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Kaizen Costing in Delphi Technologies

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ABSTRACT

Background: This study investigates how Kaizen Costing can aid in the cost savings process in material for Delphi Technologies, where a complete breakdown of the general process is given, as well as a real-life example.

Methods: The paper consists of an interventionist research case study. Qualitative and quantitative data was gathered to outline the exact cost saving process.

Results: The design change boosted company's savings by $ 761,249 for a period of twelve months.

Conclusion: Findings offer unique insights to the impact Kaizen Costing has on material cost savings, which augments its competitiveness in the fierce automotive industry.

Keywords: Kaizen Costing, Material Cost Initiative Process, Material Cost Saving

Introduction

This Work Project (WP) intends to illustrate how Kaizen Costing is implemented in a cost savings process for materials used in production. Kaizen is a process of continuous improvement implemented in organizations (Agnomi, 2016). Even though the current literature abounds with examples of the organizational and financial benefits of Kaizen Costing, there is little to no evidence of prevailing practices, as well as all its intricacies. This is exactly the gap this study pursues to close. The case study offers unique, first-hand insight into the continuous cost improvement process of one of the world's largest automotive parts suppliers: Delphi Technologies. What is more, a complete outline of its process is described in detail, including the five-phase system, the information flow, the validation methods and the employees involved. Finally, a real-life example is given regarding a design change, from its conception to the final cost savings of $ 761,249 is just one year.

The WP is organized as it follows. It starts with the literature review, where several methodologies and applications are studied. Afterwards, the entire Kaizen Costing system in place at Delphi Technologies is discussed. The study continues with the description and analysis of a specific and measurable example in order to illustrate the system and to measurably demonstrate the impact of Kaizen Costing. The WP ends with the presentation of conclusions.

Literature Review

What is Kaizen Costing about?

Kaizen is the Japanese term to define incremental, continuous improvement ("Kai" for "change" and "Zen" for "better") (Palmer, 2001). Kaizen, or Kaizen Costing, was first introduced in the competitive Japanese Industry, by companies such as Toyota, around 1964 (Feil *et al.*, 2004).

The implementation of such approach (or mindset has it was depicted by some authors) was based on the necessity to remain competitive in the ferocious landscape. Rof (2011) regards

Kaizen Costing as a managerial tool focused on improving each process of a technological product sheet, with the purpose of eliminating losses and minimizing costs. However, some researchers (Vanek *et al.*, 2015) describe it more mundanely, defining it as an application of common sense and low-cost approach. Modarress *et al.*'s (2005) concept of Kaizen goes somewhat beyond the one stated by current research, by defining it as a method for ensuring that a product meets or exceeds customer's requirements for quality, functionality and prices to sustain product competitiveness.

The issue of whether Kaizen is directly related to innovation or not is clouded by the diverging opinions of scholars. On the one hand, some affirm there is a clear distinction between innovation and Kaizen, where Kaizen signifies small improvements as a result of ongoing efforts, whereas innovation involves a drastic improvement as a result of large investment of resources in new technology or equipment (Rof, 2011). On the other hand, Feil *et al.* (2004) state the founding cornerstones of Kaizen are the complete utilization of cost reduction potentials, underlining the need for continuous improvement according to innovation developments, hence making a strong liaison between innovation and Kaizen.

Finally, there is overwhelming evidence that employee involvement, motivation and mindset is of the utmost importance for the success of Kaizen Costing. Serra (2016), as well as Agnomi (2016), emphasizes how much the employees have an influence in the successful implementation of this approach and consequently how employees must be supported and motivated by the upper management.

K**aizen Costing and Target Costing**

Current research supports the view that Target Costing and Kaizen Costing are different at their core. Monden and Hamada (1991) make the clear distinction between the two, where Target Costing's purpose is to reduce costs during the development and designing of a new product, whereas Kaizen Costing's is cost reduction on existing models. Therefore, the distinction relies solely on the maturity of the product, also supported by Feil *et al.* (2004). These researchers agree Kaizen Costing and Target Costing are inseparably related to each other. Monden and Hamada (1991) add that due to the nature of this relationship, if any one of them is ignored Total Cost Management[1] cannot be implemented appropriately.

Kaizen and other Management tools

Kaizen Events are strongly attached to Kaizen Costing. Glover *et al.* (2013, p.1167) define Kaizen Events (KE) as a "focused and structured improvement project, using a dedicated cross-functional team to improve a targeted work area, with specific goals, in an accelerated timeframe". However, he distinguishes KE from Kaizen due to its "more recent western development and short term in nature" (p.1168), i.e. 3-5 days implementation. Even though the author makes this distinction, this paper will assume Kaizen Events as Kaizen, hence making Glover *et al.*'s (2013) conclusions concerning Kaizen Events the same as Kaizen Costing's. Notwithstanding, these authors also warn to the harmfulness of excessive adoption of such tool, where excessive use of KEs may jeopardize longer-term program viability in a way that not only limits technical performance, but overall commitment to the improvement initiative.

Kaizen is also directly linked to Lean Production. Lean Production, understood as the elimination of non-valued activities in the course of the production process (Jimenez *et al.*, 2011), is especially well-known and implemented in the automobile industry, portrayed in the

[1] Total Cost Management is a methodology that creates the relationship between the technical functions of the company and its financial consequences.

high levels of quality, safety, productivity and costs (Serra, 2016). The researcher adds that in this scenario Kaizen Costing is able to step in by identifying and altering the processes to obtain a 100% waste elimination in the seven major waste activities, such as overproduction, waiting, transportation and warehousing.

The escalating market competition urged companies to implement an Activity-Based Costing (ABC) analysis (Pawllyszyn, 2017). Since Kaizen can only be implemented if there are performance indicators that can guide it and measure the impact, ABC aids greatly Kaizen (Stefea and Abbas, 2015). The latter researchers argue the ABC system is "considered as an assisting factor for the continuous improvement process because it provides the managerial staff with detailed information about the activities inside the firm" (p. 72). It serves therefore the means of comparison between the number of the actual and the planned cost drivers at the level of each activity. Stefea and Abbas' (2015) study on Egyptian manufacturing firms concluded there is a 93.80% correlation between ABC and Kaizen Costing, more specifically the outputs of ABC and the success extent of the application continuous improvement.

Portfolio of Kaizen Methodologies

Multiple approaches and methodologies can be undergone when applying Kaizen Costing. The simplest in its form and focus is the Kaizen 5S (see figure 1). Titu (2010) explains the Kaizen approach is divided into five categories: (1) SEIRI – Sorting – making the difference between necessary and useless things in the workspace (2) SEITON – Ordering/Arrangement – the ordering of all the items after SEIRI (3) SEISO – Cleaning and disturbance detection – the working areas/equipment will be clean (4) SEIKETSU - Standardizing– the extension of the cleaning concept to each individual alongside with the continuous practice of the three steps 3S (5) SHITSUKE – Disciplining – getting self-discipline and getting used to be each involved in the 5S actions through standard application.

Another approach commonly used when implementing Kaizen is what Rodriguez and Lopez (2012) call the Quality Control Circles (QCC) (see figure 2 in appendix). The purpose of QCC teams is to improve personal performance, promote a better work environment, and support the company development. The QCC development process is elementary, comprising of the following steps: (1) understand the problem, its roots and possible solutions, in a form of a list (2) the QCC communicates with the affected staff and potential helpers on the required changes (3) a timeline is implemented, going from initial steps to final conclusion of the project, taking into consideration inputs provided by previously consulted third parties – which will be affected by the change (4) upon conclusion of the project an objective and subjective performance review takes place.

The development groups implementation can be escalated to a more complex system. This approach was studied in Vallourec Tubos do Brasil S.A. and its continuous improvement program (Serra, 2016). The program consists on creating Continuous Improvement Groups (GMCi[2]) which over the course of approximately six months actively work on improving processes and waste management. The methodology undertaken by the GMCi are divided into four phases (see figure 3): (1) Team building and training (2) Preparation (3) Intensive Phase (4) Action closing and supervision.

Phase 1 is the foundation for all the other phases and involves the creation of the GMCis. The teams are picked based on clients' needs and alignment with company's strategy. To make the most out of the program, the leader of each GMCi must be proactive, skilful in kaizen methodology, committed and experienced. In addition, it is of the utmost importance that the leader desires to be one, so that an efficient project can be employed. It is also during this phase that the teams receive additional training on Lean Production, Kaizen Costing and other relevant

[2] Grupos de Melhoria Contínua in portuguese.

approaches. Phase 2 is all about collecting data to further analyse the company. Such data is collected using historical archives, added value mapping and process charting. This information is vital to understand current problems. Phase 3 is where most of the solutions and actions are taken, always based on information gathered in phase 2. Even though it is small in duration (1 week), all team members must be fully dedicated, both mentally and time-wise, to such problem-solving ideas, hence the name "intensive week" (see figure 4).

This phase's mantra is all about avoiding excuses and getting the best solutions. One of the most important tools to decide which solutions to implement is the "Priority Matrix" (see figure 5). This matrix considers two variables: difficulty of implementation and impact of solution.

After deciding which solution is best, preferably in areas 1-4 (greater impact with less implementation difficulty), a plan of actions is laid out, handed over to teams and a deadline is set for each. It is required that 70% of proposed solutions are implemented by the end of this phase. The fourth and final phase has two objectives: to monitor the results of already implemented solutions and to implement the remaining solutions, which have not been implemented by the end of two months.

The aforementioned methodology, with a short time frame, is not always the Kaizen approach implemented. Kaizen is also utilized as a daily improvement activity. Vanek *et al.* (2015) propose the Deming cycle as the founding pillar of such Kaizen (cf. figure 6). The researcher refers three tools implemented by a company to motivate continuous improvement initiatives: (1) idea card – very simple, self-explanatory and most importantly easy to provide, by informal means such as email, via cell phone or even verbally communicated (2) formation of optimization teams, where entrance is completely voluntary, and get access to numerous sectors of the company for easiness of communication (3) education, where the main focus is to create competent employees who can critically evaluate and develop the companies infrastructure.

Having said that, Agnomi (2016) takes advantage of the Fishbone diagram to aid Kaizen implementation and development (see figure 7), as well as Rajenthirakumar and Nandhakumar (2015). The Fishbone diagram is used to visually represent the effect of production or service alongside the factors or causes that influence it (Desai and Johnson, 2013). The core value of such approach is to understand the production process and determine which activities are non-value added to the final product, elementary to improving the processes, whilst shortening them.

When it comes to consultants, Schwarz *et al.* (2017) propound the view that sustained help by an internal consultant improves job satisfaction when adopting Kaizen.

Kaizen Costing and Employee commitment

Current research supports the noteworthiness of employee engagement when successfully implementing Kaizen. However, authors assign different elementary skills and foundations so that employees fully embrace Kaizen.

Monden and Hamada (1991) mention the importance of setting reasonable targets so that employees do not feel demotivated or overwhelmed by such targets. Modarress *et al.* add it is imperative to have all parties involved in the metrics' setting agreeing and accepting the elements related to the approach, hence having their full trust and support. The core concern of involving the participating members in their own performance setting is to have each employee tackling cost reduction positively.

Alongside target setting and the cost reduction mindset, to meet the "right" culture (Modarress *et al.*, 2005) accountability also plays a crucial role. Giving responsibility and credit to the involved employees insures the working teams will remain focused and determined to reach the previously set targets. To this respect, Agnomi (2016) claims without worker buy-in, Kaizen does not work. The scholar describes how a specific company he had studied implemented Kaizen and how this company improved its financial performance by focusing in employee

commitment. In addition to financial objectives, Vanek *et al.* (2015) support other non-financial targets, such as ecological improvements. safety and health protection. Consequently, employees who take initiatives and reach the non-financial goals should be compensated accordingly (Rajenthirakumar and Nandhakumar, 2015). Nowadays customers care for what companies stand for, thus these non-financial facets can quickly turn into profit making.

Rof (2011) deems communication as the lead developer of Kaizen and its most important dimension. Additionally, Vanek *et al.* (2015) demonstrate in their study the efficacy and overperformance of Kaizen with deep focus on employees.

On the other sphere of Kaizen and employees' importance in its implementation, Schwarz *et al.* (2017) state Kaizen must also take into account employee well-being as a result of the implementation of itself. Consideration for employee well-being translates into continuously identifying and managing psychosocial risk management or analysing consequences for employee well-being as a result of Kaizen.

Even though employee motivation, participation and constant feedback systems are the pillars to a successful Kaizen implementation, the role of top management cannot be ignored. Stefea and Abbas (2015) affirm that every individual within the company, whether top management or employee, is of the greatest importance in achieving the desired quality, time, efficiency and effectiveness of the production process, as well as continuously improving them. Top management comes into stage when setting the organizational cornerstones, incentives' system and the motivational backbone of Kaizen (Serra, 2016). What is more, Schwarz *et al.* (2017) state that to maximize the positive relationship between Kaizen and employee well-being, organizational objectives should be explicitly targeted within the Kaizen system.

The other end of the spectrum – poor unaligned management – may damage Kaizen. Rof's (2011) case study on Romanian manufacturers, concludes there are factors that hinder

implementation and obtaining good results in Romanian entities, giving special attention to the mentality perspective, or the psychological profile of Romanians. This mindset permits top management to not incite enough its employees to implement and reward Kaizen implementation. By contrast, evidence presented by Glover *et al.* (2013) suggest one of the non-measured benefits of Kaizen is the general cultural changes, representing over 11% of total non-measured benefits.

Empirical Evidence with Kaizen Costing across industries

The current literature on Kaizen Costing abounds with examples of industries it can be applied to. Moreover, empirical research has also been carried out by applying and experimenting different concepts of Kaizen, such as Kaizen Events or Implementation groups (Glover *et al.*, 2013; Serra, 2016).

Current research appears to validate the view that the implementation of Kaizen carries many benefits, from increased financial performance to employee and job satisfaction. Modarress (2005) applied Kaizen to improve and shorten the production time of a product, more specifically Boeing's. The researcher performed a value-added analysis to understand the extent of the non-value time, in activities such as inspection, material moving, rework, queues and wait time spent in transformation process unbeneficial to the product. Vanek *et al.* (2015) carried out a similar study in an Eastern mining company with the same core purpose. The three tools aforementioned (idea card, optimized teams and staff education) where used to extract, analyse, empower and ultimately implement what the author called an "active Kaizen". By implementing this system, one can objectively evaluate the initiatives and/or reward and motivate the staff to do so.

Regardless of the approach utilised to implement Kaizen, there is overwhelming evidence to support the notion that Kaizen significantly decreases non-value-added activities as well as

production time. The data gathered by Modarress *et al.* (2005) confirm the efficacy of Kaizen, where he was able to decrease the total time spent in 26 tasks from 4.25 hours to 3.55 hours, corresponding to a 16% reduction. Additionally, the value-added activities rose from 48% to 58%, demonstrating a dual positive effect. Rajenthirakumar and Nandhakumar's (2015) research supports Modarress *et al.*'s (2005) findings. Their data also suggests a 11% reduction in total time sent in production processes when applying Kaizen.

Along similar lines, Stefea and Abbas (2015) argue the implementation of Kaizen in the Egyptian manufacturing companies yielded surprising results in the business processes. The results provide confirmatory evidence that set up time reduced 70–90%, productivity improved 20–60%, process time reduced 40–80%, inventory reduced 30–70% and walking distance reduced 40–90%, by partially eliminating "wasteful" activities and optimizing value added ones.

Further evidence supporting decrease in production time because of Kaizen may lie in the findings of Glover *et al.* (2013), who dwell on 16 companies with established Kaizen programs. These enterprises range from Electronic Motor Manufacturers to Financial Service providers, which report an average Kaizen Event rate of as little as 4-5 times per year to 50 per month. The available data seems to point to a notably 11% decreased lead time[3] across the board, with no regards to the industry one belongs to, as well as a 11% inventory level decrease.

The most compelling argument one can make to adopt Kaizen is the financial growth improvement. Agnomi's (2016) findings lend support to this claim (see Table 1), where revenue presented a 42% growth, going from $15 million to $21 million in 1 year. Similarly, Vanek *et al.* (2015)'s research claims Kaizen was able to aid in a $38 million income increase in just three years. In addition to revenue, evidence put forward by Agnomi (2016) also supports the

[3] Lead time is the time it takes for the product to be produced, from raw material to finished good.

broadening and expansion of the business, where the studied logistics service provider (Logistica) significantly increased its footprint across the transportation instruments, with an increase in volume by 100% for airfreight, 19% for SCM[4], and 295% for ocean freight, all far above industry level. Furthermore, Kaizen Costing was not only able to increase Logistica's performance but their manufacturing customer's performance as well. The reported benefits were a reduction of 9% in unnecessary documents, improvement of 300% in filling time of documents and a 120% increase in saving space in long-term storage.

Drawing on the idea that a "proper" implementation of Kaizen also improves employee wellbeing and job satisfaction, Schwarz *et al.*'s (2017) research dives in on the importance of engaged employees when applying the Continuous Improvement approach. In their study, the issue under scrutiny is whether considering the possible consequences of all improvement suggestions for employee well-being, regardless of which area the problem/suggestion concerned will improve job satisfaction. The main conclusions the study arrived to were (a) greater integration of organizational and employee objectives when decision making takes into account employee well-being (b) more Kaizen Work[5] was related to lower levels of discomfort with work (c) more Kaizen Work was related to improved employee well-being, due to the higher degree of integration. Further evidence of such claim is provided by Agnomi's (2016) findings, where Kaizen is believed to have grown employees' support of the company, from increased competitiveness in the industry to greater job satisfaction.

All things considered, the evidence currently available seems to suggest Kaizen improves lead time, reduces waste and increases employee engagement and motivation. All in one, Kaizen seems to enhance the firm's financial performance.

[4] Supply Chain Management, which includes logistics management of product from raw material to final product.
[5] Authors use the expression Kaizen Work as Kaizen Costing.

Methodology

This WP has adopted as a research method a descriptive case study. Case study research has been especially advocated to study contemporary phenomenon in depth and within its real-life context, and whenever phenomenon are out of control by the researcher (Yin, 2014). This method is the most adequate research strategy when there is the intention to study a theoretical concept that has been put into practice. By diving into a method implemented by a company, it is aimed to address the call for more research into real-life application, so that the gap between management accounting theory and practice can be closed (Scapens, 2006). The case study here presented bases on a description of how Kaizen Costing works for a specific situation - a design change of components for one of the product lines of Delphi. Several steps were taken when carrying out the case study: (i) data collection (ii) data analysis (iii) report writing. Each of these steps are described next.

Data Collection

In this study, there were three sources of information utilized to understand the processes, information flow and initiatives' cycle. The objective of collecting divergent sources of evidence and comparing them, known as triangulation, is to comprehend the validity of the results presented (Ryan *et al.*, 2002).

Since the objective is to understand the real impact of the initiative in the Profit and Loss (P&L) statement, it is essential to set a plant's P&L statement as a base to compare against the cost savings stated initially by the Material Cost Improvement Process (MCIP) team. On the other hand, the MCIP initiatives record is also crucial to have, so that I can evaluate what affirmations the MCIP team is making and what are the grounds for such statements. This record allows to analyse each initiative to a greater level of detail, such as budgeted volume, origin of initiative and other elementary information. Finally, to fully understand the initiative process, from

conception to realized savings, multiple quantitative and qualitative data was gathered from one of the plant's MCIP managers, which were a result of the two interviews conducted. These records include beginning to end presentations on the progress of the initiative, from risk assessment to planning elements.

In order to be able to later extrapolate the findings and do similar analysis on other plant sites distributed across the globe, an assumption was made. This assumption states the processes regarding the initiatives record development and its implementation in the P&L are relatively similar across plant sites. Since Delphi is an international enterprise, it is not unreasonable to assume so, since there is a centralized approach to every process. However, there is some room of manoeuvring in this assumption, given that most likely each plant site adopts the standard process but makes slight modifications to their liking.

Taking into consideration the international setting of Delphi, it is unfeasible to make an effort to comprehend every plant's initiative's process. Therefore, I decided to focus on one plant site, which is Iasi plant, located in Romania. The reasoning behind this decision is a combination of two factors: firstly, Iasi plant is relatively new, which I assume implies that the best practices were implemented there, which in turn means I will be handling with the most well-groomed process; and secondly, since the Financial Planning and Analysis supervisor is originally from this location, her connections can/were of the utmost importance to facilitate information flow and to promote inter-departmental communication.

Even though there are many initiatives I could have looked through, I decided to go with just one, so that I can dive in deeply and fathom out its intricacies. The initiative chosen was a design change. The reasoning for choosing such initiative falls behind two self-imposed criteria: (1) the initiative should be relatively impactful in cost savings, so that one can understand to a

greater extent the effects of Kaizen Costing (2) initiative should be to a certain level visual, since it would become easier to comprehend the initiative, as well as demonstrate it.

The WP is carried out by as a visitor researcher, since I interview the subjects linked to the research, obtain information from third parties and I am not directly involved in the issues being studied (Ryan *et al.*. 2002).

Data Analysis

This WP is demonstrated in the form of interventionist research, more specifically a weak intervention research. Interventionist research implies continuous participation in doing research in practice, where the researcher is at the centre of the events to learn and know the intricacies of the research. The objective of intervention research is to amalgamate theory and practice together (Westin and Roberts, 2010). The WP is considered of weak nature because I had a low level of participation in the process, even though several meetings were held throughout the investigation period with members of the company who participate directly or indirectly in the MCIP.

The initial meeting was with the business planner in charge of global material performance (see table 2). Once again, this is an employee highly specialised in this area with extensive experience, know-how and information. The business planner introduced me to the global MCIP database, which contains succinct information on all initiatives regarding material performance. Even though this database was not utilised per say, the meeting boosted the understanding of the MCIP and its ins and outs.

The information supplied by the Iasi MCIP Manager was provided in the form of multiple presentation, databases and analysis. As an interventionist researcher, I carefully analysed them and collected the information that was needed, so that I could outline the entire process. I

combined both qualitative and quantitative evidence to tackle the initial proposition of the study – to discern how Kaizen Costing is applied in material cost savings within Delphi Technologies.

Due to the level of detail in the data provided by the MCIP manager for Iasi, several meetings took place so that I could fully understand the process, the information flow and the evidence provided. The meetings took place two times (see table 2) over the phone, which occurred on November 10th and 27th. These meetings vary in topics discussed, including high level breakdown of process, specific timeline for design change request and confirmation of financial analysis on design change. The manager in question has been handling MCIP information for more than five years, which translates into in-depth knowledge of the process and access to detailed information.

Date	Length	Place of Meeting	Interviewee
11 September 2017	1h30min	Face to face	Business Planner
10 November 2017	1h30min	Conference Call	Iasi MCIP Manager
27 November 2017	2h30min	Conference Call	Iasi MCIP Manager

Table 2 - Interviews for Research

Report Writing

Firstly, the WP dwelled on the current research on Kaizen Costing, from early foundation to its application in multifaced companies. The aim of the literature review is to understand where and how Kaizen Costing can be applied and its many benefits across a wide spectrum of industries.

The literature review was carried out previous to greater contact with participants in the process. The objective of performing the literature review prior to conducting interviews with the members aforementioned is to enhance the knowledge of Kaizen Costing and its many applications. This way the queries demanded and the level of details can be deepened, so that the subsequent cognizance of the process and information flow is of greater value.

The empirical study was written based on the presentations, testing analysis and information exchanged between employees, suppliers and customers. This documentation was provided by the Iasi MCIP manager who was akin to fill in any gaps present in the data. Following the empirical analysis, the WP was handed in to the aforesaid manager, who confirmed the veracity of the process (cf. Ryan *et al.*, 2002).

Upon the completion of the Literature Review and the Empirical study on the Material Cost Improvement Process, I proceeded with the methodology, where the source of information is explained, as well as all the intricacies that are involved in it.

Only after the three main topics of the WP were completed did I initiate the Introduction and the Conclusion. Both of these topics were developed at the same time so that a clear assimilation of the WP could be transmitted across the board.

Empirical Analysis

Delphi is a leading global supplier of technologies for the automotive and commercial vehicle market. Having said that, its business and performance depend heavily on the performance of their customers, i.e. the automotive industry. Current research appears to validate the view that the automotive industry is and will continue to being "squeezed". A study put forward by McKinsey (Mohr *et al.*, 2017) explains there will be a supplementary complexity and cost pressure. Furthermore, regulatory pressures will tighten and prices in established markets are likely to be flat. The study also states carbon dioxide regulation is expected to tighten not just in Europe, but also in China, USA, and Japan, which translates to a growing need for innovation and cost effectiveness. To understand the impact, these nations represented about 76% of the total automotive industry in 2016, according to the "Organisation Internationale des Constructeurs d'Automobiles" (OICA, 2017).

Along similar lines, a study carried out by PwC states the industry is in serious trouble, portrayed in the 2016 4% return shown by the top 10 OEM[6], amongst other factors (Parkin *et al.*, 2017). This 4% return represents about half of the industry's calculated cost of capital.

In addition to the competitive landscape, Delphi Technologies has just been spun-off on December 5th, 2017, which means the company has now become considerably smaller. Even though it remains a $4 billion of revenue a year, the decrease in size gives grounds to an additional scrutiny in the company's performance. That is where Kaizen comes into play, more specifically by propelling material performance, i.e. increasing costing savings directly and indirectly related to materials.

The KPI Material Performance can be broken down into the following items:

- Price-to-Price Performance – which considers the change in material cost due to the increase/decrease in unit acquisition of raw materials and purchased parts and components. Examples of Price-to-Price performance would be supplier rebates and supplier resourcing.
- MCIP[7] Performance – cost savings regarding material or freight coming directly from the implementation of specific MCIP initiatives. MCIP Performance can be broken down into six additional items:
    - Material Design – corresponds to material cost reduction driven by an engineering redesign which can be backtracked from a specific MCIP initiative;
    - Make vs Buy – savings related to production in-house or outsourcing, depending on the initiative;

[6] Original Equipment Manufacturer.
[7] Material Cost Improvement Process.

- Localization – regards cost savings realized from the efforts to localize imported parts;
- Usage – savings originated from change in material consumption within a specific manufacturing process
- Freight – logistics initiatives specifically aimed at reducing freight costs

The record provided by the MCIP team contains information regarding all materials' initiatives since 2015 until September 2017 (see table 3).

Global Material Initiatives 2015-2017

Performance Item	Absolute number of initiatives	Relative number of initiatives	Total Cost Savings	Relative Cost Savings
Design	617	9%	$ 49,509,198	19%
Price to Price	5709	79%	$ 158,935,534	60%
Logistics	705	10%	$ 30,055,347	11%
Make vs. Buy	69	1%	$ 19,680,173	7%
Localization	91	1%	$ 6,760,380	3%
Material Usage	54	1%	$ 614,199	0%
Totals Initiatives	7246	100%	$ 265,554,831	100%

Table 3 - Global Material Initiatives from 2015 to September 2017 in Delphi

A total of 7,246 initiatives were put forward in the January 2015 to September 2017 period. According to the data, 79% of initiatives were in regard to Price to Price Performance. It seems natural to be so, since these initiatives are the easiest and the most inexpensive to do. Simply put, a Price to Price Performance initiative mainly occurs by renegotiating the price per unit when volume is increased.

Interestingly enough, in spite of the considerable dominance in initiatives, only around 60% of total cost savings come from it. The evidence shows that in this time period, the performance was close to $ 265 million. Therefore, almost $ 107 million of savings come from the MCIP initiatives, which account for a mere 40% of total initiatives around the globe.

This WP reflects on the MCIP initiative concerning a design change (DC). Firstly, I will elaborate on what the decision-making process, information flow and the intricacies that go

along with MCIP initiatives. Then I will demonstrate how Kaizen Costing is applied in a specific initiative.

General Initiative Process

The process from idea generation to conclusion is divided into five phases (see Figure 8 in appendix). The purpose of the first phase – Concept Generation – starts when an idea is generated. Typically, there are a few tracks through which ideas are generated, which can be either internally or externally, which are all based on Kaizen Costing. On the internal side, there are three main meet-ups: (1) Design workshops, where changes are proposed by product designers and product and manufacturing engineers, based on customer feedback, know-how and production metrics (scrap, operational effectiveness, etc.) (2) Commercial workshop, where supplier related staff is involved and discusses initiatives directly related to suppliers, such as new manufacturing locations, best cost countries and supplier negotiations (3) Logistics workshops, where the plant and divisional logistics staff discusses how to optimize transport costs, packaging and customs, among others. Moreover, material related job functions, such as buyers or design engineers, can also come up with new ideas without coming directly from workshops. They do so by also applying Kaizen Costing, where they will focus on improving something they portray as inefficient or wasteful, which comes from their know-how and experience. On the other hand, the external side, there are the supplier workshops, where there is room for design changes suggested by supplier and where optimization workshops also take place, which dives into cost savings' sharing initiatives. After the development of the idea, employees are appointed to take responsibility to come through and supervise its implementation, called the MCIP owner. Once again, both internal and external tracks are based on Kaizen Costing, continuously making an effort to decrease cost and improve performance.

Stage two is denominated Feasibility Assessment, where the goal is to understand if the initiative is viable. Upon the conceptualization of the proposed change, the respective product is put under scrutiny by all functional staffs, implementation sites and product lines affected by the change. A risk assessment is carried out to understand possible risks and constraints of the proposed change, as well as mitigation methods to inspect such suspicions (see Figure 9 in appendix). The team starts off by enumerating the foreseeable potential failures and their effects. Subsequently, the potential causes or mechanisms for such failures are studied. Proceeding these, a list of tests is laid out to assess whether the initial concerns are validated. This list will be the basis for the technical validation.

Upon completion of the risk assessment, the technical validation is executed accordingly. The purpose of the technical validation is to understand what are the differences and similarities between the already instituted process or product and the proposed change, by testing them. It has also the intent of revising the risk assessment test list and act accordingly. Financial consequences of a hypothetical implementation of the requested change are not considered just yet. During this time, there is also a prioritisation of resources, where some initiatives, despite viable, may not be undertaken to promote initiatives with higher perceived cost savings.

Afterwards, the Business Case Development phase – phase three – takes place. This phase's intention is to design a Business Case for the initiative and get it approved. The Business Case dwells on the financial validation of the initiative and whether the concerned third parties, i.e. suppliers, customers or other affected parties, are onboard with the desired change. The business case takes into consideration several aspects of the initiative: (a) yearly volume for the project lifetime[8] (b) shift in customer pricing (where a price incentive may be given so that redesigned product is attractive to customers) (c) shift in material costs, direct and indirect

[8] Cost savings is based on volume and unit saving for a period of 12 months.

labour, fixed and variable overheads and logistics costs (inbound and outbound freight, customs, packaging) (d) quality or scrap costs improvement, reduction of engineering, SG&A[9] costs (e) costs related to modification of existing fixtures, machining, automation programs and supplier intervention.

Finally, preliminary milestones are deliberated, as well as tracking and achievement metrics. Decision is then taken based on the viability, which comes mainly from the objective markers NPV[10] and time for ROI[11], with a positive decision marker of less than 12 months for the latter.

Alongside phase two, these are the most important phases in the MCIP, since during this period the initiative is put under the needle from both a financial and technical stand point.

Phase four, called Implementation Planning, is all about preparing the implementation of the new change. This ranges from strategy outline to complete milestone setting. What is more, top management now steps in to oversee the change request and its implementation plan for clarity, completeness and feasibility, that is, a completely unbiased opinion from a third party. It is also the body that is in charge of giving the go-ahead.

The fifth and final phase is the Implementation. As the name portrays, the purpose is to make sure the product, manufacturing process and packaging shall now conform to the new requirements. An initiative tracking is instituted, in a form of a process and procedures building, further training and tool requirements. On the other hand, a global data capture system is also implemented so that a punctilious review on released items and documents and completeness of implementation tasks can take place.

[9] Selling, General and Administrative.
[10] Net Present Value.
[11] Return on Investment.

Specific Initiative's Walkthrough

In order to completely comprehend the MCIP, I will be demonstrating it with a real-case one. The initiative is a design change (DC), which consists of changing the design of two of the bearing heads for one of the product lines developed by Delphi Technologies. The design change also permits a change of materials, to a cheaper one, which positively impacts the material costs. The design change is possible due to the change in supplier, which is one of the leading companies in the manufacturing of automotive steel parts. The main differences between the two parts are the change in raw material, chamfer cut process and blanking (see table 4). The bearings are used in a DPF 6 engine, which functions as pump to deliver fuel from the gas tank to the engine. Every DPF 6 engine utilizes two bearings: Front Plate bearing and Housing Bearing (see Figure 10).

Concept Generation Phase

The proposed DC change was developed during one of the daily activities of a Material Buyer (MB) within Delphi Technologies. One of the functions of the MB is to understand if there are new opportunities from the suppliers Delphi buys their parts from, i.e. implement Kaizen Costing to reduce product-related costs. In this case, the MB found out there was a supplier (Large Manufacturer – LM) whose bearings had just been approved by customers product demands. Given this new information, the MB initiated an investigation on the potential DC on January 2013 to comprehend if the DC was executable. This DC was relevant because it was based on a proprietary blend feature by the new supplier, which would positively impact machining and durability of the product, as well as unitary costs. The MB was elected as the MCIP owner of the initiative, who is for the time being in charge of supervising it.

For the duration of the year, several activities took place to guarantee the bearings were compatible with the DPF 6 engine. For that purpose, due diligence was taken, which consisted

of preliminary drawings, specifications, initial quotations and purchase orders for testing trials. The outcome was that there were some initial concerns with the compatibility, as well as a future capital expenditure of $ 45 000 for specific tooling, which will be utilized during the financial validation.

Feasibility Assessment Phase

On November 2013 the Product Line Purchasing Manager (PLPM) stepped in to commence the change request, thus initiating the Feasibility Assessment phase. One of the first items on the list is the risk assessment. The risk assessment developed on the DC concluded there were three potential failures, one of which a driveshaft seizure. The main consequences of these failures would be an uncontrolled engine deceleration or sudden loss of power. In examining the cause and effect of the potential failures, it was determined there were several plausible geneses for these failures, some of which an incorrect bearing definition, incorrect bearing/driveshaft alignment or even a cavitation erosion due to incorrect bearing material specified. In order to understand the possible issues with the DC, a set of tests was outlined to put under careful perusal such concerns. The portfolio of testing comprised of three validation examinations: test to failure, endurance testing and industrialization. These tests include but are not restricted to life tests for the part, aggravated tests, start-stop systems, engine/vehicle validation, industrial trials for machining and assembly.

Not only are tests of the utmost importance to comprehend the ins and outs of the DC but they also enable a ceteris paribus comparison between the two different designs. The ultimate purpose is to have an objective assessment and evaluation to determine if the DC does what it states. Combined, the two designs are put to extreme day-lasting tests for over 13 080 hours. This demonstrates that the company desires to implement long-term initiatives that yield positive results. The technical validation includes variables such as fuel type, duration of test

and mechanical utilisation. The testing reveals that the new design is equally as good as the old one. Therefore, in terms of technical performance the DC has passed the test. It is critical that the DC does not translate into poorer performance, especially since the main client for this product is one of the company's most prominent customers.

The technical validation perdured for 19 months. It is not unusual to take this long, since extensive research, testing and analysis is performed to ensure optimal performance of the DC (see figure 11 for example of testing report output).

The DC was accepted by all staff involved, from design engineers to product engineers.

Business Case Development Phase

The third phase, the Business Case Development, was initiated on June 2015. The initial stage revealed new tooling would be necessary, for an initial investment of $ 45,000, as previously mentioned. It was also concluded that there would be no additional logistical costs, packaging or any other associated costs. On the other hand, the results from the previous phase concluded the assembly would not change, as well as bearing forming and finishing. In regard to the cost saving from the DC, the cost per unit is reduced by $ 1.21[12], from the Industry Leader's (IL) $ 3.12 to $ 1.91 of the Large Manufacturer (LM). This reveals a 39% cost reduction in cost, whose benefits will increase with production volume.

At this time, the budgeted volume for the bearings, from November 2015 to October 2016, was 655,204 units, which protrudes an estimated production saving of $ 793,636, $ 198,409 in 2015 and $ 595,227 in 2016.

[12] The amounts mentioned in this analysis are fictional due to confidentiality matters, but are still aligned with actual information.

Taking all into consideration, the cost savings discounted at annual rate of 8%[13] and the $ 45,000 of new tooling concludes in a $ 689,848 NPV for this project[14]. The time to ROI is 21 days (see table 5). Given these two indicators, the DC was given the go-ahead.

Additionally, a final meeting was taken with the customer to demonstrate the performance of the DC, where the client authorised it.

Planning Implementation Phase

The Planning stage began shortly after, on September 2015. At this moment the purpose is to understand the readiness of supplier, concerning raw materials, packaging, customs and other logistical processes. It was concluded the LM would be available for production starting November 2015, the forecasted month.

Implementation Phase

On November 2015 the new part was fully instituted. For the following 12 months this part's production was closely analysed by the former PLPM. The bearings revealed no technical issues and the customer was satisfied with its performance as well. At the 1-year mark, the volume of bearings had been 628,466, which is slightly below the forecasted volume. However, the considerable NPV of this project allowed for such a difference, having almost no impact.

Impact of Design Change

In conclusion, the NPV of this project was indeed $ 659,860 and yielded a material performance, or cost saving, of $ 126,875 in 2015 and $ 634,374 in 2016. Considering that material performance for 2015 was $ 11 million and for 2016 $ 9.225 million, this single project represents 1.38 % in 2015 and 5.77 % in 2016 (see table 6 in appendix). Considering this is one

[13] Industry's cost of capital (Parkin *et al*, 2017).
[14] The technical validation cost is not considered since it is a sunk cost.

single project one can draw the conclusion that Kaizen Costing has a great impact on material performance.

This is a clear real-life scenario where Kaizen Costing greatly allows the company, by reducing its costs in this case. As demonstrated, a single daily task of material improvement promotes a significant production cost reduction. Kaizen Costing proves to be essential for continuous improvement in a competitive segment as the automotive industry.

Conclusion

Kaizen Costing is being applied since 1964 in order to improve companies' competitiveness and performance. This WP demonstrates how Kaizen Costing accomplish its goal, by applying it in Material Cost improvement, through a simple and constructive process.

Delphi Technologies has in use a Kaizen Costing process that drives Material Performance, or material cost savings, which is divided into five phases: Conception Generation, Feasibility Assessment, Business Case Development, Implementation Planning and Implementation. This process empowers Kaizen Costing, by promoting new ideas which greatly contribute to the company's material performance and consequently its financial performance.

The available evidence lacks content on effective and practical implementation of Kaizen Costing in material cost savings, more specifically in the form of processes and actionable phases, which is the reason of this WP.

The WP goes beyond current research because it reveals the actual process utilized by Delphi Technologies, a global enterprise with over $ 4 billion in yearly revenue, hence closing the gap between theoretical approach of Kaizen Costing and the implementation of it in a real-life scenario (cf. Ryan *et al*., 2002; Scapens, 2006). The WP describes in detail who are the people involved, what their tasks are, what is the information flow and how decisions are made. Moreover, the specific timeline for the example given enables the comprehension of the

complexity and time consumption of certain tasks. The WP also manifests with hard data the benefits of Kaizen Costing, portrayed in the actual volume cost saving of $ 761,249. The elements and circumstances that are present in the WP is what makes it stand out from current literature.

There were some limitations throughout the WP. The most pressing one is the limited time associated with a Master dissertation to carry out the research, which consequently gave rise to other restraints. This limitation damped the validity of the results presented, since the information available is overwhelming for the reduced time of the study. Furthermore, had there been more time, additional interviews would have been carried out, for instance with the Material Buyer and the Product Line Purchase Manager, with the intent of triangulating the results as well as given more details to their role in the respective phases.

Having said that, I would be interesting to dive into each of the phases to understand the entire process within the phase, instead of the high-level approach taken. What is more, the most fascinating phase to research would be the first one, since this is where Kaizen is more prevailing.

An element that was kept out from the WP is employee's satisfaction. As aforementioned, there is a place for Kaizen Costing in employees' involvement and satisfaction. Employees' motivation and proactiveness is important to correctly implement Kaizen Costing. Therefore, additional studies should be performed on the impact of Kaizen Costing on employee job satisfaction in the setting of a competitive industry, such as the automotive industry.

Bibliography

Agmoni, E. 2016. "The role of kaizen in creating radical performance results in a logistics service provider", *LogForum*. Vol 12 (3): 226-245

Desai, M.; Johnson, R. 2013. "Fishbone Diagram to Develop Change Management Strategies to Achieve First-Year Student Persistence", *SAM Advanced Management Journal*. Vol 78: 51-63

Feil, P.; Yook, K.; Kim, I. 2004. "Japanese Target Costing: A Historical Perspective", *International Journal of Strategic Cost Management*. 10-19

Glover, W.; Liu, W.; Farris, J..; Aken, E. 2013. "Characteristics of established kaizen event programs: an empirical study", *International Journal of Operations & Production Management*. Vol. 33 (9): 1166-1201

Jimenez, E.; Tajeda, A.; Perez, M.; Blanco, J.; Matrinez, E. 2011. "Applicability of lean production with VSM to the Rioja wine sector", *International Journal of Production Research*. Vol 50 (7): 1890-1904

Modarress, B.; Anssari, A.; Lockwood, D. 2005. "Kaizen Costing for lean manufacturing: a case study", *International Journal of Production Research*. Vol 43(9): 1751-1760

Mohr, D.; Muller, N.; Krieg, A.; Gao, P.; Kaas, H.; Krieger, A.; Hensley, R. 2017. "The road to 2020 and beyond: What's driving the global automotive industry?", *McKinsey and Company*. abstracted through https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-road-to-2020-and-beyond-whats-driving-the-global-automotive-industry accessed on November 1st, 2017

Monden, Y.; Hamada, K. 1991. "Target Costing and Kaizen Costing in Japanese Automobile Companies", *Journal of Management Accounting Research*. Vol 3: 16-24

Palmer, V. S. 2001. "Inventory management KAIZEN", *Proceedings, 2nd International Workshop on Engineering Management for Applied Technology*. EMAT 2001. IEEE, Inc: 55-56.

Parkin, R.; Wilk, R.; Hirsch, E; Singh, A. 2017. "2017 Automotive Industry Trends: The future depends on improving returns on capital", *PwC.* abstracted through https://www.pwc.com/kr/ko/industries/automotive/2017_automotive-industry-trends_en.pdf accessed on November 1st, 2017

Pawłyszyn, I. 2017. "Time-driven Activity-Based Costing as a basis for undertaking lean activities", *Scientific Journal of Logistics*. Vol 13(2): 135-149

Rajenthirakumar, D.; Nandhakumar, S. 2015. "Reduction of cycle time in screw air compressor assembly line using Kaizen Survey", *International Journal of Lean Thinking*. Vol 6 (2): 29-41

Registration or Sales of New Vehicles – all types. OICA –abstracted through http://www.oica.net/category/sales-statistics/ on Nov 2nd, 2017

Rodriguez, M.; Lopez, L. 2012. "Kaizen and ergonomics: the perfect marriage", *Work*. Vol 41: 964-967

Rof, M. 2011. "Kaizen Costing Method and its role in the management of an Entity", *The Young Economists Journal*. Vol 16:104-109

Ryan, B.; Scapens, R. W.; Theobald, M. 2002. *Research Method & Methodology in Finance & Accounting*, 2nd Edition, London: Thompson

Scapens, R. W. 2006. "Understanding management accounting practices: A personal journey", *British Accounting Review*. Vol 38: 1-30.

Schwarz, U.; Nielsen, K.; Stenfors-Hayes, T.; Hasson, H. 2017, "Using kaizen to improve employee well-being: Results from two organizational intervention studies", *Human Relations*. Vol 70 (8): 966-993

Serra, F. 2016. "Kaizen: Uma Metodologia Inovadora na Siderurgia", *Revista Ibero-Americana de Estratégia*. Vol 16: 92-98

Stefea, P.; Abbas, K. 2015. "Contributions to improving the use of ABC in Egyptian companies by implementing Kaizen Costing", *Agricultural Management / Lucrari Stiintifice Seria I, Management Agricol.* Vol 17(3): 69-76

Titu, M.; Oprean,, C.; Grecu, D. 2010. "Applying the Kaizen Method and the 5S Technique in the Activity of Post-Sale Services in the Knowledge-Based Organization", *International MultiConference of Engineers and Computer Scientists.* Vol 3:

Vaněk, M.; Špakovská, K.; Mikoláš, M.; Pomothy, L. 2015. "Continuous improvement management for mining companies", *Journal of the Southern African Institute of Mining and Metallurgy*. Vol 115(2):119-124

Westin, O.; Roberts, H. 2010. "Interventionist research – the puberty years: an introduction to the special issue", *Qualitative Research in Accounting and Management*. Vol 71: 5-12

Yin, R. 2014. *Case Study Research – Design and Methods*. 5th Edition. London: SAGE Publications

Appendix

Figures

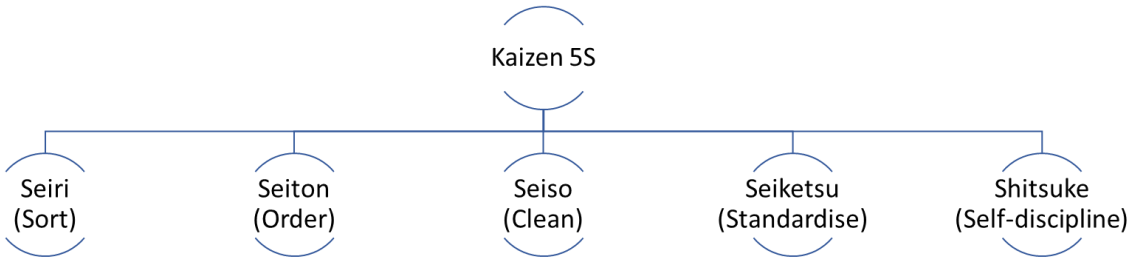

Figure 1 - Kaizen 5S

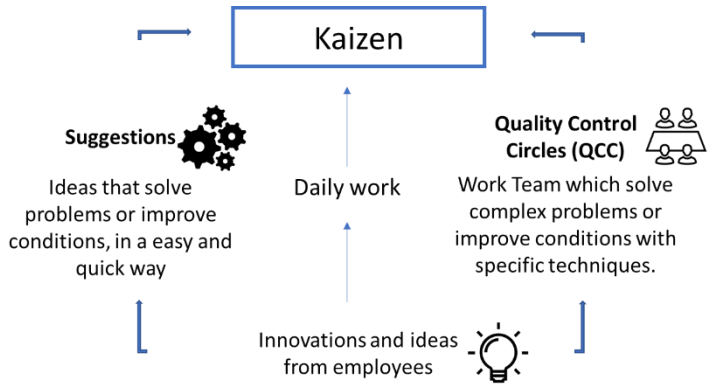

Figure 2 - Quality Control Circles

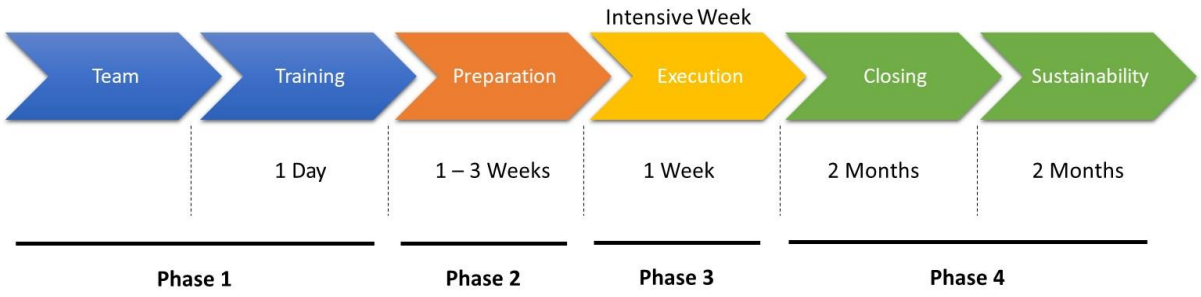

Figure 3 - Continuous Improvement Group Process

Day 1	Day 2	Day 3	Day 4	Day 5
Opening Meetng	Decision making on preferred solution	Solution implementation	Solution implementation	Standardize main actions
Idea brainstorm for solving issues	Solution implementation			
Causality Analysis				Tour around production lines
Management meeting	Management meeting	Management meeting	Management meeting	Presentation on results obtained

Figure 4 - Intensive Week

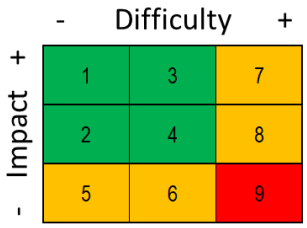

Figure 5 - Priority Matrix

Figure 6 - Deming Circle

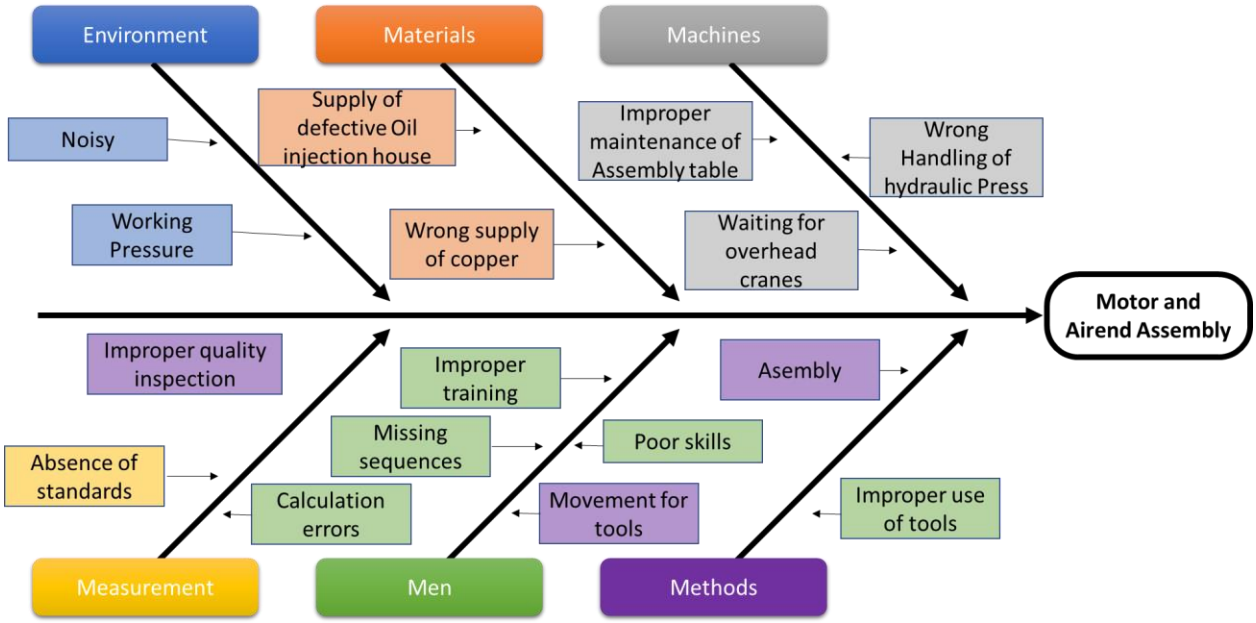

Figure 7 - Fishbone Diagram

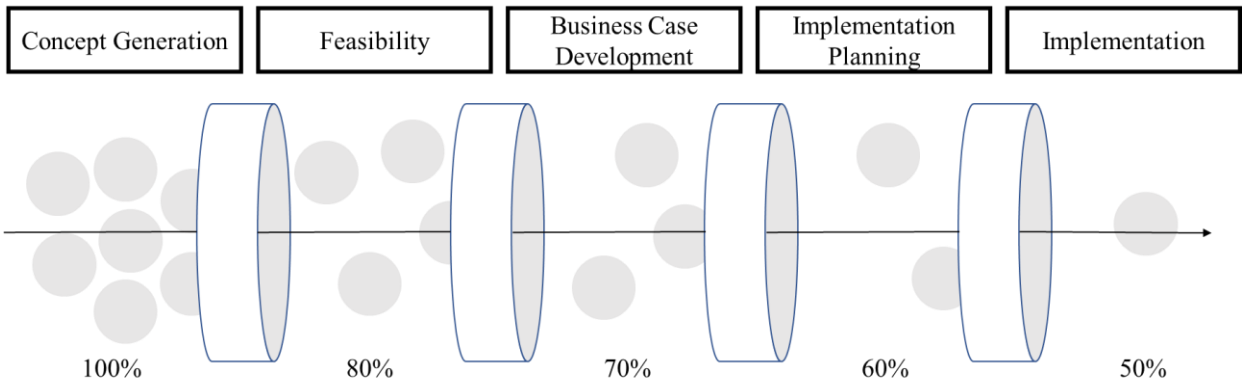

Figure 8 - General Initiative process – only half on initiatives proposed get implemented

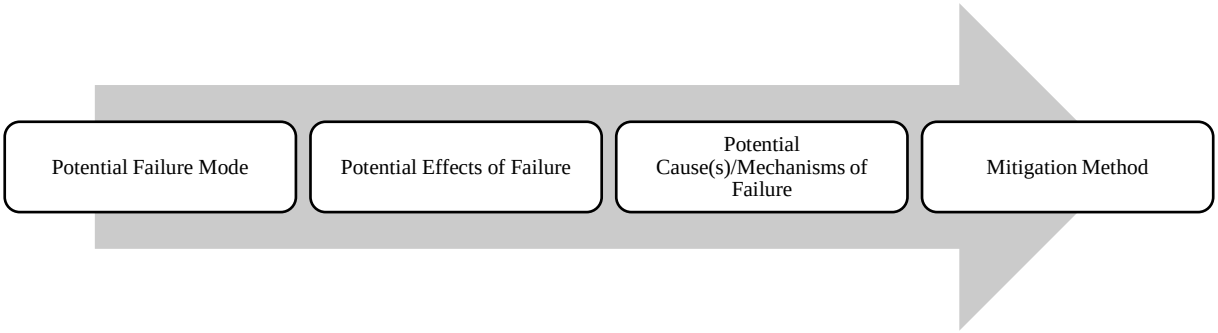

Figure 9 - Risk Assessment Procedure

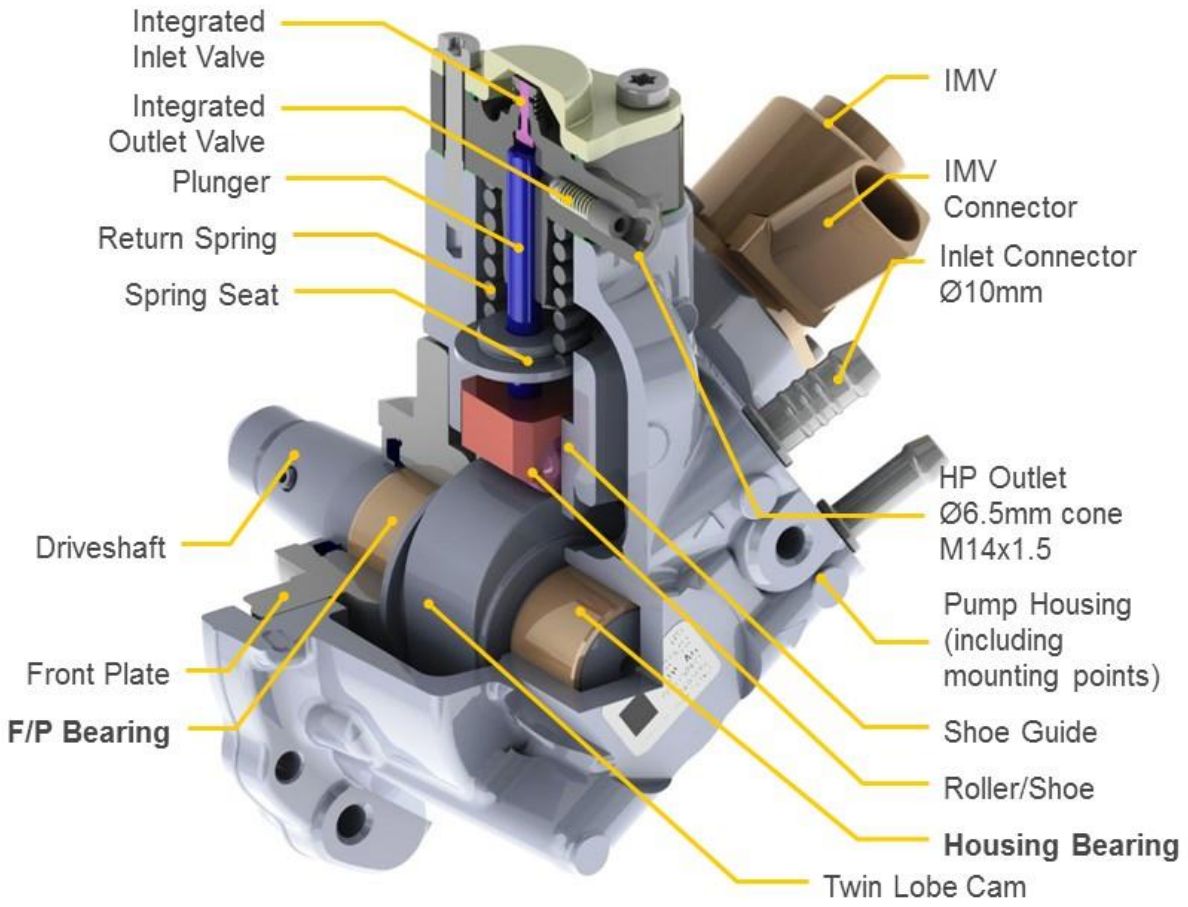

Figure 10 - DPF 6 showcasing bearings

	Part 1	Part 2	Part 3	Part 4	Part 5	Part 6	Part 7	Part 8	Part 9
Test 1	2	1	1	2	1	1	1	1	1
Test 2	1	2	1	1	1	1	2	2	2
Test 3	1	1	1	1	2	1	2	2	1
Test 4	1	1	1	1	2	2	1	1	1
Test 5	1	1	1	1	1	1	2	1	2
Test 6	1	1	1	1	1	1	1	1	2
Test 7	1	1	1	1	1	1	1	1	1
Test 8	1	1	1	1	2	1	1	1	1
Test 9	1	2	1	2	1	1	1	1	2
Test 10	1	1	2	2	1	2	1	2	2
Test 11	1	1	4	1	1	1	2	2	2
Test 12	1	1	1	1	1	4	2	1	1
Test 13	1	3	2	1	1	1	2	1	2

1	Minimum wear
2	Low wear
3	Moderate wear
4	Heavy wear, failure is imminent
5	Broken

Figure 11 - Standard output from testing phase

Tables

	Pre-ODI results	Post-ODI results	Percent Change	Percentage Industry Level during same period
Revenue (million USD)	15,106	21,503	42%	-
Air Freight Volume (tons)	-	3,189	-	3.10%
SCM Volume (000 cbm)	1,596	1,901	19%	-
Ocean Volume (TEUs)	675	2,668	295%	-9.90%

Table 1 - Agnomi's results from Kaizen Costing implementation

	Old Design Industry Leader (IL)	New Design Large Manufacturer (LM)
Raw Material	Peek P212	Peek DTK57 (includes proprietary blend)
Chamfer Cutting	Rolled	Cut
Blanking	From stell side to peek side	From peek side to steel side

Table 4 - Differences between the two designs

	Budgeted	Actual
Initial Investing (Tooling)	$ 45,000	$ 45,000
Cost savings at 1 year mark	$ 793,636	$ 761,249
Discount rate	8%	8%
NPV	$ 689,848	$ 659,860
ROI	1764%	1692%
Time to ROI	21 days	22 days

Table 5 - Decision metrics of budgeted and actual volumes

	Actual Savings		Total Performance Target	DC's weight on Performance
2015	$ 126,875	2015	$ 9,225,000	1.38%
2016	$ 634,374	2016	$ 11,000,000	5.77%
Total	**$ 761,249**			

Table 6 – Actual Savings and Material Performance

Dictionary

DC – Design Change

IL – Industry Leader

LM – Large Manufacturer

MB – Material Buyer

MCIP – Material Cost Improvement Process

NPV – Net Present Value

OEM - Original Equipment Manufacturer

PLPM – Product Line Purchasing Manager

ROI – Return on Investment

WP – Work Project