be language (production workers may not be completely comfortable with using English), social status, attitude, and the fact that many initiatives fail or die out. We observed a difference in this behavior and engagement during informal settings, such as upon meeting over a coffee in the office or in production to discuss process improvements casually. Therefore, when initiating the BPIs carried out in this research, the facilitator did not present the BPI as "another new lean initiative from the top management." The facilitator rather tried to introduce the initiative as a series of meetings to informally discuss and understand the causes of the problems and suggest ways to eliminate such problems. The facilitator, as expected, used the BPI methodology but did not impose theoretical information regarding the methodology on the participants. This approach might have contributed to the positive responses to RQ2.

However, when conducting a BPI with employees who are familiar and comfortable with lean but lack the tools to implement them, the facilitator should extended the methodology itself to incorporate a bigger focus to enable reuse of the method at a later stage.

RQ3: Wastes identified. Prior to this research, we expected *waiting* to be the most common source of waste. This is because several business processes at GAN have a lead-time of several days and in some cases weeks to solve tasks for which the actual time required ("touch time") are only a few hours. Bjørn Andersen stated in his book that processes that are undertaken across several departments often have poor performance as each department predominantly focuses on their own priorities and responsibilities because these activities are the most probable to satisfy their superiors. Research has shown that it is fair to assume that each department boundary crossing adds one week of lead-time to a process because the activity often reaches in a new priority que for each boundary passing (Andersen, 2007). These claims correspond with observations made by us and should be considered when designing a new process.

We did not expect that the BPI groups would identify *defects* as often as *waiting*. The number of responses citing *defects* might seem distressing in the aerospace industry, but *defects* as a waste in

processes should not affect the quality of the components manufactured by the organization. Examples of *defects* in processes are extra labor to check work, missed deadlines, poor communication, and insufficient training.

One interesting result of this research is that even though the BPI groups identified *inventory* and *motion* in six out of the eight BPIs, they only addressed these wastes in three out of the six. Through structured interviews, the BPIs revealed that in some cases, possessing a large inventory of tools was less expensive than having a downtime in production due to the lack of tools. The BPI groups quantified this tradeoff, and it depends on the tool cost vs the cost of downtime in each case. They also explained that to remove *motion* in some of the cases, a large investment in new digital tools is necessary. In a time where GAN is trying to standardize systems with other GKN sites, the BPI groups recommended alignment with other initiatives across other GKN sites at a higher level in the organization.

RQ4: BPI Cost. The costs of conducting BPIs at GAN vary between BPIs based on the number of participants and workshops the project group has to hold to address the problems causing waste. Large groups and several workshop meetings are more expensive but in some cases necessary to ensure the new process meet all the stakeholder needs. From Figure 9. RQ5 Results: Pitfalls, we can see that "stakeholders not present" is the most critical pitfall identified when conducting a BPI.

One limitation of the cost estimate in this research is that we used the same average hourly cost per person per hour. This is due to the lack of access to the data required to make estimates that are more realistic. It is reasonable to assume that BPIs with participants from the top management are more expensive than BPIs with workers from production since managers tend to have a higher salary. Future research should consider if the cost estimates should reflect a more realistic cost estimate based on the participant role.

RQ5: Success factors and pitfalls. During the structured interviews of this research, the success factors that the BPI facilitators and participants answered most frequently were "A structured and trained facilitator who keeps people focused and keeps discussions on topic" and "That all stakeholders are identified and are present in the workshops when they are needed." This corresponds with our observations during this research. Another observation is that it is important to set a clear agenda with a goal for each workshop. Otherwise, the workshop discussions have a tendency to diverge.

One success factor that only two interview subjects reported but that We expects to be significant to succeed with BPI initiatives in the future is "That a sponsor approves and supports the initiative. (That the BPI participants have a mandate to make changes)." We observed several initiatives and projects (other than BPI) being abandoned due to the lack of management buy-in prior to the commencement of the project. However, it does not help that the top management prioritizes the initiative if the BPI participants themselves do not give precedence to the initiative. The two most reported pitfalls relate to the lack of priority from the participants of the BPI. This corresponds with our observations during the BPIs carried out in this research. If the parties meet late, unprepared, or not at all, then these factors could reduce the workshop's efficiency significantly.

One pitfall that the interview subjects did not answer when being asked to list pitfalls during the interviews, is the lack of information sharing and cooperation between ongoing BPIs. We observed this to be a plausible pitfall, as ongoing BPIs could affect each other and cause critical changes that the other group must consider.

Conclusion

The purpose of this research was to evaluate the successfulness of the GKN lean BPI methodology in improving business processes at GAN. Additionally, we studied stakeholder satisfaction, cost of conducting a BPI, wastes identified, and pitfalls/success factors for the methodology.

- Out of the eight BPIs analyzed in this research, seven of them improved the process *efficiency* between 33% and 77%, and one improved only the process *effectiveness*. The KPIs used to measure the *efficiency* are *lead-time* and *workload*. All *lead-time* improvements were more than 50%, while the improvements in *workload* were less than 46%. We observed improvement in terms of *effectiveness* in more than half of the BPIs. However, KPIs to measure improved effectiveness was outside the scope of this research.

- The BPI participants were asked to rate their satisfaction with the initiative, both before and after the initiative was implemented. The general feedback was positive. The NPS scores were +35 before participating in the BPI and +60 after participating in a BPI. The NPS scale considers both results as "great." The last score, however, is close to scoring "excellent."

- *Defects* and *Waiting* are the most identified types of waste. However, the BPIs observed all the other types of waste quite frequently.

- The average recorded cost of conducting a BPI during this research was $9 903. The BPI with the highest cost was $15 300. More workshops and participants drive cost.

- Two success factors dominated the feedback from the BPI stakeholders "A structured and trained facilitator who keeps people focused and keeps discussions on topic" and "That all stakeholders are identified and are present in the workshops where they are needed." The most recorded pitfall was "That stakeholders are not present in workshops/do not prioritize the initiative." Feedback from the facilitator of one ongoing BPI also indicates that management buy-in prior to project start is critical to the success of the BPI.

The results in this research clearly indicate that the GKN lean BPI methodology has been successful in improving business processes at GAN. Additionally, the participating stakeholders are satisfied with the initiative. However, some stakeholders indicate that the implementation of sub goals for each workshop and better preparation by the facilitator prior to each workshop can further improve the effectiveness of the improvement initiatives utilizing the lean BPI methodology.

The RQ5 results list several success factors and pitfalls that have shown to affect the performance of the BPI implementation and execution. This research recommends other companies that are considering the implementation of BPI to foster a conscious relationship with these factors. By ensuring this, the payback rate of the efforts and resources invested in BPI initiatives are more likely to increase and the likelihood of project failure will decrease.

Recommendations for Future Research

During this research, we observed significant improvements in the *effectiveness* of some of the processes improved in the BPIs carried out. Unfortunately, these improvements fell outside the scope of this research. We suggest that future research conducted on BPI include the use of KPIs for *effectiveness*.

To better align ongoing initiatives and plan future activities according to an organizational strategy, future research should consider the implementation of a BPI roadmap. The GKN lean BPI methodology evaluated in this research suggests the use of a roadmap. However, the implementation of such a roadmap has not been a priority in the initial stages of the implementation of BPI at GAN.

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Biography

Niclas Måren received his BSc in Cybernetics and Mechatronics from the University of South-Eastern Norway in 2016 and his MSc in Systems Engineering from the same university in 2019. He worked in GKN Aerospace Norway as a systems engineer and project manager during the research period. Måren is currently working at Tomra Systems AS in Norway. This paper is the result of the research done for his Master's degree in Systems Engineering.

Gerrit Muller, originally from the Netherlands, received his master's degree in physics from the University of Amsterdam in 1979. He worked from 1980 until 1997 at Philips Medical Systems as a system architect, followed by two years at ASML as manager systems engineering, returning to Philips (Research) in 1999. Since 2003, he has worked as a senior research fellow at the Embedded Systems Institute in Eindhoven, focusing on developing system architecture methods and the education of new system architects, receiving his doctorate in 2004. In January 2008, he became a full professor of systems engineering at University of South-Eastern Norway in Kongsberg, Norway. He continues to work as a senior research fellow at the Embedded Systems Innovations by TNO in Eindhoven in a part-time position. Since 2020, he is INCOSE fellow.

Elisabet Syverud, received her MSc in Aerospace Engineering from the University of Kansas, US, and her Dr.Ing in Thermal Energy from the Norwegian University of Science and Technology in Trondheim, Norway. She started her industrial career in 1993, and has worked in multiple roles in the oil&gas and defense industries for almost 20 years. Since 2019, she is Associate Professor of Systems Engineering at University of South-Eastern Norway in Kongsberg, Norway.