A benefit costing process for Lean Six Sigma programs

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Abstract

Purpose – This study aimed to bridge the gap between the financial measurement of process improvement ideas and Lean Six Sigma measurements. It was required to increase employee engagement in process improvement initiatives.

Design/methodology/approach – Through both a practical and theoretical application of the Design for Lean Six Sigma methodology, the researcher was able to design a process and a benefit measuring methodology that was acceptable by finance and aligns with the benefits expected from the elimination of the Lean wastes.

Findings – The project found that benefit measurement methodology is not understood by most employees, which leads to a lack of engagement in working on improvements. The result of the study was a model for employees to identify and quantify these benefits. This has resulted in a model for cost-benefit analysis aligning financial costs with non-value add waste costs and cost of poor-quality costs resulting in increased process improvement ideas and activity.

Research limitations/implications – While this study was limited to one company, applying this methodology could benefit any company experiencing the same difficulties.

Originality/value – This is one of the first studies to try and cost the benefits of LSS projects both from an organisational and generic viewpoint.

Keywords Lean Six Sigma, DMADV, Finance, DFLSS

Paper type Case study

1. Introduction

Traditional accounting concepts and techniques need to change to enable people in business to access relevant information more easily (Dai, 2022). The roles performed by accountants are dynamically changing in small and medium enterprises (SMEs) and large enterprises (Oyewo, 2021). Moreover, traditional management accounting (TMA) systems cannot provide information on managing the manufacturing processes (Oyewo, 2021). Companies which operate in a highly competitive environment tend to undergo reorganisation and redesign processes to survive in the market. This is often carried out by embracing the principles of Lean Six Sigma (LSS) (Fullerton *et al.*, 2014). The most successful companies have embraced the principles of LSS and understand the impact of changes on the bottom line

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of manufacturing. Performing the cost/benefit analysis is highly important even though an alignment with finance and process improvements is not simple to quantify (Neuscheler-Fritsch and Norris, 2001). With finances' alignment and a clear financial method used to calculate benefits, company employees are more likely to participate in these initiatives and make an LSS program successful (Richey *et al.*, 2011). The purpose of embracing LSS is to deliver improvements and efficiencies for a business through lower costs, higher product quality and shorter lead times (Aaver and Simon, 2009). Capturing financial benefits that arise from using LSS methodologies will require changes in how accountants are involved in projects and how benefits are measured (Neuscheler-Fritsch and Norris, 2001). Many providers of financial services are primarily focused on hard numbers, often losing sight of what is important to the customer. However, profitability increases when employees use data to increase revenues, reduce expenses or both (Turban and Volonino, 2010).

Adopting a successful Lean manufacturing strategy in the business strongly depends on establishing a unified and coherent system that will provide high customer value. This unified and coherent system comes from employees working together and knowing they are making a difference with the LSS process improvements they implement (Sopko and Demaria, 2013). To quantify the benefits that can be achieved from implementing an improvement, the support of the finance team is essential at the Define phase of a continuous improvement project. The Lean Define phase is required to scope the idea properly and to estimate the impact of benefits that could be delivered during the following Lean phases. To achieve this, there is a need for a clear guideline/roadmap that can be followed that is aligned with the project objectives and supported by validated financial calculations (Sopko and Demaria, 2013). The accountant must apply business knowledge and new thinking methods to support people with this cost/benefit calculation. This is a new way of thinking, and the organisation's accountant is best positioned to provide the positive influence needed to implement these changes using such assumptions (Kapanowski, 2017). Despite the evidence that traditional accounting has many disadvantages and that concepts like lean accounting can help, many companies and their employees need help calculating the cost/benefit of their improvement ideas.

This research is focused on finding a solution that aligns both LSS concepts for value creation improvement ideas with financial data. The providers of financial services have been slow to adopt LSS principles that are the drivers behind lower operational costs, improved quality and efficiency (Delgado *et al.*, 2010). Few papers have explored the complexity of cost and data measurement systems (Efatmaneshnik and Ryan, 2016; Ruiz-Hernández *et al.*, 2021).

The objectives of this research are to:

(1) utilise DFLSS DMADV methodology that can be used to provide a guideline/roadmap for cost/benefit calculations required for any process improvement in a Manufacturing company **(RO1)** and

(2) design a training program to ensure consistent implementation of these guidelines for all future process improvements (**RO2**).

The literature review is outlined in Section 2, the methodology in Section 3 and the results, discussion and conclusion are outlined in Sections 4, 5 and 6, respectively.

2. Literature review

Traditionally, the expectation was that the management accountant provided the information on decision-makers to base their decisions, but the move is now for management accountants to be an integral part of the strategic decision-making process (Aaver and Simon, 2009). This is further supported by the thinking that the accountant's role

needs to move away from the stereotypical role of the "bean counter" to acting in an advisory capacity that is integral to decision-making in companies (El-Sayed and El Aziz Youssef, 2015). This will require re-evaluating the accountants' role to provide clear guidelines/roadmap on quantifying the benefits of LSS process improvement ideas to assist people in calculating the cost/benefit of potential improvement ideas.

Traditional accounting systems that must be followed to comply with accounting regulations favour methods like standard costing or full absorption (Fullerton and Wempe, 2009). These costing methods promote production in large batch sizes and see Inventory on the balance sheet as an asset, ideas not aligned with LSS methodologies (Chopra and Meindl, 2013). Some alternative financial approaches (volume-based costing, activity-based costing [ABC] and time-driven ABC), which are more consistent with LSS thinking, have been previously integrated (Wemmerlöv, 2020). However, the alternative methods must be further improved for broad application in the industrial sector. Costs calculated under traditional accounting regulations methods can be misleading and result in incorrect decisions (Gupta and Galloway, 2003).

Moreover, TMA methods have been criticised for being too rigid in their implementation, too internally focused, not aligned with business goals and incapable of producing performance measures that apply to the business (Oyewo, 2021). The previous research underlined that many standard cost accounting principles no longer make sense due to their reliance on efficiency and machine utilisation, which can lead to long run times and high inventory levels, which in Lean terms is the waste of overproduction (Kroll, 2004). In addition, the financial measures must be aligned with the behaviours of managers and leadership to implement LSS improvements successfully (Lambert and Enz, 2015).

Pulakanam (2012), in his study on the costs and savings of Six Sigma projects, highlighted the difficulty of linking direct costs and savings from implementing quality management programs and the lack of study in these areas. The main finding from his research of 28 organisations and their financially published reports was that implementing Six Sigma led to average savings of 1.7% of revenues throughout implementation with an average return on investment of more than $2 direct savings for every dollar invested in Six Sigma. Duque and Rivera (2007) also discussed how difficult it is to value and quantify the real economic impact of a Lean implementation. They proposed a methodology decision tree to quantify if a change in a procedure or action brought about by implementing a Lean technique will have a measurable economic impact. The quantification of process improvement savings can be difficult without a recognised methodology or framework to point to, and it can be difficult to measure transactional efficiencies (Anthony, 2014). Some organisations have utilised simulation modelling to build a design or product, thus trying to quantity a cost-benefit (CBA) analysis based on the proposal (Ryu and Fan, 2023). However, simulation is impractical on a daily or month-to-month phased continuous improvement initiative and can rely on many assumptions built into the costing model. Many projects rely on a proposed cost-benefit analysis upfront, and these proposed cost benefits may not always be realised or may be exceeded. As a result, unanticipated cost benefits arise, and "soft" cost savings should be built into the CI benefits, but excessive focus on CI cost benefits can "drown the objectives" (Nollet *et al.*, 2016).

Mader (2018) discussed the importance of "soft savings" in an LSS program. He stated that while hard savings can get realised over time and it is normal for savings over time per project to reduce, this means a program is effective and not ineffective as often thought and opened up the opportunity for chasing soft savings. However, despite the difficulties cited in quantifying LSS savings in the literature, many studies have demonstrated savings from CI, but how "complete" and "holistic" these overall savings are not easily quantified.

3. Methodology

3.1 Background to the case study

This case study research is carried out in a manufacturing company employing close to 380 people and considered a large enterprise as it employs more than 250 people (Enterprise Ireland, 2023). The company is one of many suppliers for a large multinational company. As with many multinational companies, key performance indicator goals are set annually for their suppliers, and these goals must be delivered to maintain competitiveness. One such goal set annually is achieving a certain % productivity based on the total controllable costs of the site. However, not everyone in the organisation could understand how productivity is measured. The company originally used an excel spreadsheet with heading to record different improvement initiatives. Personnel were not aware of how to calculate savings leading to slow put forward ideas by remaining disconnected with the measurement and data collection. At a later stage, the company advanced from excel spreadsheets to ASANA tool for a better track of projects and ideas. Users of ASANA required an additional training on how to perform the calculations. However, the ASANA panel was not user friendly, making it difficult for personnel to calculate actual savings delivered to the financial bottom line, overheads, headcount, reduced downtime, materials-related expenses, etc. The company management expected personnel to lead, but people struggled to perform simple calculations of cost and benefits. The results of an internal survey identified that the main reason for this struggle was a lack of clear guidelines on how to translate the improvements into benefits, along with a lack of clarity around what improvements can be classified as productivity savings. Another reason was linked by the company employees to the lack of clarity during completion of projects on which part of methodology was not delivering productivity. This reduced their motivation to be involved in the improvement process, leading to challenges in achieving the productivity target. The novel methodology from the process flow to the finalised benefit measurement using LSS tools could enable personnel to calculate the benefits from their improvement ideas. New competency-based measures will be introduced using LSS methodology to ensure personnel is fully trained and supported.

3.2 Design for Lean Six Sigma

The methodology chosen for this research is Design for Lean Six Sigma (DFLSS) and its structured Define, Measure, Analyse, Design and Verify (DMADV) methodology because the problem requires a design of a new roadmap/guidelines process and not an improvement to an existing one (Keene *et al.*, 2007). Within the company, LSS is being embraced as the strategy for operational efficiency to impact meeting the annual productivity key performance indicator (KPI). Once designed, finance will validate the guideline/roadmap to ensure compliance with accounting guidelines so that DMADV will be used. The tools selected for each phase of the DMADV are shown schematically in Figure 1.

A quantitative survey will also be used to ascertain the levels of knowledge of productivity and cost measurements within the company.

3.3 Define

The Define phase is required to ensure a clear understanding of the problem and a measurement system capable of measuring and comparing projects of various types, including the benefits (Ray *et al.*, 2013). The goal of any business is to improve the bottom line. For improvements to be effective, the benefits obtained must be higher than the invested capital (Ray *et al.*, 2013; Aaver and Simon, 2009). The selection of the Project Charter as a tool ensures that the overall project is clearly defined along with the scope, timeline and deliverables. A risk of this tool is that it may be seen as overly complicated in the project. The Suppliers, Inputs, Processes, Outputs and Customers (SIPOC) are selected as a tool to ensure

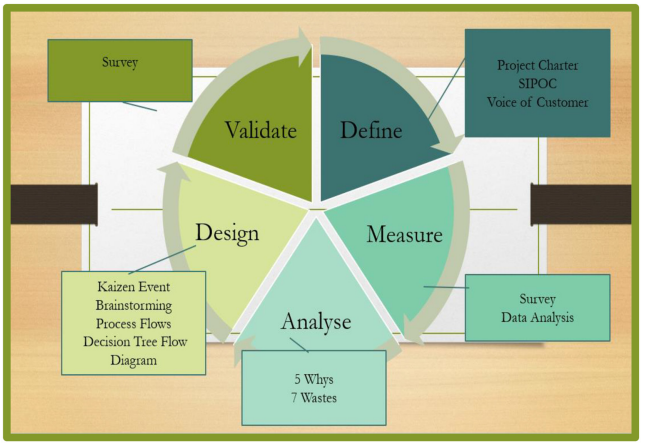

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Figure 1.
Tools chosen for each phase of DMADV

the team considers all possible inputs into the research. This tool helps clarify the process's starting and end points, but it may not be easy to develop when it is unclear. The Voice of the Customer (VOC) tool will bring clarity to the business requirements from the guidelines/roadmap, but it can be of limited benefit as not all views can be obtained, and it is not possible to consider all possible cost/benefit potential.

3.4 Measure

To gain knowledge on calculating cost/benefits, a quantitative survey will assess the gap between how employees measure benefits and how traditional accounting principles measure them. The participants for this survey will represent employees from all departments in the company and will represent people involved in process improvements and some that are not. The questions posed to the participants are shown below in Table 1. The survey was circulated to 160 people, with 40 responses, representing a 25% response rate. According to Easterby-Smith *et al.* (2012), a response rate of above 20% is valid.

3.5 Analyse

The outcome of the questionnaire is expected to confirm the level of awareness in different cost savings categories. The 5 Why's analysis is the tool that will be used to identify a problem's root cause to ensure the successful design of the project guideline/roadmap.

Another tool used in the Analysis phase is the 7 Wastes analysis or non-value add analysis to evaluate participants' confidence in calculating benefits from different categories of process improvement. The team will identify waste from any manufacturing activity that

1. Do you understand the term productivity as it is used in this company? Yes/no, please elaborate
2. How aware are you of this company's different categories of cost savings? Yes/no, please elaborate
3 How confident are you in calculating benefits for process improvements? Liker Scale
4. "Waste" from a lean perspective means any non-value adding activity (NVA) – Can you name the types of waste from a lean perspective? Please list
5. How confident would you be in calculating a benefit for each type of improvement listed? Liker Scale
6. Would you expect your measure of the benefit and productivity measure to match or correlate? Yes/No. Please elaborate

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Table 1.
Questions that will form the survey

absorbs resources but creates no value (Chauhan and Singh, 2012). Benefits can result from many different types of improvements, and it will be necessary for the guideline/roadmap to enable the correct calculation of benefits from many different improvement types. The improvements could result in less human effort, less Inventory, less time to develop products, and less space to produce quality products most efficiently and economically (Motwani, 2003).

3.6 Design

To design the new process, there is a need for cross-functional involvement. Accountants must support Kaizen activities and the decision-making process to succeed in a Lean improvement (Cunningham and Fiume, 2017). Kaizen events have been previously used to optimise financial processes (Delgado *et al.*, 2010). Key resources are leveraged, and a Lean expert will be used to lead the events (Awad and Shanshal, 2017). During Kaizen events, other tools like brainstorming and process mapping are used concurrently. Although process mapping is often considered a tool for the Define phase, it can facilitate communication and transparency when working on business process improvement ideas (Bowles and Gardiner, 2018). The Kaizen event will aim to design the optimal guidelines/roadmap for leaders to follow when calculating the cost/benefit of any potential process improvement idea. The Design phase will be based on results from the 5 Whys and the 7 Wastes applications in the Analyse phase.

The process map includes steps from the start to the end of the process, which are further used in the cost/benefit analysis. For example, what are the different calculations which depend on the various types of initiatives? Given the complexity of businesses and the variety of LSS process improvements that people propose to initiate, the roadmap is unlikely to be the same for all improvement ideas. As a result, a decision tree flow chart will be established to point to different options for costing the suggested improvements. These decision tree flow charts will be created using a software package, and different branches of the tree will be followed depending on the type of improvement.

3.7 Verify

The financial flow analysis using DMADV methodology must be next validated to evaluate how the project objectives from the Define Phase were met. This will be done by sharing the guideline/roadmap with the same individuals who participated in the Measure phase's initial survey. The individuals will be first trained according to the new guidelines/roadmap and later be asked to apply the guidelines/roadmap to various improvement projects. Finally, they will be asked to answer the survey questions discussed in the Measure phase. The expected outcome of this survey can provide clarity around the newly designed process, including a level of awareness in the different improvement type process categories and cost savings in the company. A survey will also provide an estimate of the confidence with respect to calculated benefits from the different categories within the LSS methodology. The guidelines will then be shared with relevant employees responsible for identifying process improvements through a training program.

4. Results and findings

4.1 Define

The Define stage focused on gaining acceptance from management that a problem existed in the business and defining the problem. The researcher undertook to hold a focus group meeting for the establishment of the VOC. A focus group was created to discuss the Problem Statement to find agreement on the project objectives.

The problem statement was simplified as "*no defined process or knowledge for costing LSS project improvement actions*." The project charter was framed in the VOC to ensure that senior management understood the problem statement and project scope clearly. The milestones that would need to be met throughout the project were defined in relation to assumptions, risks, dependencies, benefits, justification and resources.

As part of the ***Define*** phase, a SIPOC diagram was prepared. Figure 2 illustrates the SIPOC diagram to identify the input parameters into the process, the suppliers who provide the inputs along with the process outputs and the customers who receive the outputs. SIPOC is a simple tool that helps to map a process from start to end (Carey and Stroud, 2013). The finance managers and project leaders re-confirmed from this exercise that there was no clear process in place in the enterprise.

The result of the SIPOC analysis showed that the suppliers in the process were employees and various departments within the company because they provided the required inputs for process improvements. The process itself can be defined in 4 steps, and the outputs of the process could align benefits and approved ideas. SIPOC analysis was further used to evaluate the overall benefit measurement methodology.

4.2 Measure

During the ***Measure*** phase, information was gathered to understand the current state of the benefit measuring process. This information was gathered from surveys sent out to assess how well people understood the measured benefits of using LSS concepts and the benefits of traditional accounting principles.

The survey consisted of a series of questions. The results of the survey are illustrated in Figure 3. The participants' responses indicated a problem in the enterprise regarding people's understanding of productivity and how it is measured. The reasons behind the identified challenges will be further explored in the ***Analyse*** phase.

4.3 Analyse

A workshop was facilitated with finance, project leaders, and management to look at the results from the *Measure* phase and further understand the reasons behind the discussed challenges. In addition, a brainstorming activity (see Figure 4) was carried out to gather ideas.

Various ideas were analysed and categorised into several groups to identify a root cause using the 5 Why template. The result is shown in Figure 5.

A theme evident during this session was the lack of clarity or understanding within the group of how to determine the benefits of a project if the project's purpose is the reduction of any of the 7 Wastes of Lean. In addition, the finance members struggled to accept that eliminating waste could result in a productivity benefit for the business. Therefore, it was necessary to explore the issue and to find links between the reduction of waste and the benefits to the business a reduction in each type of waste would generate. The results of the waste reduction benefit analysis are shown in Table 2. There are much literature data on waste (Madhani, 2020; Chauhan and Singh, 2012), but information on how to quantify the benefits of reducing these wastes is rare.

While performing this analysis, the team identified a need to understand costs and the types of costs within the business. This was also a finding that 88% of survey participants said they did not understand the different cost savings categories. Reducing costs is seen as one of the key benefits of any Process Improvement Project (PIP) or CI project. The team brainstormed this topic and found that costs can be grouped into categories of Process Cost, Cost of Quality and Cost of Poor Quality.

The Cost of Poor Quality (COPQ) is the cost incurred to correct processes that fail to perform as intended (Caldwell, 2006). These costs include Rework, rejects, testing and

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Figure 2.
SIPOC diagram

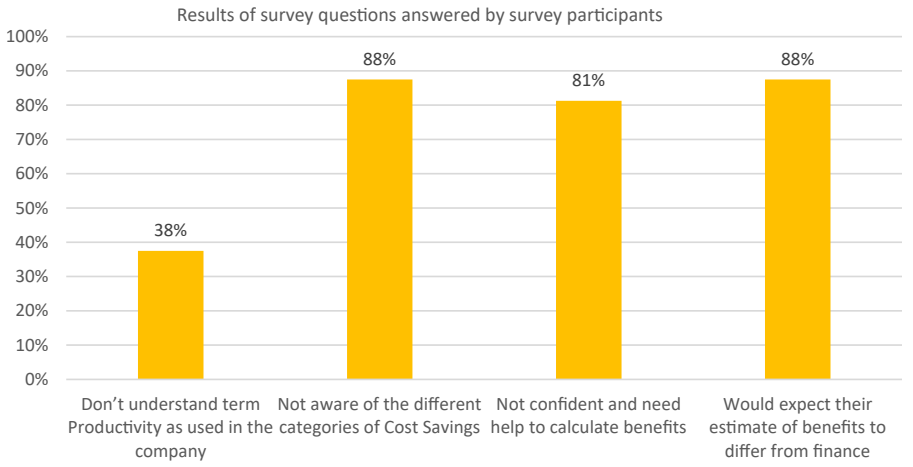

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Figure 3.
Results of the survey

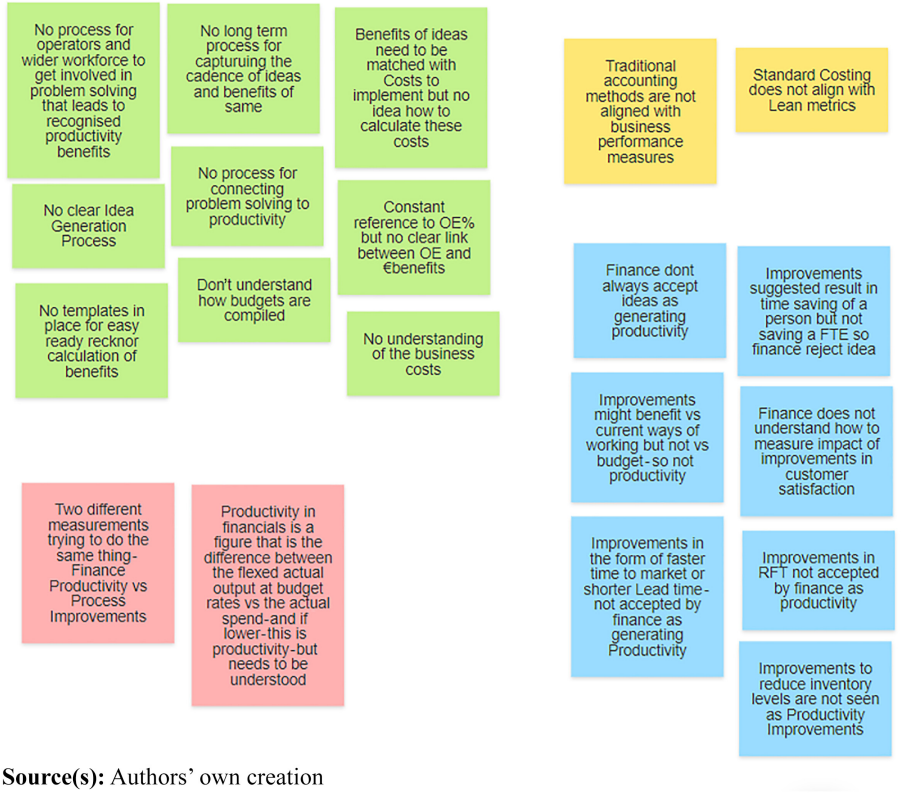

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Figure 4.
Output from the brainstorming session

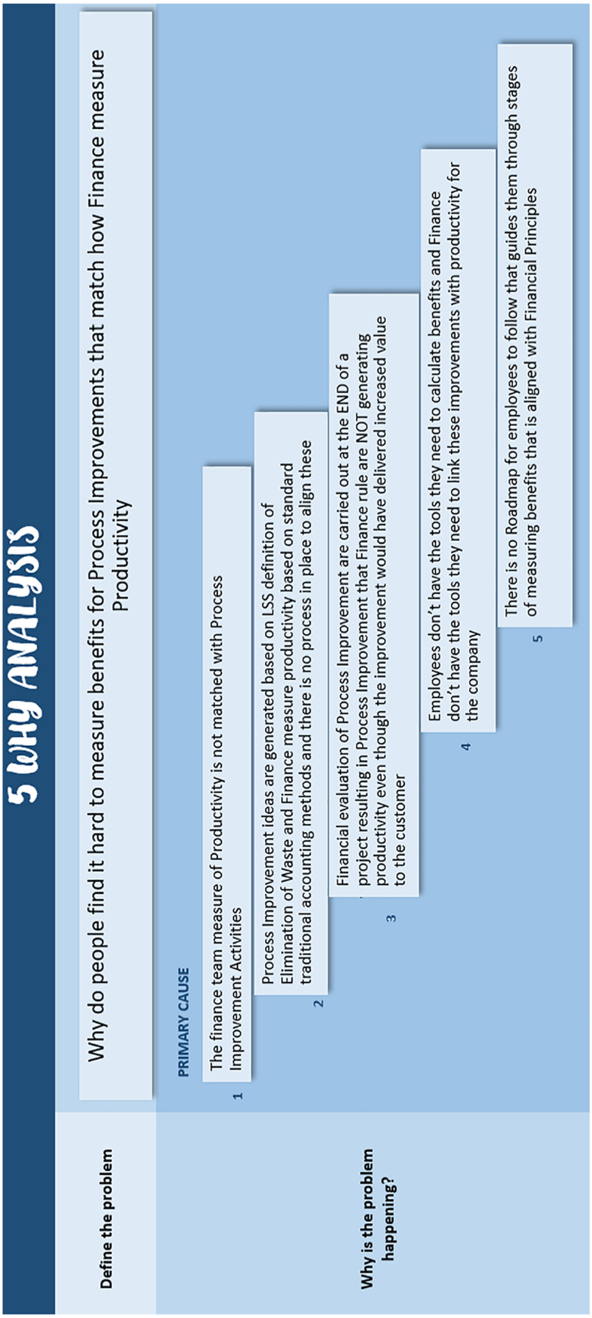

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Figure 5.
5 Whys analysis

How reducing these wastes (TIM WOOD) will benefit businesses (Wilson *et al.*, 2012)	
Transportation	Costs time and money to transport anything—Inventory, spare parts, documents, samples. This means that the less you transport, the better
Inventory	While you have it and it is not being used or worked on, it has to be maintained, insured, moved, stored and paid for
Motion	If machines and workers should move as little as possible–it will be faster and less wear and tear
Waiting	If people are waiting (i.e., not adding value), they are being paid wages that are wasted
Over production	Overproduction ties up capacity, material, time, and other resources. This creates more excess inventory, transport and movement and can also cause defects
Over processing	If a customer is unwilling to pay for it—over-designed or over-engineered features—it can be considered a waste
Defects and rework	Any product or service that does not satisfy requirements and must be reconsidered is a waste. It includes cost capacity, material, and time. For example, reworking costs require more capacity and time

Source(s): Wilson *et al.* (2012)

Table 2.
How reducing waste benefits a business

retesting, time spent analysing failures, operational downtime and scrap. The team could see a similarity between the types of costs that fall into these categories and some of the 7 wastes. These similarities are shown in Figure 6 using arrows to align the 7 Wastes with the COPQ. The box around the 7 Wastes and the COPQ costs represents the costs that could be reduced from a process improvement perspective.

The team concluded that Tangible Benefits from Process Improvements would increase when the costs associated with the 7 Wastes and COPQ decrease.

The survey results showed that 80% of participants were not confident in calculating process improvement benefits. Furthermore, another 88% of participants reported they did not expect their calculation of benefits to match with finance. This demonstrated little knowledge or awareness of how to quantify the benefits. Therefore, a roadmap was designed to ensure that project leaders could identify the project benefits when the reduction of waste or COPQ was performed.

4.4 Design

To "Design" the benefit measurement methodology, it was agreed that guidelines/roadmap in the form of a process map (see Figure 7) would be the best tool to provide for employees. The process starts with an employee having an improvement idea and ends with an

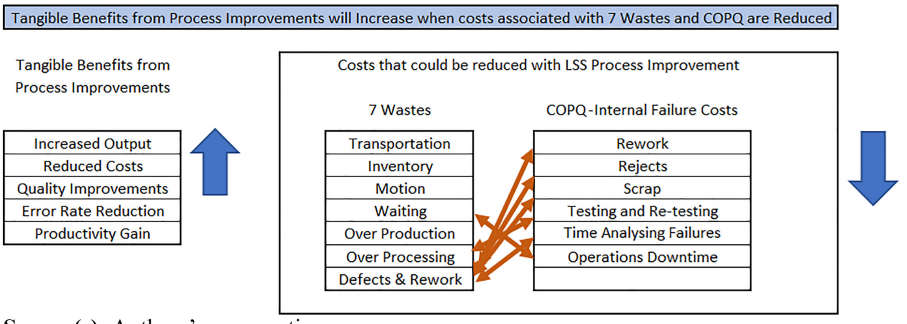

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Figure 6.
Showing the relationship between benefits and costs

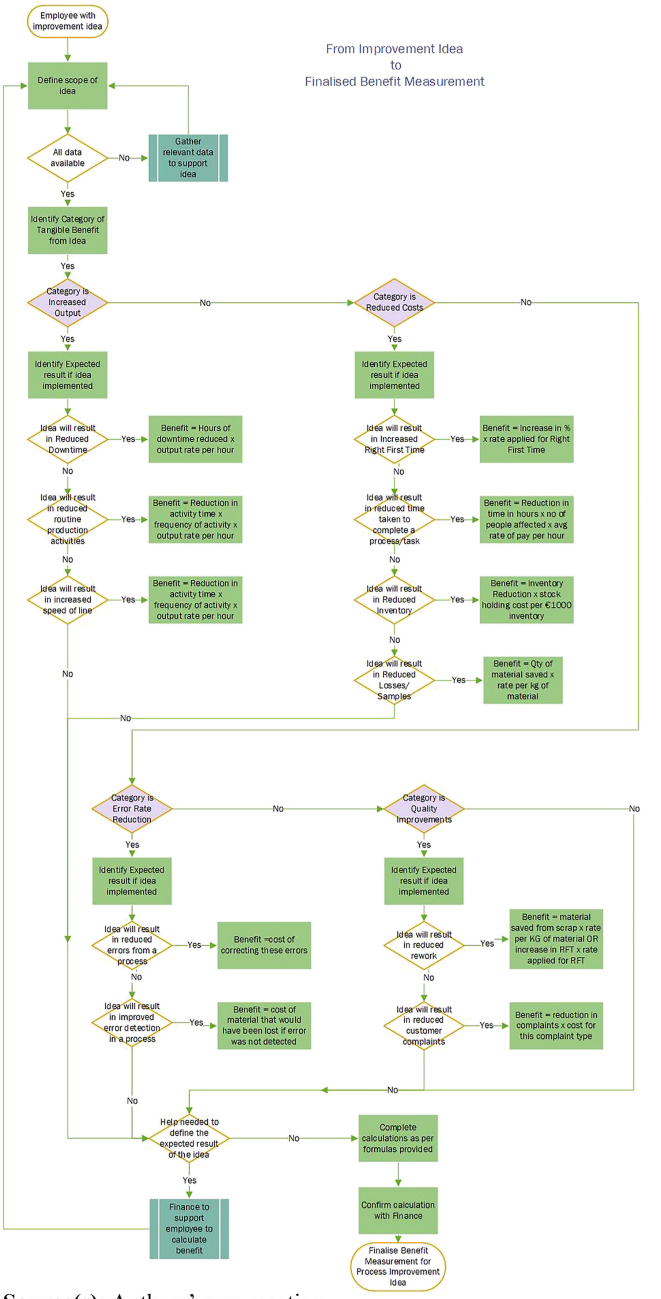

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Figure 7.
Process map from idea to benefit measurement

improvement idea with a finalised benefit measurement aligned with finance. Once an idea is formed, the employee should define the scope of this idea. If the employee does not have all the data needed to complete this scope, the employee gathers the relevant data to support the idea. When all the data are available, the employee should identify the category of tangible benefit that the idea belongs to. The design team identified that there are 4 main categories of tangible benefits (shown on the process map in 4 shaded diamond decision points), and for each category, several possible results depend on the type of waste the idea aims to reduce.

If the improvement idea falls into the tangible benefit category of increased output—the employee must look at the options and determine which option best matches their idea. For example, if the idea will result in reduced downtime, the benefit is calculated as "*Hours of downtime reduced multiplied (×) by output rate per hour*." If the idea will result in reduced routine production activities, the benefit is calculated as "*Reduction in activity time* ×-*frequency of activity* × *output rate per hour*." If the idea will result in increased line speed, the benefit is calculated as "*reduction in activity time* × *frequency of activity* × *output rate per hour*". If the employee cannot identify an option that matches their idea and needs help, they should seek support from the finance team to calculate the benefit of their improvement idea.

While working with the design team on calculating these benefits, it was agreed that finance would generate a reference document to provide employees with annual rates and cost information. This document would provide employees with the Euro value of *output rate per hour, the average rate of pay per hour for employees, the cost per kg of material, the costs per complaint type*, etc. needed for the benefit calculations. Finance will update this document annually using new budgets and information on company spending. Combining the process map and the clear annual rates and costs ensures that employees are well-equipped to determine the benefits of any ideas.

If the employee has all the information needed, they should complete the calculation per the formulas provided and using the rates, etc. provided for the year by finance. The employee should then confirm the calculation with finance, and following this, the idea has a finalised benefit measurement aligned with finance.

If the improvement idea does not fall into increased output, the employee must determine if it falls into the tangible benefit category of reduced costs, error rate reduction or quality improvements. Depending on the most relevant category of tangible benefit, the employee must look at the likely results of their idea within this category (see Figure 7) and determine which option matches what their idea will result in.

Once identified, the employee should calculate the benefit as detailed in the process map. For these categories also, if the employee cannot identify an option that matches what their idea will result in and they need help, they should seek support from the finance team to calculate the benefit. Following these guidelines or roadmap as detailed in this process flow, the improvement idea can be measured in terms of the benefit to the business.

4.5 Validate

To "validate" the design, project leaders and managers were trained in the new benefit measuring methodology and colleagues who participated in the first survey were also trained according to the new process requirements. This ensured that all participants understood how to progress from the process improvement idea and to follow the benefit measuring methodology. The various pathways representing different tangible benefits were structured so that as many individual roadmaps as possible could be tested during validation. The result showed that several calculations were unclear to someone who looked at them for the first time. This involved an element of collaboration with finances, emphasising the roadmap's importance in the improvement process. Following this, participants were asked to apply

these guidelines/roadmaps to various improvement ideas to ensure the process worked and calculations were completed.

A similar set of survey questions as previously asked in a Measure phase was given to participants of the validation phase questions. The survey responses from the measure and validation phases were compared in Table 3.

The survey result shows that before the study, 38% of people did not understand productivity as it applies to this company, and this has reduced to 19%—an improvement of 50%. Before the study, 88% of people were unaware of the different categories of cost saving, and after, 45% were unaware—an improvement of 49%. Before the study, 81% were either not confident or needed help calculating benefits, whereas after this, it was 35%—an improvement of 57%. Before the study, 88% of people would not expect their estimates of benefits to match finance, which has improved to 26%—an improvement of 70%. This survey confirmed that the benefit measuring methodology worked well for participants and was ready to be rolled out as the standard way of working.

4.6 DMADV implications

This study does not only empirically complement state-of-the-art research, but also extends our knowledge on the impact of staff motivations, implementation of challenges on LSS training program, and its subsequent effect on organisational performance. The results of the study are of interest not only for managers, consultants, and strategists in companies of various sizes, but the study's outcomes can also assist operations managers, continuous improvement professionals, and investors with operational and financial benefits through implementation of LSS methods.

Establishing concrete and detailed KPIs is one of the most important hurdles to overcome when integrating LSS within finance. While the LSS DMADV offers a powerful framework for improvement, effectively leveraging tools like process mapping often requires a culture shift in organisations that adopt them. Employees should be trained to improve their efficiency to reduce the defects by providing them with the feedback on a regular basis. One of the key traits of successfully leveraging LSS methodology in a finance and accounting sector is the ability to step back and look at existing processes objectively to recognise that. Even if a process has existed for decades in an organisation, it may not be the most efficient way of doing things.

Another KPI for the success characterisation is recognition on how internal department processes may impact other stakeholders throughout and outside of an organisation. For example, inefficiencies in invoices' processing could make it more difficult for other departments to work with external vendors. A certified LSS training of professionals in a finance and accounting sector will ensure that the key stakeholders are aligned toward a common goal and that teams can effectively manage all complexity of a process change. The

	Before (%)	After (%)	Improvement (%)
Do not understand the definition of Productivity – as it applies to this company	38	19	50
Not aware of the different categories of cost savings	88	45	49
Not confident or need help calculating benefits	81	35	57
Would expect that their estimate of benefits would not match the Finance	88	26	70

Source(s): Authors' own creation

Table 3.
Results of survey before and after

establishment of a company culture will make an organisation conductive to changes through adopting LSS principles and positively affecting internal company teams, external stakeholders and society as a whole.

5. Discussion

This study uses the DMADV methodology to find a solution that aligns LSS concepts for value creation improvement ideas with financial data. The company was not equipped to quantify benefits from LSS process improvements that were aligned with the interest of the finance department. This impacted the business's ability to reach its annual productivity target and engage the workforce in problem-solving. Many companies struggle to adopt programs concerning quality improvement to balance cost savings and streamline operations (Pritchard, 2011). However, this study has shown that process improvements can be carried out efficiently and beneficially for an enterprise with clear guidance and information available to employees. As a result of this study, there has been an increase in participation in suggesting LSS process improvement ideas (***RQ1*** and ***RQ2***). The lack of appropriate financial information to enable project leaders to measure the benefits and costs was one of the reasons why people did not engage in process improvements (Sabath and Whipple, 2004). However, this work has shown that, given the right tools, this problem can be overcome.

The project has led to the establishment of the benefit measurement methodology. Much literature is on how process improvements benefit financial outcomes, but little is written on how enterprises determine benefits derived from process improvements (Wemmerlöv, 2020). Utilising the DFLSS methodology with the DMADV aided the design and effective validation of the new process (Trubetskaya *et al.*, 2023). A key driver of change in this project was the recognition by the finance team that to measure the benefits of process improvements, they needed to understand the Lean definition of waste and how reducing these wastes leads to tangible benefits. They also recognised the need to support project leaders to calculate this benefit early in the benefits measurement process to ensure correct decisions were made regarding the approval or rejection of the project ideas (Beer *et al.*, 2016; Arcidiacono *et al.*, 2016).

Interestingly, one word that needed to be clarified as part of the study was what the term productivity means as it is used in the enterprise. The survey results showed that almost 40% of employees at the company did not understand the term productivity. Productivity in the wider world is a term everyone agrees is important, but there is little agreement on what the term means (Pritchard, 2011). Some definitions of productivity are efficiency, effectiveness, performance appraisal of individuals and competitiveness. The study found that using the term as a measure of process improvement benefits was confusing. In this company, the term represents the difference between expected costs (based on the budget) and actual costs (measured in the P&L statement). These measures are not directly linked to any project or process improvement, and the only people that would have access to this information are the finance team. However, the business uses this term to capture also benefits from process improvements. This does not align with Lean thinking. In Lean thinking, the measure of process improvements relies on workers understanding information to evaluate process improvements (Ruiz-de-Arbulo-Lopez *et al.*, 2015). The result of this study is a process that can be followed to allow employees to evaluate process improvements using costs aligned with finance. However, there is an additional agreement among the team members that the alternative name will have to be used in future to identify the cumulative benefits of the process improvements undertaken in the present study.

For an improvement idea to be implemented, it must generate real financial benefit for the business (Antony and Banuelas, 2002). However, this study found that quantifying this

benefit was difficult as different team members had different opinions onion should be done and what could be defined as a benefit. Many authors have noted this as an issue in costing LSS improvements (Pulakanam, 2012).

This is not unusual, and one specific example of this difficulty was the benefit to the business of reducing inventory (Johnson and Kaplan, 1987). The measure of productivity previously applied by the finance team for improvement ideas did not recognise inventory reduction as a benefit to the business. However, as a fundamental goal of Lean is to eliminate excess inventories as a form of waste (Demeter and Matyusz, 2011), thus we identified the need to explore this more fully and align on a benefit measurement for inventory reduction. From this study, the finance team agreed on a method to quantify improvements resulting from increased stock turns and reduced inventory, thereby aligning the financial principles with the measurement methodology. The benefit measurement is "*Inventory Reduction* × *stock holding cost per €1K inventory*."

Another area that generated different opinions between the finance team and project leaders was the benefit of process improvements which result in less work for an employee, e.g., less over-processing and less waiting, i.e., the "soft savings." Initially, finance believed that without eliminating the need for an employee, no productivity could be assigned to process improvement. While this view disagrees with much of the literature around soft savings bringing further business benefits that are not easily identifiable as "hard" P&L savings (Mader, 2018). Finance argued that the company was still paying the cost of the employee. However, from the discussion and learnings during the study, an aligned approach was related to the possibility of assigning productivity for the proportion of the time saved. For example, the benefit of an idea that reduces the time taken to complete a task is "*Reduction in time in hours* × *number of people affected* × *average rate of pay per hour*." In addition, a strict application of accounting methods, such as not valuing the benefit of eliminating waste from employees' work, may lead to employees not suggesting ideas that eliminate waste (Ruiz-de-Arbulo-Lopez *et al.*, 2015).

The benefit measurement methodology has delivered manually calculated individual process improvement ideas. Personnel in finances and accounting was motivated and creative on providing new ideas on the ways to continue further integration of DMADV methodology.

Though this research provides various illustrations of benefits of LSS deployment in the finance and accounting department according to the research objectives (***RO1-RO2***), it is necessary to analyse LSS deployment through all other departments to link the existing DMADV methodology to other existing LSS platform in the organisation. Thus, future studies can give more examples of LSS deployment in finance and accounting practices in a more integrated manner. The future research will focus specifically on the benefits of LSS deployment in finance and accounting and other departments to measure performance improvement along various dimensions and as such quantitative studies at other locations of Danone would be also interesting. Moreover, there are many limitations to the manual process in finance and accounting sector. Thus, the automation of the benefits measurement methodology can be integrated in the future using an Industry 4.0 technology or artificial intelligence (AI) model. Such automation will allow employees to quantify the benefits more easily using various visualisation tools. In addition, this new platform will allow finance to keep the rates on which the calculations are performed up to date leading to more collaboration between finance and the project leads to identify relevant cost savings.

6. Conclusion

The novelty of this study relies on the benefit measurement methodology, which is well aligned with the work of the finance department to sustain process excellence and

continuously improve results. The lack of appropriate financial information and methodology to measure the benefits and costs was one of the main reasons why personnel were not engaged in process improvements.

The research emphasises overall benefits of LSS deployment in finance and accounting services in terms of higher efficiency and effectiveness that also provides a set of guidelines for its successful deployment and synthesise customer value creation process. The quality improvements resulting from reduction of inventory and increased stock turns using LSS DMADV methodology led to high motivation and creativity of personnel which supported LSS deployment in finance and accounting in various future projects. From the practical implications point of view, this study added to the limited state-of-the-art literature on costing LSS and CI projects and presented a novel holistic approach to the costing process by assigning productivity to the proportion of the time saved.

The limitation of the study is the manual calculations at all stages of the DMADV model requiring integration of digital platforms in future projects. In addition, future work will involve integrating the costing process into a more automated AI or visual management solution enabling employees to quantify benefits more easily, leading to further process improvement and employee engagement.

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