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Implementation of the Six Sigma methodology in SMEs: the Staccata Srl case

Supervisor: Prof. Alessandro Brun

Master Graduation Thesis by: Cristina Peruzzo
Student Id. number 735936

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Abstract

The pursuit of quality comes when two subjects are confronted with contradictory requirements: the producer-seller and the buyer-user. It is clear that any trading activity inevitably entails a quantitative and qualitative evaluation of goods, products and services. The evolution over the years, the concept of quality and the related statistical methods of measurement can be analyzed at the beginning of '900. From the second half of the century the approach to quality tends to be concentrated to a research problem in which each manager can or should be reduced to a set of statistic problem: identified the real problem, it is useful to proceed assessing what data are needed to give answer, how to detect them, from what source drawn it, such as statistical techniques used. From the data collection phase it is returned to the stage of data processing, before examining the results in the context of the problem formulated in managerial terms.

The classic definition recognizes the term as "the adequacy and suitability of the product or service" since this definition, generally accepted, also the monitoring of quality within organizations has evolved as a consequence.

The methodology for the dissemination and monitoring of quality is influenced by competition. The company is in fact an open system that works in close liaison with other larger systems, such as the market environment, which is an external reference from which the management can not ignore.

In the general context, each organization is entering into contact with more markets, which provides various reports with. The scenario in which a company operates is so complex and highly interrelated by several factors, and the need to understand this complexity is crucial. The understanding of the relationship between the factors must necessarily pass through a phase of description and measurement of phenomena, study of relationships between phenomena and decisions under uncertainty. The use of statistical data and statistical analysis is an important tool to emerge in this context.

Today the world is changing more rapidly than it has ever happened. Managers are faced with the need to address the rapidly changing external environment and adapt the concept of organization to new needs and market demands.

The cliché that the world is getting smaller is definitely true for all types of businesses. With the rapid advances in technology and communications, the effect of events occurring in different areas and localities, is transmitted and distributed in all areas in a short time. The world is becoming a global arena; the trade barriers fall faster and faster, communication becomes quicker and at a low cost and the consumer tastes converging in each field. This interdependence growth means that the environment is becoming increasingly complex and competitive for businesses.

Organizations must learn to cross the cultural and geographical boundaries of time, to survive. Every company, large or small, is looking for appropriate structures and processes that can help you to reap the benefits of global interdependence and minimize its disadvantages. A significant challenge is represented by the speed and effectiveness of response to environmental changes, the organizational crises, the changes in customer expectations. The leader companies, for example, know that their organizations must be prepared to constantly evolvement and adaptation, to follow the customers' needs, which require new and innovative products and services; while for the most of the twentieth century, companies had to operate inside a relatively stable economic environment.
In a scenario like this, the attention to quality becomes even more important. In particular, the concept of quality has begun to spread to the '60s, taking on different developments over time.

After introducing the concept of quality, I focus on the Six Sigma methodology, which is the latest way to improve quality, comprehensive and encompassing within itself all the principles and methodologies of the previous approaches, using not only a coherent system set of methodological techniques, but also an appropriate organizational structure.
Six Sigma is a structured approach to quality monitoring, aimed at continuously improving business. Starting from the research of the highest customer satisfaction as a priority, it adopts advanced tools that allow the collection of field data and analyze the information received to determine a value for the performances of their production processes to be compared with the needs and customer expectations, ensuring finally a real and concrete improvement of the system. The underlying principle is the measurability of the process of completing an analysis according to a precise structure through the use of statistical tools, with the goal that permits to reduce the variability of the process. Indeed, there is a clear correlation between the performance of a product life cycle and the amount of rework that had become necessary and / or difficulties that arose during the production. In other words, products with a smaller number of non-compliance during treatment are those that create fewer problems for customers during its use.
This result can be achieved through a planned and sustained effort tends to reduce variability and through the improvement of the ability of a process, getting a substantial reduction of all costs associated with low quality.
The interviewed companies (*FGA Spa, Telecom Italia Spa and Whirpool Corporation Spa*) that have implemented Six Sigma claim to be fully satisfied with the final result achieved and everyone can now argue that the methodology applied in the right context guarantees maximum satisfaction. But what are the conditions that an organization must have in order to implement this methodology? These conditions exist only in large multinational companies that have actually entered the Six Sigma in their structure, or can meet and / or be developed in small and medium enterprises, typical

of the Italian system? Which is the development margin to adapt the instrument to these organizations with fewer investment opportunities, resources, knowledge and skills?

The following sections present the organizational and statistical techniques necessary for an effective implementation of Six Sigma in a way that they are streamlined and understandable by everyone. Then, the chapter deals with companies cases like *FGA SpA*, *Telecom Italia SpA* and *Whirpool Corporation SpA* who are working to disseminate this tool into their business reality in order to define the conditions that allowed the company to implement a successfully Six Sigma methodology and assess the real possibility of finding such conditions in a medium-small organization like *Staccata Srl* (Italian start-up).

The main objective is to provide a concrete idea about the possibility of undertaking in the future the development projects of Six Sigma in *Staccata Srl* that doesn't still know this new methodology, and trying to provide all the relevant information relating to:

- The conditions necessary for its proper application,
- The factors that make it possible to verify the existence of such conditions,
- The actions to be taken to organize the structure in an optimal way to best support a project of these characteristics,
- A real chance to achieve real results by applying statistical tools commitment and perseverance.

In this way, it is possible for *Staccata Srl* to guess solutions to hack the possible lack of requirements for an effective and correct application of the methodology, pointing out the advantages that a company can seek if it decides to implement Six Sigma in one or more business processes and stressing the importance of the diffusion and the use of sophisticated tools in line with the times, without forgetting at the same time the commitment and effort required at all levels and at all hierarchical functions: from the top management to the operational staff.

Sommario

La ricerca della qualità nasce nell'istante in cui vengono a confrontarsi due soggetti con esigenze opposte: il venditore-produttore e il compratore-utilizzatore. E' infatti evidente come ogni attività di scambio comporti inevitabilmente una valutazione quantitativa e qualitativa delle merci, dei prodotti, dei servizi. L'evoluzione nel corso degli anni del concetto di qualità e delle relative metodologie statistiche di misurazione può essere analizzata a partire dall'inizio del '900. Dalla seconda metà del secolo l'approccio alla qualità tende a concentrarsi verso un percorso di ricerca in cui ogni problema manageriale possa o debba essere ricondotto a un problema impostato statisticamente: individuato il problema reale, si procede a valutare quali dati occorrono per darne risposta, come rilevarli, da quale fonte attingere, quali tecniche statistiche utilizzare. Dalla fase di raccolta dati si passa quindi alla fase di elaborazione dei dati, prima di esaminare i risultati nel contesto del problema formulato in termini manageriali.

La definizione classica riconosce nel termine qualità "l'adeguatezza e idoneità all'uso del prodotto o servizio"; avendo questa definizione, genericamente accettata, è evoluto di conseguenza anche il monitoraggio della qualità all'interno delle organizzazioni.

La metodologia di diffusione e monitoraggio della qualità è influenzata dall'ambiente competitivo. L'impresa è infatti un sistema aperto che opera in stretto collegamento con altri sistemi più ampi, quali il mercato e l'ambiente, che costituiscono un riferimento esterno dal quale la gestione aziendale non può prescindere. Nel contesto generale, ogni organizzazione opera entrando a contatto con più mercati, con i quali stabilisce diverse relazioni. Lo scenario in cui opera un'azienda è pertanto complesso e fortemente interrelato a diversi fattori, e la necessità di comprendere questa complessità è un aspetto cruciale. La comprensione delle relazioni tra i fattori passa necessariamente attraverso una fase di descrizione e misurazione dei fenomeni, di studio di relazioni tra i fenomeni, di decisioni in condizioni di incertezza. Il ricorso a dati statistici e analisi statistiche costituisce uno strumento importante per emergere in un simile contesto.

Oggi il mondo sta cambiando più rapidamente di quanto sia mai successo. I manager si trovano di fronte alla necessità di fronteggiare il rapido cambiamento dell'ambiente esterno e di adattare il concetto di organizzazione alle nuove esigenze e richieste del mercato.

Il luogo comune secondo cui il mondo sta diventando più piccolo è decisamente vero per tutte le tipologie di imprese. Con i rapidi progressi nel campo della tecnologia e delle comunicazioni, l'effetto di eventi che si manifestano nelle diverse zone e località viene trasmesso e diffuso in tutte le aree in tempi brevissimi. Il mondo sta diventando un'arena globale; le barriere commerciali cadono sempre più rapidamente, la comunicazione diventa più veloce e a basso costo e i gusti dei

consumatori convergono in ogni campo. Questa crescente interdipendenza implica che l'ambiente sta diventando estremamente complesso e competitivo per le aziende. Le organizzazioni devono imparare ad attraversare confini temporali, culturali e geografici per poter sopravvivere. Ogni azienda, grande o piccola, sta cercando le strutture e i processi adeguati che possono aiutarla a raccogliere i vantaggi dell'interdipendenza globale e minimizzarne gli svantaggi. Una sfida significativa è rappresentata dalla rapidità e incisività di risposta ai cambiamenti ambientali, alle crisi organizzative, alle modificazioni delle aspettative dei clienti. Le aziende leader, ad esempio, sanno che le loro organizzazioni devono essere costantemente pronte a evolvere e adattarsi, per seguire le esigenze dei clienti, che richiedono nuovi prodotti e servizi personalizzati ed innovativi, mentre per gran parte del ventesimo secolo le aziende potevano operare all'interno di un ambiente economico relativamente stabile.

In uno scenario di questo tipo, l'attenzione alla qualità assume sempre maggior importanza. In particolare, il concetto di qualità ha iniziato a diffondersi verso gli anni '60, assumendo nel corso del tempo differenti evoluzioni.

Dopo aver introdotto il concetto di qualità, mi sono soffermata sulla metodologia *Six Sigma*, che rappresenta la modalità più aggiornata e completa per migliorare la qualità e che ingloba in sé praticamente tutti i principi e le metodologie degli approcci precedenti, avvalendosi non solo di un sistema coerente di tecniche metodologiche, ma anche di una struttura organizzativa appropriata.

Il metodo Six Sigma è un approccio strutturato di monitoraggio della qualità, finalizzato al miglioramento continuo aziendale. Partendo dalla ricerca della massima soddisfazione del cliente come obiettivo prioritario e fondamentale, adotta strumenti evoluti che permettono la raccolta sul campo dei dati e l'analisi delle informazioni recepite per giungere a determinare un valore relativo alle performance dei processi produttivi da confrontare proprio con le necessità e aspettative dei clienti, garantendo infine un miglioramento reale e concreto dell'intero sistema.

Il principio di fondo è la misurabilità del processo che consente di condurre un'analisi seguendo una precisa struttura tramite l'utilizzo di strumenti statistici, con il costante obiettivo di diminuire la variabilità del processo stesso. Esiste, infatti, una precisa correlazione fra la performance di un prodotto nel ciclo di vita e la quantità di rilavorazioni resesi necessarie e/o difficoltà emerse durante la produzione. In altre parole, i prodotti con un numero minore di non conformità in fase di lavorazione sono quelli che creano meno problemi ai clienti durante l'utilizzo. Questo risultato può essere raggiunto attraverso uno sforzo costante e pianificato tendente alla riduzione della variabilità e al miglioramento della capacità di processo ottenendo, inoltre, una sostanziale riduzione di tutti i costi legati alla bassa qualità.

Le aziende intervistate (*FGA Spa, Telecom Italia Spa e Whirpool Corporation Spa*) che hanno applicato il Six Sigma dichiarano di essere pienamente soddisfatte del risultato finale raggiunto e tutti possono oggi sostenere che tale metodologia applicata nel giusto contesto garantisca la massima soddisfazione.

Ma quali sono le condizioni che un'organizzazione deve avere per poter implementare una metodologia di questo tipo? Tali condizioni esistono solo nelle grandi realtà multinazionali che hanno realmente inserito il Six Sigma nella propria struttura, o possono ritrovarsi e/o venire sviluppate anche in medio-piccole imprese, tipiche del sistema italiano? Che margine di sviluppo esiste nell'adattare lo strumento a queste organizzazioni dotate di minori possibilità di investimenti, di risorse, di conoscenze e competenze?

Nei seguenti capitoli sono presentate le tecniche organizzative e statistiche richieste per un'efficace implementazione del Six Sigma in maniera tale che risultino snelle e comprensibili da tutti. Quindi, il capitolo tratta di casi di aziende quali: *FGA Spa, Telecom Italia Spa e Whirpool Corporation Spa*, le quali stanno lavorando per diffondere questo strumento nelle loro realtà aziendali, al fine di definire le condizioni che hanno permesso all'azienda stessa di implementare con successo la metodologia Six Sigma e di valutare la reale possibilità di trovare tali condizioni in una organizzazione medio-piccola come Staccata Srl (start-up italiana).

L'obiettivo principale è quello di fornire un'idea concreta circa la possibilità di intraprendere nel futuro progetti di sviluppo del Six Sigma in *Staccata Srl* che ancora non conosce tale metodologia, cercando di fornire tutte le informazioni principali relative a:

- Le condizioni necessarie per una corretta applicazione;
- I fattori che permettono di verificare l'esistenza o meno di tali condizioni;
- Gli interventi da attuare per organizzare la struttura nella maniera ottimale per supportare al meglio un progetto di queste caratteristiche;
- La reale possibilità di ottenere risultati concreti applicando con impegno e costanza gli strumenti statistici

In questo modo, è possibile per *Staccata Srl* intuire le soluzioni per poter fare fronte all'eventuale mancanza dei requisiti richiesti per una corretta ed efficace applicazione della metodologia, ricordando i vantaggi che un'impresa può ricercare qualora decida di implementare il Six Sigma in uno o più processi aziendali e sottolineando come sia importante la diffusione e l'utilizzo di strumenti sofisticati in linea con i tempi, senza però dimenticare allo stesso tempo l'impegno e lo sforzo necessario, richiesto a tutti i livelli e a tutte le funzioni gerarchiche, dal top management al personale operativo.

Chapter 1 The Six Sigma methodology

1.1 The history of Six Sigma

An organization adopt an approach of continuous improvement to ensure a high level of quality of processes and products, with the primary objective to acquire a stable competitive advantage over its competitors. It must plan and implement monitoring processes, measurement, analysis and improvement[1].

The Six Sigma methodology addresses the need for all organizations that have as final objective the achievement of Total Quality. Six Sigma is a strategy, a culture and a language necessary to get the company significant cost savings.

In recent years a large number of entrepreneurs, executives managers and consultants have been involved in projects relating to this content and purposes, initially in the U.S., then around the world [2].

The history of Six Sigma began at Motorola, through statistical studies of Mikel Harry, a statistician, who noticed the correlation between change processes and customer dissatisfaction. After communicating the importance of measuring these changes, his colleagues involved in implementing a series of tools to reduce and control the size, significantly improving the efficiency and effectiveness; the results of his work were collected in a document "The yellow brick road to Six Sigma", which came to the organization's CEO, Bob Galvin, encouraging him to immediately adopt a Six Sigma philosophy for all business processes.

The methodology soon became a true philosophy by which was given to personnel operating a new awareness of the concept of product and process. Motorola was the first company that has distinguished itself by ensuring the full participation and commitment to quality. This program, which in 1992 led to the achievement of a situation consistent with the objective processes of Six Sigma, led to a period of growth and unprecedented sales and led Motorola to win several national awards in the field of quality. In 1995 Motorola was one of the first American company to win the Malcolm Baldrige[3].

1 “www.aslrmc.it”

2 M. Gibertoni, “Six Sigma e azienda snella”, prefazione. Il Sole 24 Ore

3 G. Eckes, “Introduzione a Six Sigma”, Hoepli

It should be noted that the term "Six Sigma" is a registered trademark of Motorola, as it was the Motorola engineer Bill Smith in coining the name and today the company can estimate a reduction of losses, waste, scrap and defects on a total of 17 billion dollars since its inception until 2006[4]. Motorola has been identified as an international reference for total quality. Mikel Harry founded in 1994 the Six Sigma Academy, in collaboration with the former manager Richard Schroeder. Through this Academy the methodology is spread in international companies, including General Electric, Honeywell, Microsoft and Allied Signal[5].

The most important figures were Lawrence Bossidy and Jack Welsch, who are the main exponents of Six Sigma respectively in Allied Signal and General Electric.

In 1991 Bossidy decided to cope with the major crisis that was going through his company introduced a significant improvement of performance through the development of a dedicated team with the aim of spreading and practicing Six Sigma. The brilliant achievements over three years, which allowed the organization to significantly improve its reputation among customers, pushed Welsch, who was a student when Bossidy worked at General Electric, to contact them to ask for their return, with the aim of implementing the methodology in all processes of the value chain.

Today it can be argued that General Electric is the company that took full advantage, thanks to formal support and participation of the entire management that is strongly requested by Welsch[6], which has operated in such a way that GE becomes the first company that has published the methodology at all levels of its organization. Already in 2000, the first year of implementation of the overall project, GE has saved the equivalent of 6.6 billion dollar[7].

By the time the Six Sigma methods have been developed in many different areas of production, such as financial services. When it is applied to IT, for example, Six Sigma can focus on internal processes (such as software development) or on those processes supported by IT business, and is considered an excellent choice for CIOs that looking for tools to measure the ROI of investments. Many large companies create Six Sigma team to manage major IT projects.

On the basis of Six Sigma application there must certainly be strong investment in mainly economic elements, but also of human resources and time detract from everyday activities. Given

4 "www.europe.isixsigma.com"

5 P. L. Floris, "Six Sigma, organizzare l'azienda partendo dal cliente", F. Angeli

6 G. Eckes, "Introduzione a Six Sigma", Hoepli

7 "www. europe.isixsigma.com"

these motivations, these methods are not suitable for companies without solid leadership and for realities in crisis. They are also very suitable for very small organizations, and for business models based on the very close relationship with customers and therefore on the abilities that are difficult to measure and to analyze with statistical techniques.

These are ideal for companies focused on improving operational efficiency or product leadership in high quality[8].

The Six Sigma methodology has in fact been taken mostly from major corporations and industry groups. Initially in Italy, the spread has been checked in branch offices and plants of foreign multinationals such as GE, Whirlpool, ABB, Motorola, and has also taken hold in big Italian companies like Italtel and various overseas companies such as Fiat Avio and Iveco. Then the long wave of Six Sigma began to involve the supply chains of these large industrial groups.

1.2 The characteristics of Six Sigma

The Six Sigma approach indicates a Quality Management program that relies on the control of variance and it is proposed to increase the quality of products and / or services at an optimal level, focusing on customer satisfaction and needs. There are three main macro objectives to be achieved with this type of approach[9]:

- Improve customer satisfaction,
- Reduce the defects of business processes,
- Speeding up business processes.

Six Sigma, compared to business strategies based on quality, is different since it has a strategic time part not only to develop the full commitment of management, but it requires his active participation, so the concept of quality is transmitted from the top and it can reach the function of encouraging staff. At the project level, Six Sigma tactics requires the formation of a dedicated team for a period of 4-6 months, which implies that the personnel involved should spend about 20% of their time working on the project.

This possibility becomes real and feasible only if resources recognize the importance of the project and consider it an opportunity to improve a problematic situation[10].

8 D. Lazzarin, " La metodologia Six Sigma"

9 G. Eckes, "Introduzione a Six Sigma", Hoepli

10 P. L. Floris, "Six Sigma. Organizzare l'azienda partendo dal cliente", F. Angeli

In detail, the term Six Sigma relies on the statistics that is on the base of it: “The ultimate goal of the project is trying to get a paltry number of defects, such as business process to associate a value of 6 Sigma”. The Sigma is a statistical indicator that determines the goodness of the current process performance compared to how it should be, and it consists to translate the output of a process in units of standard deviation of the standard normal distribution. Sigma, in greek, is the letter used to describe the variability. Applying the normal curve, Six Sigma wants to relegate the problems of defect and quality in the tails of the distribution so that these problems result, in rare cases, to be a process that operates almost without defects.
A process is considered optimal if it conforms to 99.99%.

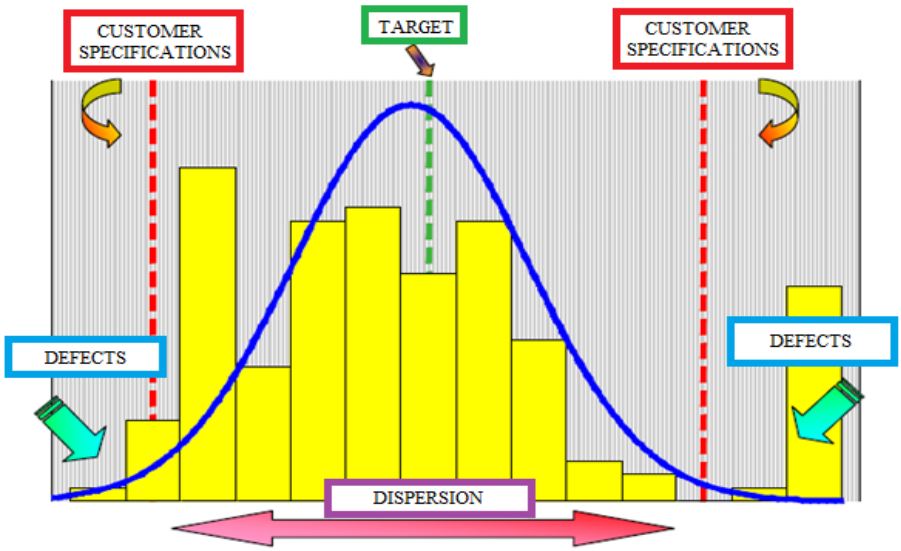

Illustration 1.2.1:Rrepresentation of a Gaussian process with low value of sigma

From here it is developed the concept of Six Sigma to indicate a highly disciplined process that allows to develop and deliver products or services that border on perfection. The word has a statistical significance that measure the deviation from the perfection of a process. The main idea is: if you can measure how many defects there are in a process, you can eliminate them systematically to zero. Pursuing the Six Sigma means that any process or product should be achieved without "Muda", ie without waste, squander, errors, ... ensuring the maximum satisfaction and total final customer needs[11]. To calculate the goodness of a process, it refers to three basic concepts:

- Yield (% goodness),
- DPMO (Defects per Million Opportunities),
- Sigma Process (best sensitivity for good jobs).

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11 M. Gibertoni, “Sei Sigma, il sapere minimo”

The DPMO is the ratio multiplied by 1,000,000, between the number of defects (in the sense of comments that do not meet customer requirements), and the total number of opportunities, calculated as the product of number of opportunities for the unit and the number of total units processed. The DPMO index allows an immediate evaluation on the fate of a process and its variability.

The yield is calculated by the difference between 1 and the value obtained for the DPMO[12]. Define these values, it is possible to trace the value of Sigma.

DEGREE OF COMPLIANCE	DPMO	SIGMA	COST OF QUALITY
60,000%	680.000	1	40-50% OF TURNOVER
69,150%	298.000	2	30-40% OF TURNOVER
93,320%	67.000	3	20-30% OF TURNOVER
99,380%	6.000	4	15-20% OF TURNOVER
99,997%	233	5	5-15% OF TURNOVER
99,999%	3,4	6	< 1% OF TURNOVER

Illustration 1.2.2: Tables of sigma value

The value of Sigma represents the standard deviation and is equivalent, on the Gaussian curve, the distance between the central axis and the point at which the curve passes from convex to concave trend. The amplitude range over which the measurement values are distributed is called dispersion.

Quality is assessed through the ongoing confrontation between input and output, ie by analysis of the causes and process variability. The Six Sigma can be reached only in the presence of controlled processes, such that the eligibility of error appears to be close to zero.

It is verify the so-called "stiletto effect", which involves a Gaussian curve where mode, median and limitations coincide, through sequential stages that lead to losses and thus reduce the variability.

The median is the central element of a numerical sequence in ascending order, is an index that can be expressive of the phenomenon observed when the statistics are characterized by low

12 M. Gibertoni, "Six Sigma e azienda snella", Il Sole 24 Ore

variability. Mode is the value in a data set that occurs more frequently; it is significant when you want to know the size of a predominantly statistical distribution. Media, mode and median size are indices that provide the synthetic expression of a phenomenon when he is represented by a number of quantitative observations. In other words, they can replace a single significant value to a series of statistical data. As they give concise expression of the observed phenomenon, instead the indices of dispersion provide a measure of its variability, that is, more or less distant from the value of statistical data from their mean value[13].

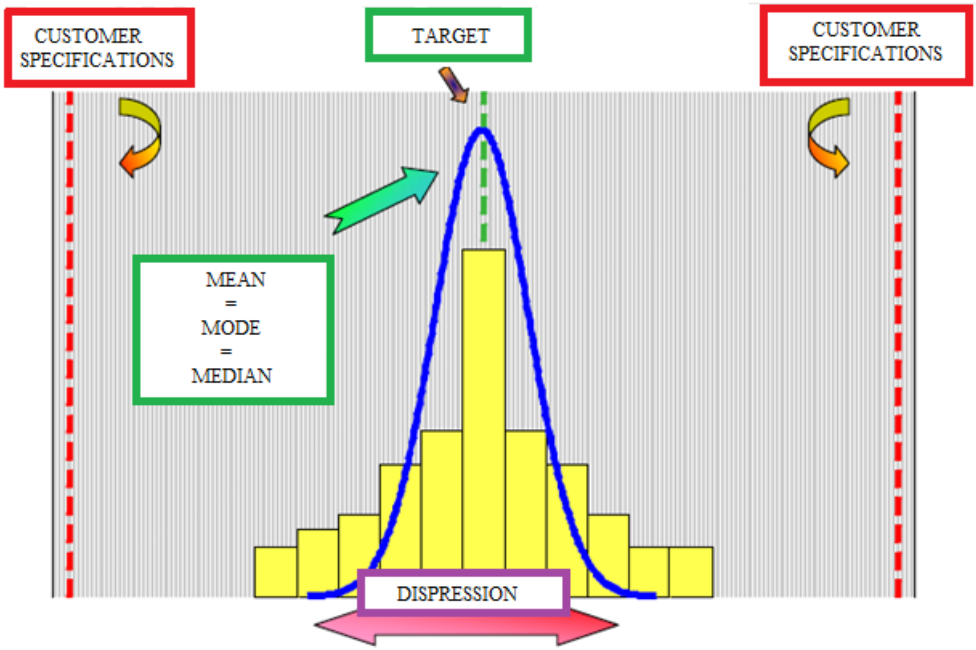

Illustration 1.2.3: Gaussian representation of a process aimed at 6 sigma

The outcome of the Six Sigma methodology is advanced in the use of specific tools, through a statistical analysis of the problem and / or situation, these tools provide the ideal solution for process management. The Six Sigma translates customer expectations in terms of operations of the organization and defines the critical processes and core activities to be carried out aiming at excellence in order to eliminate the defects. For customers not only means the final recipient of the product or service, but also all those who receive the results of an activity or operation, both internal and external[14].

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13 "www.statsoft.com"

14 P. L. Floris, "Organizzare l'azienda partendo dal cliente", F. Angeli

Six Sigma is a philosophy of production, highly operational and practical, aimed at achieving excellence in various business activities in order to give the customer a product and excellent service, in line with the more ambitious expectations. It 's the achievement of results, made possible by studies done to collect the various techniques of Total Quality Management and focus on their application to the objectives of excellence of the processes[15].

1.3 The success factors

After presenting the characteristics and describing the approaches and main tools of Six Sigma methodology, it is interesting to see what are the concrete benefits that an organization can track and assess the full scope of Six Sigma, if there are any limits and / or minimum essential in order to establish an adequate even for the small to medium enterprises spread in our country.

The success depends not only on the use of appropriate statistical tools. It is crucial the total involvement of the management perspective of a philosophy that seeks excellence in customer satisfaction, continuous improvement and learning processes. This approach must be widespread and be extended to all hierarchical levels, so that the company can achieve benefits, both short term and long term, these benefits would improve the market competitiveness and achieve cost savings to be reinvested in innovative activities[16].

In detail, the positive result in the short-term consist of[17]:

- Development and improvement of know-how and technical and managerial skills,
- Reduction of errors, defects, waste, rejects, returns,
- The use and dissemination of tools and methodologies throughout the organization,
- Improving communication within the company, in all departments,
- Implementation of a working group organized in teams,
- Sharing of the success or failure and responsibility, merits, demerits.

But the results expected by the top management, given the investments made by the organization, are mainly those of medium to long term. Companies exist to make a profit, accessible by the presence of extremely satisfied clients, who recognize that the product offered and / or the

15 R. Tartari, “Manuale del Sei Sigma”, F.Angeli

16 Sinedi, “Evoluzione delle iniziative per la qualità: l’approccio Six Sigma”

17 P. L. Floris, “Six Sigma. Organizzare l’azienda partendo dal cliente”

service provided fully reflects their expectations. The matching of needs enables organizations to be effective and be known and recognized as such on the market. It is not sufficient, however, that efforts be concentrated exclusively on the effectiveness for customers, because, to be profitable, an organization should strive to be efficient. This concept concerns the amount of resources consumed to be effective and can be measured in terms of time, cost, labor and value[18].

At the basic level, Six Sigma aims to improve simultaneously both the effectiveness and efficiency, guaranteeing the company to achieve tangible economic results that will enable the top management to recover the money invested in the project and to obtain significant and demonstrable benefits market in order to significantly improve its competitive position[19]:

- Reduction of production costs,
- Reduction of non-quality costs,
- Reduction in delivery times,
- Reduce time to market,
- Improved productivity and efficiency,
- Achieving the highest customer satisfaction,
- Growth in the value of the company,
- Increased profits.

The Six Sigma has proven over the years that it can be reasonably designed to achieve substantial results presented, assuming that the real source of the success of the methodology appears to be the staff. Highly motivated, involved, positive and competent human resources are required, , to which it is possible to subtract time from their jobs to devote themselves to work that make up the project. An organization must first analyze their own internal situation, to ensure its compatibility with the overriding need in terms of time and human and financial resources. To implement a successful methodology, the first step is to understand and identify the needs and capabilities of those resources in a given period and the business environment in order to activate appropriate procedures and methodologies, adapted to individual situations and not generally standardized[20].

The organizations are in fact a structured system where functions and variables are interconnected. The application of certain concepts and tools is therefore a function of the situations, the dynamics that the company faces over time, ultimately local events. There are no pre-established standards and models, indeed there are tools and concepts to know and apply, wholly or partially, depending on the utility and contribution to the improvement that can be provided.

18 G. Eckes, “Introduzione a Six Sigma”, Hoepli

19 R. Tartari, “Manuale del Sei Sigma”, F. Angeli

20 M. Gibertoni, “Six Sigma e azienda snella”, Il Sole 24 Ore

Knowledge and human capacity are the primary guarantee success[21]. The success of projects geared on getting the maximum value attributable to the sigma of the process clearly depends on the specific conditions that the organization must first know, then share them in order to ensure and to enforce[22]. Presenting in detail the success factors, it is very interesting try to figure out which are already in business reality, which is necessary to set and build and which can be managed outside the organization. The important thing is that an enterprise present a general framework in which these conditions are cumulatively present and interconnected with each other.

a) *Plan of Implementation*. It 's the first step towards successful implementation, as demonstrated by the failures of projects in which the organization has neglected the development of the plan. It must be defined precisely and in detail, so that it can play a true supporting role. The management of any company is responsible for the strategy of execution of work, elaborated in a plan or method by which to formalize the steps to be followed to achieve a goal or an outcome clearly identified[23].

b) *Active involvement of management*. Concept whose importance depending not so much critical approval of costs and resource allocation, because as a practical support. Management must believe in the project and communicate this belief to all the functions involved. Must clearly define the objectives, check the progress and success of the partial activities implemented. Must be present in all key stages in order to make information available to the team's own ideas, skills, knowledge and experiences. The other qualitative approaches of the past simply requires management to nominate and select the figures that were placed inside and outside the lead partner. With Six Sigma, the work begins and spreads through the top management, which is responsible for monitoring and control[24].

c) *Organizational Infrastructure*. The company must first organize a team to support the project that is defined, functional, consistent and sustainable. The team must have access to facilities and all the tools required for a complete implementation of planned activities.

d) *Informatics infrastructure*. One of the major limitations that lead to Six Sigma project is the lack of an efficient system of monitoring and control. It is important to have an infrastructure that allows to receive, organize and translate the information gathered in decisions. This system must be perfectly known and used in all phases of the project. There are in addition

21 C. Donini, “Lean Manifacturing”, F. Angeli

22 P. L. Floris, “Six Sigma. Organizzare l’azienda partendo dal cliente”

23 G. Eckes, “Introduzione a Six Sigma”, Hoepli

24 G. Eckes, “Introduzione a Six Sigma, Hoepli

specific software that can easily calculate indices of complex process required by the most advanced and sophisticated tools such as Design of Experiments, Total Productive Maintenance, the FMEA, the Anova, Quality Functional Deployment, indexes Capacibility Process.

e) *Review of projects*. Provide an overview of the progress and implementation to ensure that these are respected and followed the guidelines. Not intended to propose technical solutions, but mainly to know the status of the project, to renew the trust and promote knowledge.

f) *Technical support*. Unlike the revisions, it is a real support that the project leader must provide to the personnel to overcome the barriers born mainly because of technical issues to which you cannot find an immediate solution and shared.

g) *Allocation of resources*. The organization must perceive the project's impact on the corporate structure in order to establish the number of resources and commitment required to define each of them individually in terms of time. This is a decision made on an individual basis, dependent on the type of company and industry. The top management must be responsive and ready to review the allocation of staff during the development of activities.

h) *Training*. To ensure a successful Six Sigma project, it is essential that the functions involved have the skills to perform the required tasks to the best. Usually, this knowledge does not appear to be already fully present, the company must define and draw up a plan for training, planning time, materials and resources as to make sure the assessment of the effectiveness of training. The investment in training is a necessary, not only for members of the team, but also for the same management that will act as a sponsor of the project (100).

i) *Communication*. The training appears to be the first step towards the involvement of people. The second step consists in the transmission and communication of project goals, methods, objectives, expected benefits of the reach of individual and corporate level and the customer benefit. This communication is intended to hear the entire organization active part of the project, so they can be shared responsibility for common and widespread. Empowerment, involvement, delegation and the power to make proposals must become an integral part of corporate culture. This becomes feasible if the Management demonstrates the power to rethink the business to boost excellence in process and this change in attitude must be transmitted to all levels of hierarchy, since then the team should be the real creators of processing[25].

j) *Prioritization and selection of the project*. The top management must clearly understand the end point of the project, first by defining the characteristics of the project, thus providing a degree of priority to be assigned in order to prevent delays, misunderstandings, frustrations

[25] Sinedi, "Evoluzione delle iniziative per la qualità: l'approccio Six Sigma"

due to non-selection. To select the project, the organization is based on criteria of business benefits, feasibility criteria, criteria of organizational impact, financial,...

k) *Tracking project*. A system to track and record all projects warrant to monitor all activities in progress and reporting projects proposed but not accepted in order to prevent them from being replicated. Allows you to provide information to the team and reporting to extract useful for analysis at regular intervals.

l) *Incentive Program*. Training and staff involvement are the first step necessary to make the resources involved and actively engaged. Since the project is very expensive in terms of time and energy, and taking into account the fact that the team may struggle with failures related to the outcomes of individual activities, the organization must select the best people with the appropriate features, then identify and create incentives for the achievement of individual and group. The Six Sigma should be evaluated as a means to career advancement, not as a means to create personal turmoil, hardship and career blocks. Scholars consider Six Sigma a new paradigm of human resource management, as it is defined as a business model consists of general representations, assumptions and methodological principles, the application allows, through the involvement of staff, to make progress in knowledge scientific needs of the customer. The incentive appears to be a primary condition for motivation of staff, a problem which is being presented with particular severity, also in relation to the welfare of the modern era. The standard of living is significantly increased, as well as increasing levels of education, at this point that seems increasingly difficult to motivate staff. But organizations without motivated staff can not pursue excellence required by Six Sigma for customer satisfaction in companies must therefore create conditions favorable for each one if his motivation.

m) *Open environment*. As mentioned, the Six Sigma requires long-term efforts and considerable investment that will lead to actual results only after a long time. This can be frustrating and discouraging many resources. It is necessary that people need to be positive and have no fear of repercussions. An open environment allows the identification, sharing and solving problems, in terms of improved learning.

n) *Involvement of stakeholders*. Six Sigma is a business strategy, and as such, takes into account the Porter value chain. A condition for success is to ensure an efficient supply chain to meet demand and customer requirements. The project begins and ends with the customer, through two basic steps and consequential damages. The organization must first identify the core competencies, outputs and key customers who benefit from these primary output. The next step is to define the needs and expectations of the customer, taking into account their variation

and their evolution continues. Identify the requirements, improving the quality of its service in line with what the customer wants.

To achieve this, it is essential to identify and involve key suppliers, as the purchased product is the starting point of the production process. To this end, it can be appropriate to include the same supplier at different stages of the project and involve them in training and communication. A big problem that causes the failure of the Six Sigma methodology depending on the collaboration with suppliers of poor quality or with attitudes not in keeping with the perspective of continuous improvement of the organization. It can reconcile the needs of the person, as a customer outside and inside the company, both market, provided that all those who implement and manage processes are strongly convinced of the centrality of the client and witness with constancy and coherence that conviction[26].

o) *Culture Change*. The organization shall require that within the common mentality is spreading for change methodologies and working procedures. Resistance to change is a major cause of failure of the Six Sigma methodology. The constraints that may present a company may be technical, political, individual and organizational. The project requires that all these four aspects are positive at the same time and for the entire duration of the project. Strategic management, Six Sigma, therefore, requires a real rethinking of business by the management. The limit of this condition will be difficult to decipher the change itself, since it can not be assessed in its results, is full of expectations and at the same threats.

The ability of top management lies in accepting the challenge of Six Sigma in terms of active and proactive, taking into account the difficulties of today, due to the increasing speed with which change occurs, which overwhelms the pace of work but also organic. Between all the tools to process excellence, Six Sigma appears to have the greatest impact on business success, with a percentage of projects to successfully complete approximately 70%. Most companies in recent years have won awards demonstrate the quality achieved significant levels of excellence through achievement of Six Sigma in their production processes. This value has guaranteed them a better competitive position in its market.

Despite these results, the methodology still difficult to spread in Europe and especially in Italy. Many companies believe that to excel is sufficient to obtain a value of 3 Sigma, which requires the expenditure of less energy and resources.

[26] R. L. Daft, "Organizzazione Aziendale", Apogeo

In addition to the limits mentioned above, one can describe the major causes of detention of the organization before the possibility of implementation of this instrument, due to the little in-depth knowledge of Six Sigma and the impossibility to respect and fulfill all the necessary conditions:
Quality initiatives developed in the past without success,

- Difficulties in determining the success of a Six Sigma methodology,
- Reduce the risk of employee creativity,
- Fear of results that are pushing for a reduction of jobs made redundant,
- Lack of statistics and mathematical skills,
- Inability to devote time to the development of required activities,
- Lack of belief in ensuring the success of the methodology.

1.4 The application approaches

The Six Sigma methodology can be combined in a single systematic approach to the most significant methodological tools developed over time to search for and ensure the improvement of processes. The first step in developing a Six Sigma project is to define the scope, organization may in fact decide to implement a system like this in order to achieve three macro-objectives:

- Troubleshooting existing processes already in place (eg the reduction of variability and the elimination of the causes of non-compliance): *DMAIC approach,*
- Development of new products or processes: *DFSS approach* or *approach DMADV,*
- Identify and eliminate waste: *Lean Six Sigma approach.*

The road that leads to the optimal level of 6 Sigma goes through the identification and management processes for all business activities, getting to follow a series of well-defined step:

1. Identification of important customers and key processes,
2. Definition of customer requirements (product specifications and / or service),
3. Current performance measurement and evaluation of deviations,
4. Identifying priorities for improvement and implementation,
5. Expansion and integration of Six Sigma System.

The Six Sigma stands, in all projects that can arise within a company, two main types of projects[27]:

[27] P. L. Floris, "Six Sigma. Organizzare l'azienda partendo dal cliente", F. Angeli

- *Product Area*: Projects relating to product performance, based on the use of sophisticated statistical tools,
- *Transactional Area*: Projects relating to the management, be it commercial, logistics and production, characterized by the adoption of advanced tools and instruments that simple and logical.

Most Six Sigma projects are developed within transactional area, with the aim of achieving the improvement of the system. The underlying principle is the measurability of the process of completing an analysis using a format that involves the use of statistical tools designed to reduce the variability of the process up to and exceeding of 3.4 defects per million. This can be achieved through a planned and sustained effort. For existing processes within the business, the organization is developing the project following the DMAIC phases of intervention required from the approach. This approach, described in Illustration 1.4, is a planned development of the 5 steps presented above, in line with the steps required by the Deming PDCA Cycle, as a result of measurements of the output of the process analyzed, the analysis of significant data activities involved in the process of customer requirements, in particular key, and the subsequent analysis of the gap with the standards required by the customer and the market, triggered the process of improvement and monitoring.

PHASE	DEFINE	MEASURE	ANALYZE	IMPROVE	CONTROL
SCOPE	Define the scopre of the project and built the team	Examine the key processes and measure the defects generated, assessing the impact	Analyze the defects and identify the causes	Tackling the key variables to control the effect to improve the process	Ensure the stability of processes over time
INSTRUMENTS	CQT Tree Project Charter GANTT Diagram SIPOC Map Form Data Collection QFD Matrix	Brainstorming Cause-Effect Diagram Priority Matrix Range Method Control Charts Frequency Diagram Historical Series Diagram Pareto Diagram Capability	Flow-chart Linear Regression Analisys Logistic Regression Analisys Residuals Analisys Hipothesis Test	DOE Creativity Techniques Affinity Diagram Selection of Solutions Matrix FMEA	SPC First Sampling Range Method PDCA Cycle Control Charts DOE Regression Reaction Plan Should-be Map Corrective and Preventive Actions

Illustration 1.4.1: 5 phases of DMAIC approach

The improvement phase consists of directly intervening in the process and leads to a re-engineering of the process in order to achieve the target. An organization may decide to develop a new process from a Six Sigma approach, based on two possible methods. In the next chapter will present statistical tools and the operational and management available to companies to implement a

Six Sigma project, following the DMAIC approach. The goal is to offer an understanding of how and when to use these tools within the various phases of the activity and intuit the real benefits and measurable benefits in relation to the efforts and costs involved, trying to adapt the approach to the realities of middle-small spread in our country, which cannot develop projects which are particularly challenging because of limited resources, both human and economic, and because of the pressing need to prioritize the economic aspect.

The interesting aspect is to assess how it may become possible to implement a methodology of this magnitude within such organizations, assuming that it must be both flexible and effective. The DMADV methodology is a rigorous approach to design and redesign of processes / products, the focus is on defect prevention and reduction of the same. In fact, while the DMAIC approach is based on improving existing processes, DMADV allows you to develop a product / process does not exist yet in the company, or product / process exists but that does not reach the level Six Sigma, with the objective of overcoming customers' expectations through the use of simulation technology, embedded within the five sequential stages:

1. ***D****efine*
2. ***M****easure*
3. ***A****nalyze*
4. ***D****esign*
5. ***V****erify*

The methodology DFFS (*Design For Six Sigma*) is the other type of proposed approach to developing products and processes with a six sigma quality level. Proposes the use of a package of techniques able to design and certify the level of capability of the process, whose main components consist of:

- Understanding the customer,
- Knowledge of systemic,
- Project validation,
- Quality preventive and control plan.

A medium-small businesses are not likely focus their project on these two approaches, which require detailed knowledge immediately available and meaningful in terms of time and economic resources. For this type of situation, it is convenient to understand how to develop projects to improve the processes already in place, after learning the methodology and eliminated the most

obvious problems, you can take steps to implement the most challenging management of new processes.

Finally, a brief introduction to Lean Six Sigma methodology, as it represents the most powerful breakthrough management available today to significantly increase market share and profitability of the company. It is not a new approach to quality, but rather a new strategy, a new way of thinking throughout the organization. Company developing this methodology integrates the concepts of continuous improvement and lean organization with the Six Sigma approach, using the fewest available resources, overseeing and improving its ability to consistently meet customer expectations over time.

The control of variability in the process remains the core of the Lean Six Sigma system. Reduce it, if not possible to eliminate it, allows you to achieve maximum customer satisfaction by providing products systematically and / or services free of defects, and reducing the costs and inefficiencies.

Chapter 2 The DMAIC Approach

The dictionary definitions of the word "project" describe it as being a scheme, plan, proposal or an enterprise requiring determined effort. As far as "planning" is concerned, it refers to the systematic execution of actions, aimed at attaining a particular objective. Therefore, while the project is a description of what is supposed to be done, the plan details how it is proposed to be accomplished.

It is possible to integrate both by using DMAIC. A comprehensive DMAIC approach comprises integration of the project schedule development and financial analysis along with Six Sigma tools, all of which are vital to accomplish success.

Success in Six Sigma is not based on complicated and high-tech procedures. It relies wholly on tried and tested systems, which have been in use for a long time. It simplifies things by reducing the many complexities that are the hallmarks of TQM (Total Quality Management). It takes just a handful from the plethora of tools and techniques that characterise TQM, and concentrates on inculcating high levels of proficiency in their application in a few technical leaders selected in-house, to turn professionals into sharp Six Sigma Black Belts.

Even when using the latest methods in computer technology, Black Belts use the simple define-measure-analyse-improve-control framework of DMAIC for the application of the tools. Anyone with exposure to the plan-do-study-act model of TQM would find DMAIC to be similar.

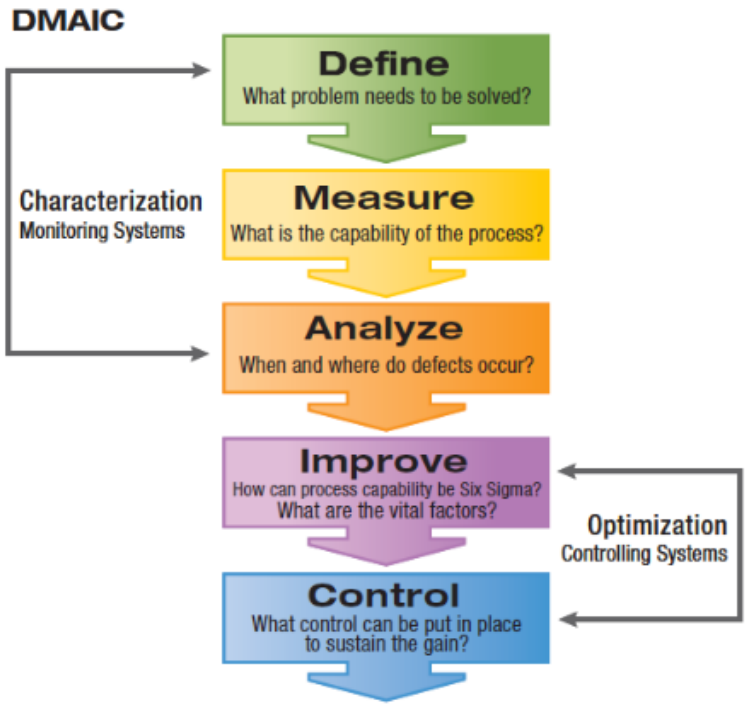

Illustration 2.1: DMAIC Phase

2.1 The Define phase

During the Define phase of the organization shall identify the project, defining what is the problem on which you want to focus on the project, establishes the scope of the quality parameters and the ultimate goals, clearly delineating the boundaries of the application and also providing for the assessment of economic benefits from the achievement of improvement[28]. It may be useful to try to answer specific questions as a starting point of the[29]:

- How do you measure the influence of the problem?
- How do you measure the success of the project?
- What is the economic cost of the project?
- What is the impact of the issue on business?
- What are the objectives and benefits of the project?
- Who are the stakeholders to refer to?
- How to identify members of the project?
- What are the resources needed to pursue the project?

[28] L. Degan, "Desing for Six Sigma"

[29] "Sei Sigma: una strategia per la competitività" Confindustria

In this phase, the organization focuses on customer needs. Surely all customers are significant, but some are more important: the magnitude of the turnover, the prestige of the brand, the potential acquisition are the main variables for establishing a sort of hierarchical classification of customers. Each is available for purchase a particular product and wants a particular service. The products and services that represent the customer receives the output to determine which are the key business processes. Identified significant customers and the key processes is essential to define the customer's requirements: the organization should establish performance standards required by the customer, so they can be proposed methods for measuring customer satisfaction[30]. There are different types of customers, each of which has different needs and requirements, which are classified into three types:[31]

- Explicit requirements: these are the expectations, the basic characteristics that must be offered in order to be competitive, serving as part of the product and / or service. If you do not meet these expected standards, the customer tends therefore to seek elsewhere.
- Implicit requirements: these are a set of everything the client says, but he expects to see fulfilled. Standards are necessary for the proper use of the product / service, which must be defined and respected by the organization.
- Unexpected requirements: these are the characteristics that make one product, plus that comes as a feature of the product / service, where up to become a standard meet the favor of customers.

Customer requirements, once identified, are then translated into requirements. The tree of the CTQ (*Critical To Quality*) is a graphical tool in which can be summarized the requirements that are represented and in which the basic needs of the customer's critical requirement for every expressed requirement.

[30] R. Tartari, "Manuale del Six Sigma", F. Angeli

[31] A. Chiarini, "Total Quality Management", F. Angeli

Illustration 2.1.1: Determining value addable areas

Six Sigma projects do not always arise from specific customer expectations, and very often their origin is derived from business needs as a result of the analysis of customer satisfaction and the general requirements of the market. In this case we speak of CTB (Critical To Business), which represents the basic element in improving economic performance and survive the competitive pressure. In all cases, it is necessary that the CTQ / CTB product are connected to the phases of the process to prevent defects in the process, leading them by the VOC (*Voice of the Customer*) to the VOP (*Voice of Project*).

The first activity to be developed as the basis of a successful Six Sigma project, is developing a *project charter*, with a view to *project management*. Project management is a management system that provides the results-oriented:

1. A clear definition of objectives, resources, time, cost, quality,
2. Planning activities,
3. The establishment of criteria for monitoring and evaluation.

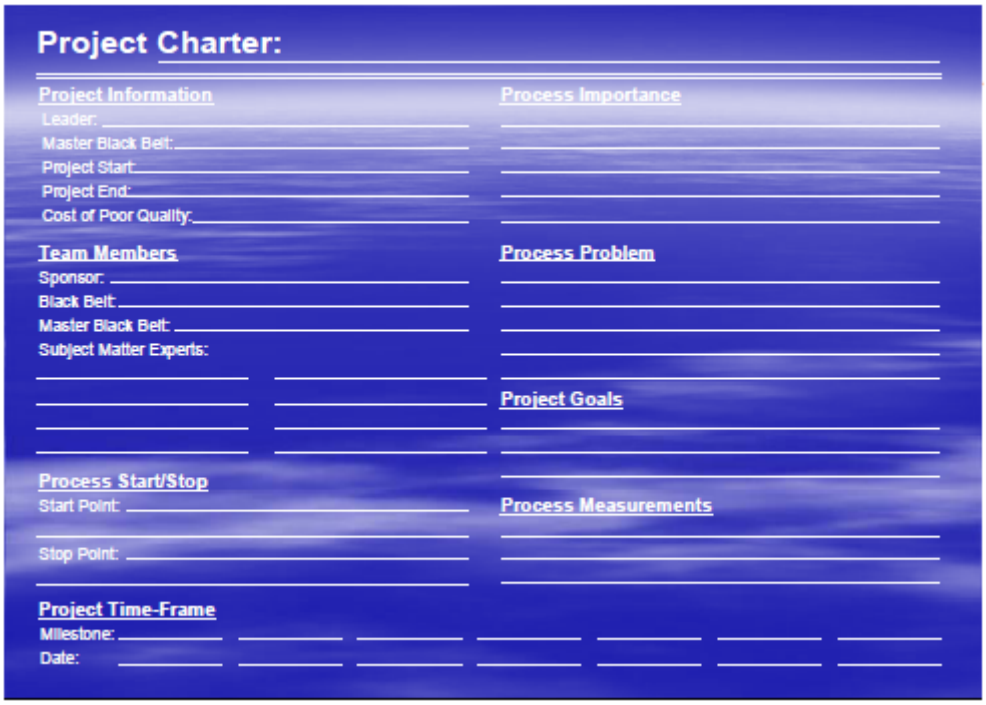

Illustration 2.1.2: Project Charter [32]

The project charter is a summary of the project work plan that describes the assumptions characteristics and objectives. It is the excellence instrument of the Define phase, allows you to plan activities in a planned and controlled way, through project management techniques with which they develop basic concepts about how to manage a project. The Project Management applies the tools that ensure that the project is carried out properly. The main tools that should be contained in the Plan are:

- Basic information on project management, such as expectations and goals of the project, the importance for the organization, the risks and limitations involved, the economic-financial costs and benefits involved, the problem definition and related techniques measurement. The choice of the project is carried out according to the parameters CTQ / CTB and is treated very accurately. Implementing a Six Sigma project aims to produce concrete economic results, taking into account the specific company and organizational goals, and therefore must be defined in terms of these,
- Timing of planned and anticipated start and the end of a project. Within the project charter it will have milestones, milestones that tell the team the sequence and timing budget for each phase of DMAIC. The development of the project can be so disruptive, involving simultaneously throughout the organization, or gradual. This second way is better suited in the context of Italian SMEs, since it is less traumatic in terms of investment and allows a

[32] www.6sigma.us

natural fit, "on the job", including corporate organization and methodology. Among the instruments used are the Gantt chart (to represent the sequence of tasks) or action plans.

ID	Task Name	Predecessors	Duration
1	Start		0 days
2	a	1	4 days
3	b	1	5.33 days
4	c	2	5.17 days
5	d	2	6.33 days
6	e	3,4	5.17 days
7	f	5	4.5 days
8	g	6	5.17 days
9	Finish	7,8	0 days

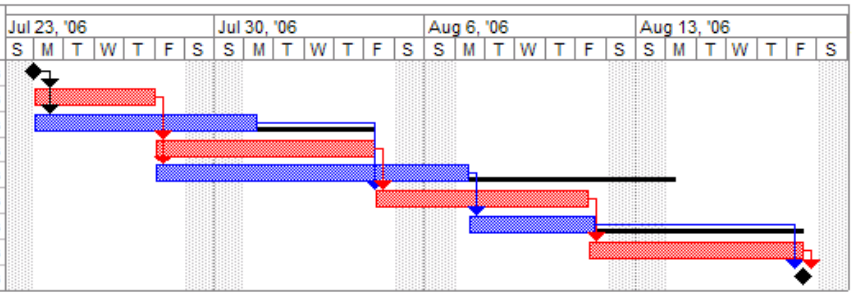

Illustration 2.1.3: Gantt Diagram[33]

- Team work. The project charter is the first step towards organizing a team, as it formalizes the composition of the working group, responsibilities, roles. In detail, the team of a Six Sigma project is composed of the following professionals:
  - *Quality Leader*: is the company's board, the area of responsibility and identify areas for improvement and consists of operational projects. Check the progress of the program to approve projects of Champions. It is committed to the success of the project, the change leader and the sponsor of the Six Sigma Strategy,
  - *Champion*: "process owners" who led the project team on the strategic plan, but is not a member of the project full time. Usually it includes the CEO and other key members of senior management. It has the responsibility to create a corporate vision of Six Sigma helps to select the team and ensures that the other roles have freedom of action and resources needed to explore new areas of improvement, it removes the obstacles that are created,
  - *MBB (Master Black Belts)* who act as experts and resources to guide the Six Sigma organization. They are employed full time in this role, but not necessarily. They assist the *Champion* and guide *Black Belts* and *Green Belts*. They identify new projects to be developed, care integration projects between different business functions and ensure the correct and rigorous application of statistical techniques in ongoing projects. They are the experts of Six Sigma methodology: their preparation places them as a benchmark for other Belts to manage and ensure the permanence of a highly specialized know-how in the company,

[33] Rielaborazione tratta da: www.ganttchart.com

- *Black Belts*: they devote 100% of their time to Six Sigma, usually placed in different projects. They operate under the guidance of *Master Black Belts*, providing assistance, training, supervision and support to various project groups,
- *Green Belts:* internal resources with a purely operational role, devoting a portion of their time to specific activities of the project. These are called *Project Leaders* responsible for achieving results of their project. They prepare a methodology similar to that of the *Black Belt*, and represent the team against the organization.

Illustration 2.1.4: The structured approach of Six Sigma

After identifying the process on which you want to intervene, it is appropriate that the organization provides a representation of the current framework of the steps, through the use of process maps, which allow you to define the project, focusing on customer needs. They are highlighted in the Voice of the Customer, by means of translating what the customer wants in measurable characteristics of the process. The process map then provides the definition of the customer's Critical to Quality. In particular, there are available to the management four types of process maps:

- *Map SIPOC*, developed in the Define phase: high-level map, through which the team focuses on the steps of a higher level in the existing process,
- *Map of sub-processes* defined during the Analyze phase: a map is more detailed than its predecessor,
- *Should-be map*, drawn in the Improve phase: it reflects what should be the new process,
- *Map Could-be*, usually used in the Design For Six Sigma[34].

[34] L. Degan, "Desing for Six Sigma"

SIPOC Map is a detailed process map not very valid to simplify complex processes and assign responsibilities and powers as necessary. A SIPOC scheme is used to define 5 variables that influence the process, summarized in Illustration 2.6.

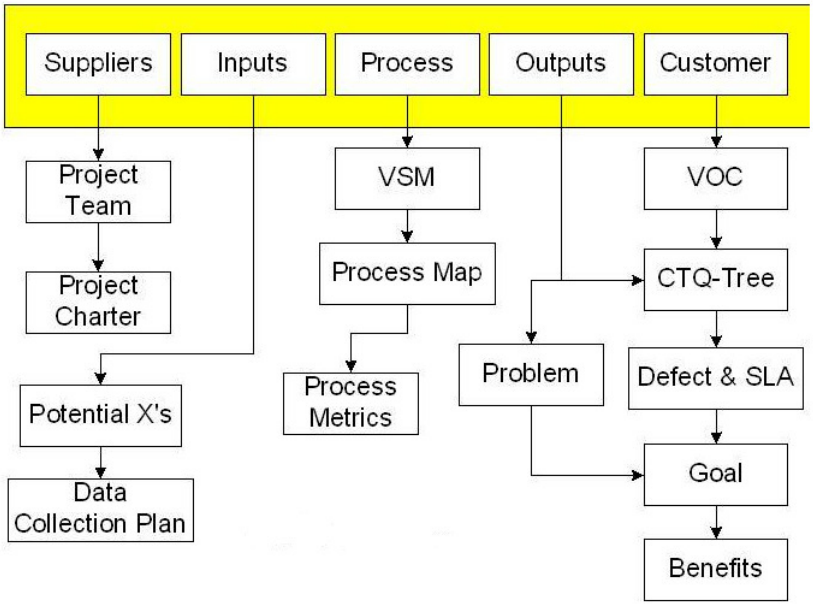

Illustration 2.1.5: SIPOC map[35]

The objective of the map is to identify the limits of the process and create a level of knowledge and common understanding among the members of the working group. SIPOC with the scheme can then describe the process steps, inputs and their suppliers, the outputs of the process and the recipient. In developing this map, it is important to define the limits (the voices start and stop the process), paying particular attention to catch all the phases occurring in the process, not the way you would like it to occur, it is also important to avoid mixing the various maps (paper Should-be can be an effective tool if used at the appropriate time) and immediately involve team members in the definition of variables.

In clarifying what are the critical aspects for the customer which the company will have to focus, and primary and secondary units that reflect what the customer wants, the ultimate goal is to determine the output parameters of the project, which are defined the Y project. The first step, as explained above, is the identification of the CTQ, which can and should be measured internally, through the gathering of customer data, useful for making comparisons of situations and different periods. The data collection must be planned and developed following sequential activities and taking into account the basic rules and common sense:

- Clarify the purpose of data collection to adopt the most appropriate processing,
- Establish procedures and responsibilities,

[35] http://blogs.isixsigma.com

- Outline the steps to perform and verify the adequacy of the measurement system,
- Objectifying the measurements,
- To train and inform staff,
- Develop the use of necessary equipment.

This simple procedure allows you to work with data that contains information appropriate to the purpose of the organization, as they have the necessary characteristics:

- High validity of data (at least 95%),
- Possibility of reconstituting the time the data,
- Appropriate type of data (there are two types of data: discrete data are binary, whereas continuous data are based on a continuum, and are generally preferred because they provide more information about a process,
- Real-time detection and online.

Data can be collected in a reactive approach, characterized by the fact that they come in-house or through a proactive approach, through interviews, research, analysis, benchmarking, analysis of satisfaction. The team usually committed two errors and the main opposition. The first is to measure not enough, while the second is to measure too much. To prevent this situation, the organization can also use the data collection, suitably designed to provide a simple and concise collection, in order to:

- Simplify the collection,
- Allow the stratification of the data,
- Ensure a rapid and immediate reading and interpretation,
- Provide clues to the cause analysis.

The data collection sheet is not a standard tool, but provides ad hoc projects, depending on the process in question. Should facilitate the automatic aggregation of data in order to speed up subsequent operations. Often data collection is an activity in which several people work together and take turns, the sheet must standardize the work of different individuals involved.

Once identified customer needs, the team translates the voice of the customer CTQ, defining priorities and then verifying their presence in the company. During this analysis it can be used an instrument in the matrix QFD (Quality Function Deployment), that relates to customer needs with the possible responses and / or technical solutions to meet the need, in order to understand what benefits a customer wants to be satisfied. To do this, it is important to determine which part of the product market is direct and stratify the market for all the associated variables.

The QFD provides a series of sequential steps:

1. The definition of customer needs,
2. Translating market requirements into technical requirements,
3. Evaluation of the quality perceived by the customer,
4. Assign value of strengths,
5. Calculation of the absolute weights and / or relative[36].

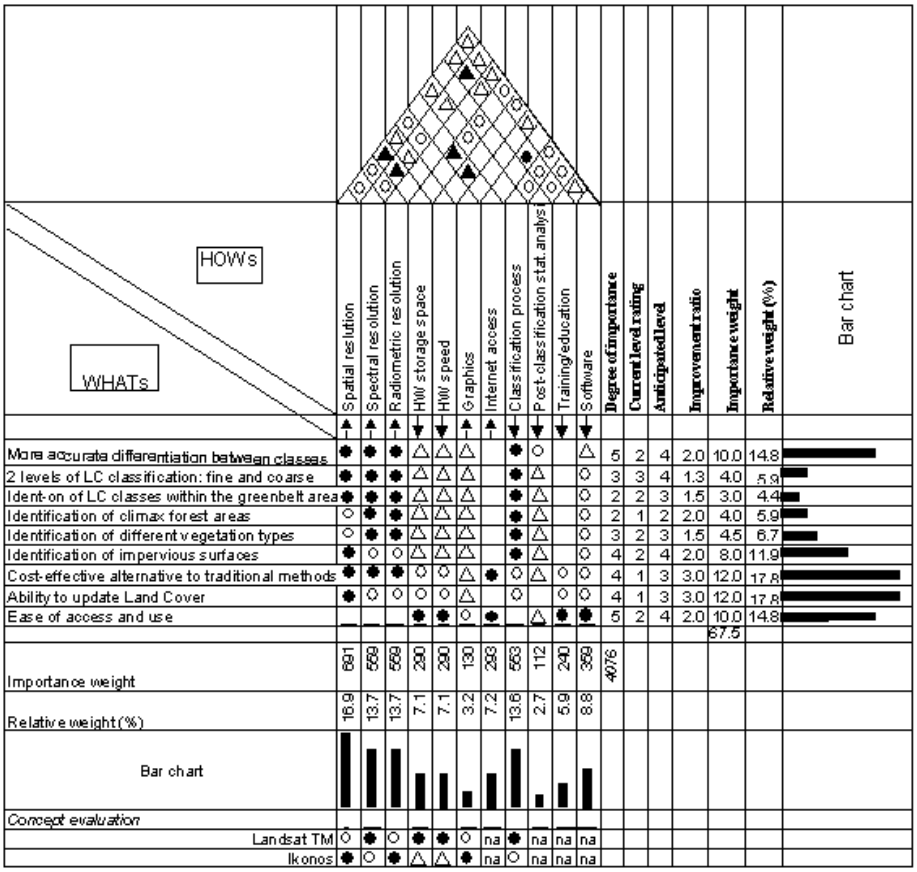

Illustration 2.1.6: QFD matrix[37]

The philosophy of the Quality Function Deployment is to design products that ensure satisfaction and customer value first and then play it back so forever. It is therefore the ideal place to translate the expressions and real customer needs through various means, including the most effective within Six Sigma is the QFD matrix. Once transcribed the specifications, it shall identify the dimensions of the quality perceived by the customer, each of which defines the weights explaining their importance. After selecting a scale, the team assesses the size refers to the specific individual and multiplying the result by the weight transaction through which you can obtain the

[36] A. Chiarini, "Total Quality Management", F. Angeli

[37] www.icrest.missouri.edu

correlation indices for each dimension, then they are aggregated indices refer to a single correlation specification in order to obtain an overall assessment of weighted specification.

2.2 The Measure phase

In developing a Six Sigma project, the basic assumption is to recognize that every activity is measurable; the organization, after assessing the process to be worked on, after defined the CTQ values to work on, in terms of improved , and after an exhaustive collection of data, it should proceed in the most representative indicators for measuring the process. The objective is to assess the current performance level of processes or products for the requirements identified in order to define the gap between the "baseline" of the process and goals for improvement.

The measurement is statistical, and the validity of the measurement system is necessary that the data are reliable. In making the measurement, you must first identify and validate an appropriate measurement system. Finally, to compare the results with the required standards, we can calculate the current level of sigma. The Six Sigma metric is an innovative assessment of the benefits of process, fits-all business processes, through which you can make understandable comparisons.

In creating the team on the project, the focus is immediately on the ultimate goal: improving the effectiveness and efficiency of the process experienced. In particular, the effectiveness of the output refers to the important measures to the client, requiring a certain level of efficiency of suppliers. Efficiency measures, however, relate to what happens in the process, relative to the amount of time, cost, labor, the value that occurred between the start and stop points of the process map.

The most common reason underlying the failure of Six Sigma projects is the lack of concentration on the formal dynamics of the team, consisting of the motivating forces that push the group toward its goal. After a careful selection of persons, must be involved since these early stages, to get the best of all.

The Measure phase begins with the implementation of the plan for data collection, developed during the Define phase, assuming that you cannot implement measures to improve if you do not have accurate figures, because only if you know you can intervene effectively. You cannot improve what you cannot measure. Defined performance standards required by the customer, it is essential to verify performance and identify the gap between the capability of the customer satisfaction.

I dati, che verranno poi analizzati nella fase di Analyze del progetto, devono essere raccolti seguendo quattro attività consequenziali:

1) Decisione delle variabili X,Y da misurare,

2) Verifica del sistema di misura e approccio del campionamento,
3) Sviluppo della raccolta dati,
4) Determinazione della capacità iniziale/attuale del processo.

The data, which are then analyzed in the Analyze phase of the project, must be collected by following four consequential activities:

1. Decision of the variables X, Y to be measured,
2. Check the measuring system and the sampling approach,
3. Development of data collection,
4. Determination of the initial / current process.

Through the project charter, the map SIPOC and harvesting plan explicitly identifies the organization's output of the process Y[38], employees affected by the potential input variables X, which are independent variables.

In this phase must be identified the critical variables in order to define how they should be measured. The list of X on Y and the process is related with customer requirements and market developments, in order to prioritize and control measurements performed at. This process involves three consequential stages:

- Increasing the number of potential X (usually > 50),
- Reduction of potential X variables through qualitative techniques (< 15),
- Identification and screening of critical variables X (<5).

The goal of the DMAIC is precisely identify the few input variables that influence the measurements of process output.

The identification of variables is mainly based on two phases:

1. Increase the amount of potential causes (X), through *brainstorming* or *cause and effect diagram*,
2. Reduce the variables to include in *data collection*, using *array priority* or *multi-vote.*

Brainstorming is a method designed to encourage creative thinking to develop new ideas through group work. During the brainstorming session, the team records as many ideas as possible concerning the problem to be measured, without paying attention to the content of ideas, not necessarily related to the subject in question. The ideas should not be judged until the session

[38] R. Tartari, "Manuale del Six Sigma", F. Angeli

ended. Group brainstorming is effective if each member of the team uses its experience and creativity to the benefit of all, to create new ideas. To conduct a group brainstorming the best, however, should be clear from the outset the rules that underlie the use of this discipline to avoid the risk of curbing people more fearful of being criticized for some of the developed ideas:

- Involve all members of the group,
- See all the ideas that emerged without criticizing the views of others,
- Clarifying questions,
- To develop ideas that emerged from the best idea[39].

The cause and effect diagram, also called a *Fishbone Diagram of Ishikawa*[40], is a tool that allows you to identify all the factors that may cause a particular problem and the relationships between them. Through brainstorming sessions, it derives a large number of variables, which are then organized into a few homogeneous groups on specific factors related to the final effect generated by their presence in the process. The depth of the plot, set at the discretion of those involved in the project, is represented by the formalization of the causes of different levels (primary, secondary, tertiary, ...) located on different branches (called bones) of the main arrow. This would give each greater detail due to a different weight. The classic pattern of Ishikawa, which has the merit of having developed an effective and practical methodology of problem solving, consists of five main categories which fall within the possible causes of a problem known as 5M, respectively, attributable to the material supplied, machinery used, the human resources involved, the methods and work procedures and the environment in which you run the process.

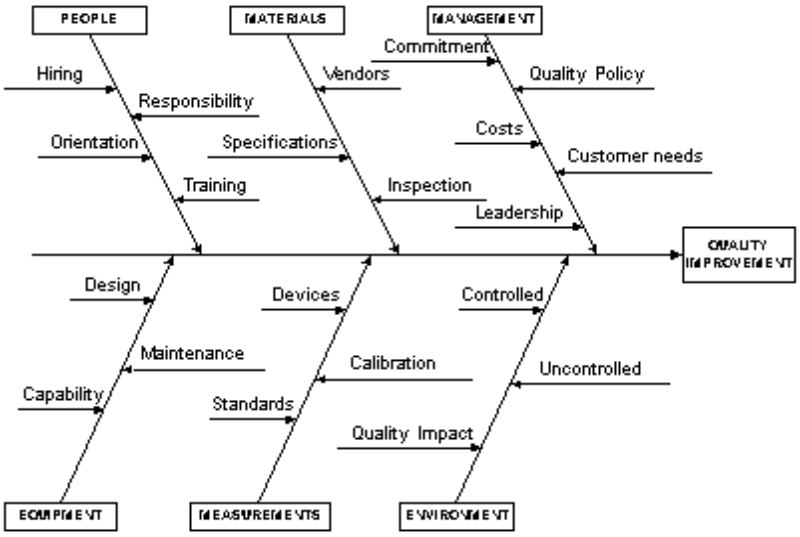

Illustration 2.2.1: Cause-Effect diagram

[39] www.qualitiamo.com

The Matrix of priorities[41] is the tool used to prioritize the input variables, provided outside the process and / or controlled within the process, the working group can order the priorities of the possible causes using the previously identified. Matrix evolves according consequential step:

1. Consider only those that are fundamental for the process,
2. Assign a weight (preferably a value in tenths) to each variable obtained at earlier stages,
3. Numerically represent the relationship between cells,
4. Multiply the data with the weight assigned to the variable,
5. Verify all the factors listed in the output,
6. Discuss with all concerned the outcome of the matrix.

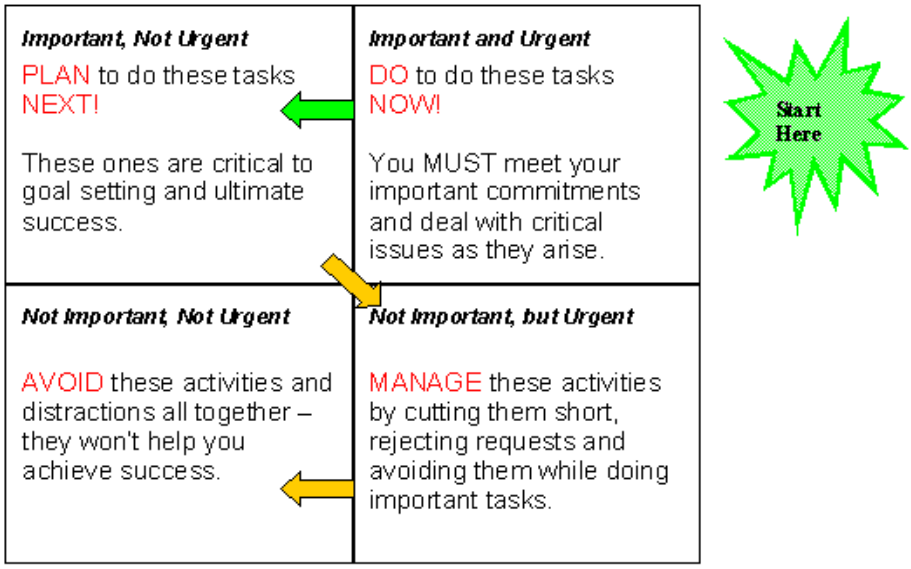

Illustration 2.2.2: Priorities matrix

A second way to determine the priority of the potential causes that can be used if there is only one output variable Y important for the project, is the M*ulti-vote*. Each group member should be assigned to each potential cause X a predetermined and limited number of votes, so it is possible to establish a hierarchy in terms of magnitude of the cases.

2) Verify the measure system

The Six Sigma requires data processing as necessary activities to make decisions. The information is collected by means of measurements of the process. Every time you make a measurement, the result arises from several factors. The measurement system consists in its generality, operators, tools of measurement, the measurement procedures. The analysis of the measurement system ensures that your system is able to provide adequate data and this is necessary because each of the three factors listed above make a part of measurement error and uncertainty. The errors of the measurement system can be classified into two categories:

[40] lorien.ncl.ac.uk
[41] www.achieve-goal-setting-success.com

a) *Accuracy*, which describes the difference between the measurements and the actual value, in turn divided into:
   - *Stability*: it is a measure of how accurate are the measurements of the components over time,
   - *Bias*: it studies the accuracy of the instruments compared with a reference value,
   - *Linearity*: verify the accuracy of the instruments within the range of measurement,
b) *Precision*: which describes the variation during the measurement of the same component, with the same instrument. It is determined by:
   - *Repeatability:* it defines the imprecision of replicates in an interval of time, carried out by one operator using the same devices. It represents the degree of correlation between the results of successive measurements of the same component, under the same conditions of measurement,
   - *Reproducibility:* it indicates the imprecision of replicates carried out using the same analytical method but not identical in terms of time and usually not restricted.

During the assessing of the performance of the data collected, a key concept in Six Sigma is the variability of the process, generated by two types of cases:

a) *Common causes*: they are intrinsic to the process as a result of natural variation of a process. They come from many individual factors generally unimportant, so they are difficult to identify and to eliminate.
b) *Special causes*: they come from factors that have a significant impact on the variability of the process, which can be identified and eliminated. The right approach is an immediate action to improve the processing time for non-compliance in order to prevent its possible recurrence in the future.

The variability is an unavoidable aspect of any process and the objective is to minimize the causes using statistical techniques. Already Deming assumed that on average of 85% of non-compliance was due to a common cause, to be managed by managers, while only the remaining 15% is attributable to special causes, the relevance of technical, personnel and operational process. A process can be defined in statistical control when only the special causes are eliminated. In this case it makes sense to proceed according to the DMAIC approach, otherwise, if there are special events that make the negative process, the DMAIC approach is not appropriate. The analysis of the causes returns to the stage of Control[42].

[42] M. Bertocco, P. Callegaro, D. De Antoni Migliorati, "I sette strumenti per la qualità"

The statistical process control is mainly based on the use of control charts, designed by Walter A. Shewart. This tool is useful for identifying the intervention of special causes of variability and gauge whether the changes observed in the percentage of non-compliant situations are detected or not significant. Since this is a graphical representation of the time evolution of a specific variable that characterizes the output, the cards are generally adequate to continuously observe the variability of a process, and work primarily with data:

- Continuing,
- Normally distributed: the normal distribution, represented by the Gaussian curve, with mean μ and variance, is represented by a symmetric function, increasing the interval (- ∞, μ) and decreasing in the interval (μ, + ∞), has two inflection points corresponding to x=μ±σ, is concave downward in the interval (μ-σ, μ+σ) has the asymptote of the x-axis. The normally distributed data have a chance of being randomly out of control limits of 0.27%;
- Independent: the points are defined as independent if an observation does not affect the next point and is not influenced by the preceding point.

Through the study of control charts can immediately identify the point at which there is a condition that can lead to variability, since they show atypical patterns of the process, facilitating the distinction between special causes and common causes. They can also define the factors behind the situation fails to comply, in order to ensure immediate action. The control chart is constructed by a system of reference axes kept under observation for a variable, whose variation is represented in the axis of ordinates at a given time period repeated in the axis of abscissas. Once reported measuring points on paper, these two segments that are joined with a broken line, immediately making an analysis of the phenomenon of time.

In order for the reading to be effective, it is necessary that the paper is regulated by the evaluation criteria to allow non-arbitrary judgments about the process and make rational assessments on appropriate actions for improvement. Within the chart are identified:

- *The upper control limit UCL,*
- *The lower control limit LCL,*
- *The average of the process μ (x),*
- *The historical standard deviation σ (x)*[43].

The average value of u (x) of the process is the arithmetic mean of the observations, while the index σ (x) defines the standard deviation, which coincides with the square root of the variance. The variance indicates the average of squared differences of the individual observations from their

[43] www.statsoft.com

average value. Control limits are the lines that demarcate the region of natural variability of the process and represent the reference system for the evaluation and interpretation of results. If they are not special cases, the observed points fall in that area with a predetermined level of probability. For this reason, immediately identifying abnormal situations due to the influence of certain factors. Control limits are symmetric about the center line CL, which represents the average value of measured process.

Conventionally, the control limits are calculated using the mathematical formula:

$$UCL / LCL = \mu (x) \pm 3\sigma(x)$$

so that they represent the range within which falls 99.73% of the observations if the variability remains constant. The assumption has been established through which this value refers to the conventional statistical theory, according to which the sample means, ie a process with normally distributed random variables, it may specify, for the confidence intervals, the following characteristic limits:

$$\mu (x) \pm k\, \sigma(x)$$

The limits are thus a function of k, which indicates the value of standard normal random variable, usually indicated with $z (\alpha/2)$.

The percentage of units covered within the range depends on the choice of k. In general k can take values of 1, 2, 3, but for the calculation of control limits are set the values of 3, in order to obtain the most significant limitations to the interpretation of control charts, since the them include the area of natural variability of process $\sigma^2[100 (1-\alpha)]\%$.

For the positioning of the control limits we referred to statistical criteria, therefore, this is because the construction of control charts has much in common with statistical tests for hypothesis testing. Setted the control limits, as described, the team has provided a tool to monitor the process, verifying the number of observations that fall within the area of natural variability, if it is or not in a statistical state control. The natural tolerance of the process oscillates between the limits, and as long as the units observed within the range defined, the process produces products which comply with a probability of 99.73%. The sample can be decomposed into sub-groups, bearing in mind that the greater the range of r subgroups, the greater the loss of data. Moreover, the value of the range is closely tied to the value α of the sigmoid, which can be calculated using the following formula:

$$\alpha = \mu(r)/d2$$

where μ (r) defines the average range of subgroups, and 2d represents a correction factor equal to:

- 1.128 if the number of elements of the sample is equal to 2,
- 1.693 if the number of elements of the sample is equal to 3,
- 2.059 if the number of elements of the sample is equal to 4,
- 2.326 if the number of elements of the sample is equal to 5.

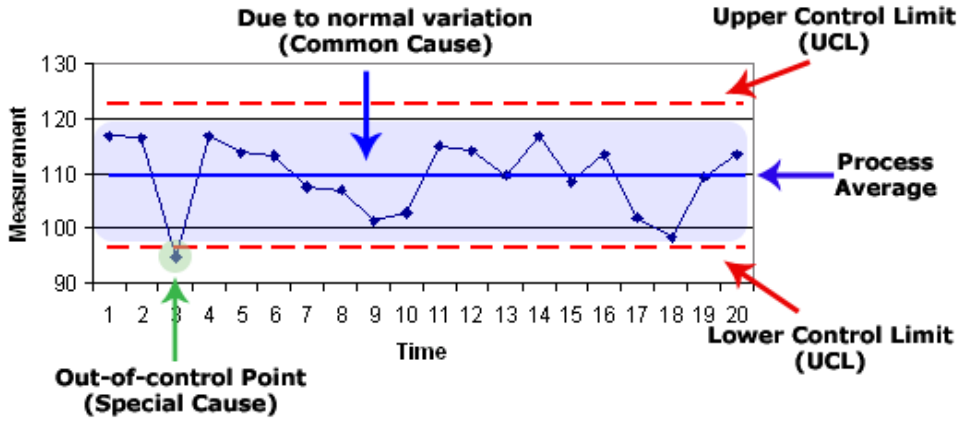

Illustration 2.2.3: Control Charts

Defined the general form valid for all measured data, depending on the variables taken into account there are different types of control charts, which is a list in Illustration 2.10, it is not appropriate to examine in detail here, if we consider the fact that small-to medium-sized manufacturing companies will work primarily with papers variables.

Other instruments that are used in the Measure phase are *diagrams*, which fall into the category of the seven tools for total quality management. This definition is outdated, considering the evolution and enrichment of these instruments.

In choosing the most appropriate graphical tools you need to consider the type of variable that must be observed, as each plot is more or less appropriate depending on whether the team has to work with continuous or discrete data.

In the case of continuous data, the most effective tool for the representation of the distribution of a measure is a *diagram of frequency*, present in three main forms: the histogram, the plot points, the box-plot diagram.

The *histogram* shows the frequency distribution of sample data collected from a population, between the minimum and maximum value. It is characterized by the graphical representation of data grouped into classes, where the range represents the amplitude. The limits are calculated by

taking the classes that must contain the minimum and maximum value. The maximum frequency of the chart indicate the central tendency of the data: if it matches or is close to the value of the particular customer, it is possible to overlay the picture with the normal Gauss curve. Otherwise, the process is influenced by special causes, on which it is appropriate to intervene. It is a popular instrument and is commonly known, but are adequate when the organization has provided a large sample of data.

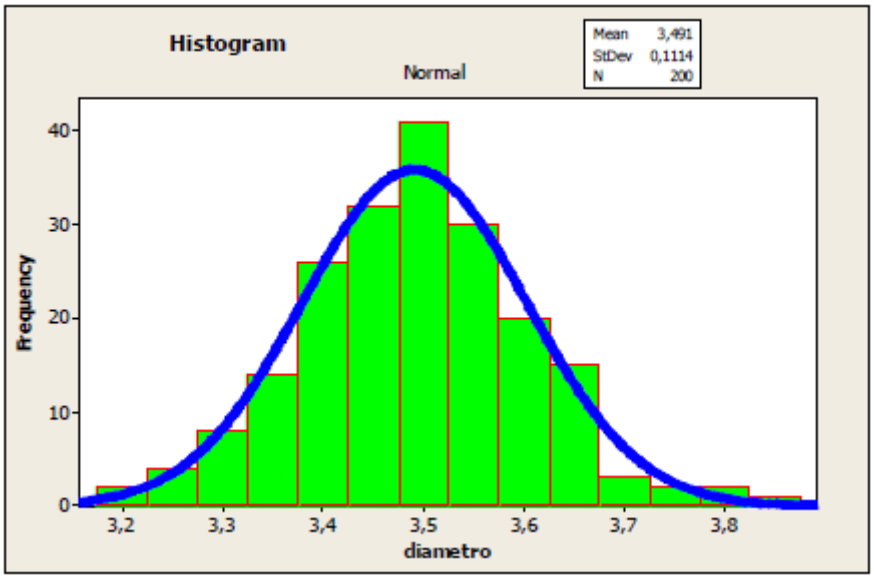

Illustration 2.2.4: Histogram

The *Dot diagram* summarizes and highlights the main features of the distribution of a phenomenon. The horizontal axis shows the values of the variable considered, represented by one point for each found observation. The graph allows you to observe in great detail the distribution of the phenomenon and does not involve the loss of information concerning the variability measured. Immediately identifies the maximum and minimum value of the distribution and any off-specification parts. It is a simple instrument, in which all points are visible, even if it does not provide clear guidance on the type of distribution.

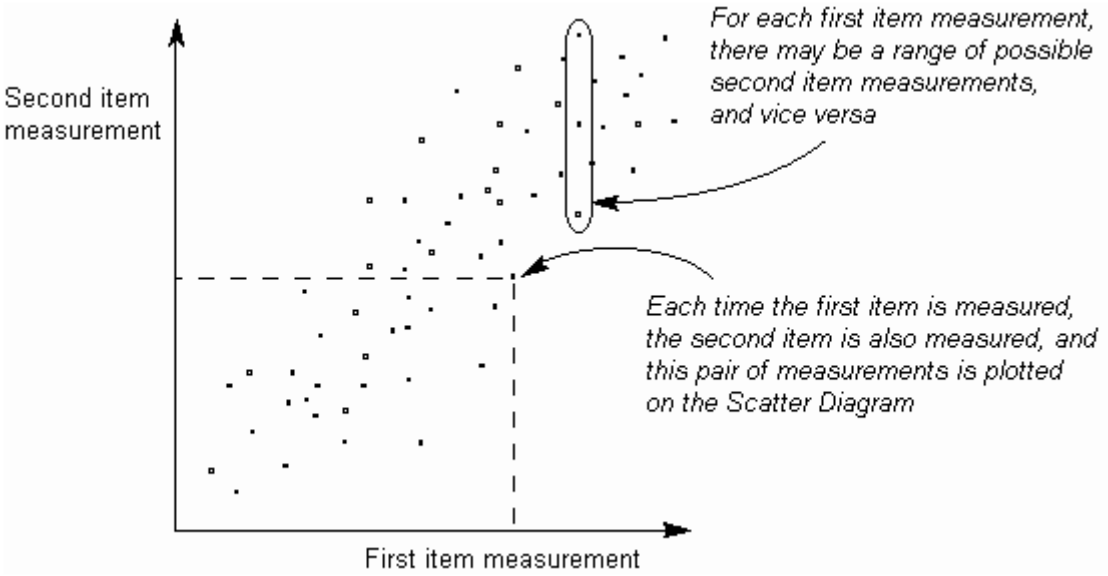

Illustration 2.2.5: Point Diagram

The *Box-plot diagram* is a relatively a new type of graphical analysis, which allows to represent the behavior of a variable as long to sort the data first in ascending order. The chart brought both vertically and horizontally data, provides a lot of visual information on the distribution. For example, it visually indicates the presence of anomalous observations that come from the extremes, the team will focus on which to apply interventions troubleshooting. The disadvantage is that it requires detailed statistical knowledge for its use and interpretation, and graphically represents a large sample of data but not the scale of sample size.

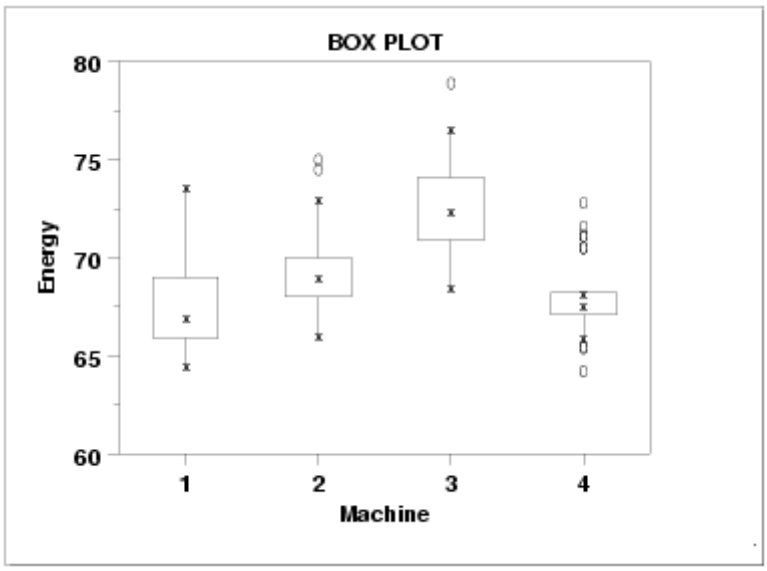

Illustration 2.2.6: Box Plot[44]

The *Time series diagram* shows the variation of a measure in time; the variables may be quantitative, discrete or continuous. It has a series when the levels of a given phenomenon are associated with successive instants. The representation consists of a system of Cartesian axes, on which the horizontal axis there are the time instants of reference, while on the vertical axis there is the intensity with which the phenomenon under study is manifested in time.

The graph is completed by joining the points identified in the system at each of the pairs of coordinates, thus forming a broken line that provides an immediate idea of the evolution of the phenomenon over time and its characteristics and trends. Operators can also identify any periods of high volatility and abnormal behavior, called *outliers*. Unlike the other diagrams, this tool provides information about the chronological sequence of measured data.

When the organization is faced with many elements of which he wants to know its importance, the most effective tool is the *Pareto Chart*, which shows the impact of different types of input X to an output value Y. In any system is shown how few are the elements relevant to the behavior of the process, the Pareto Principle states that "few cases generate the bulk of the final".

The principle underlying the relationship is 80/20, made in the "80/20 law" by *Juran*. Pareto himself was inspired by it, and his diagram allows for example to decipher 20% of cases on the 80% of the problem. The first step in the Pareto chart is to decide what issues are to be analyzed by defining what data are needed and how to classify them. This step is implemented by means of data collection, once established duration. Collected data, the team should identify priorities, because there is the importance of acting according to the magnitude of the problem.

The graph is represented by a Cartesian axis, in which the x-axis shows the mode of the categorical variable (eg types of defects in a product), while the ordinate shows the frequency of their presence or, alternatively, a percentage that corresponds to 'height of the respective segments. The methods are proposed in descending order of importance based on the absolute frequency of each category. The sum of the frequencies of a given class and those of all previous classes is called a cumulative frequency.

The graph obtained is then superimposed on the *curve of cumulative frequency*, from the origin of the axes and joins with the right edges of the rectangles representing the groups. The more the curve is steep, the more important are the first categories represented.

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[44] www.itl.nist.gov

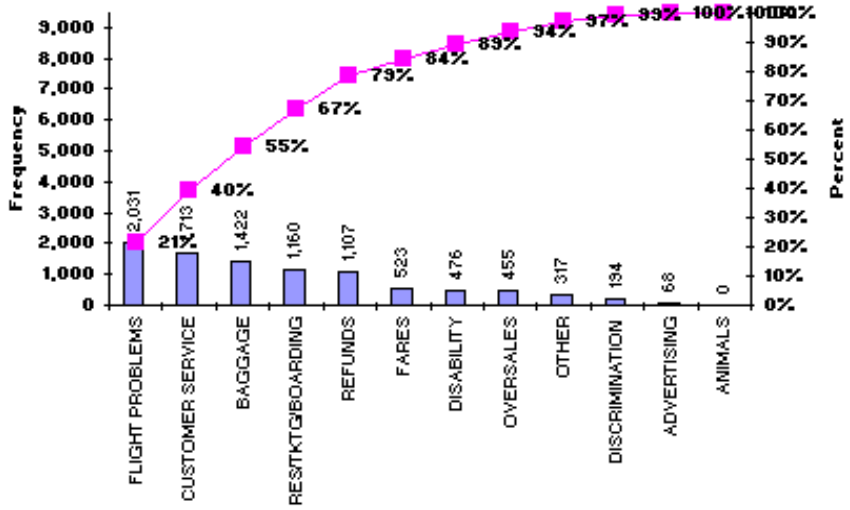

Illustration 2.2.7: Pareto Diagram

The instrument described is especially useful in the exploratory phase of the data, but not always generate significant results, to make it really effective, the team must work to get to the bottom in the analysis using the technique of layering. Having identified the category associated with greater frequency, if it considers a sub features more detail and with reference to the category considered initially, it builds another Pareto chart, to trace the causes that have generated on which to intervene in phase Improve.

The peculiarity consists in fact of the diagrams that can be layered over a discrete variable X. *Layering* means the sharing of data in a number of factors that allow a better understanding of the sources of variability. Allows you to more easily identify the causes of defects, avoiding the risk of incurring speculate about situations, the common characteristics of homogeneous groups are called the factors of stratification.

The *Control Charts* are a powerful way to keep a process under statistical control, identifying the special causes that generate an undesirable level of variability, but without taking into account the specific process. They are therefore not adequate to determine the actual capacity of a process, nor how this can be effectively improved. The capacity is defined as the relationship between the measured process performance and the fulfillment of specific, identified by managers, engineers, customers, suppliers, regardless of the natural behaviour of the process. Therefore, there is no connection between the control limits, which represent the range to determine the variability of the process, and specification limits, by which it determines the ability of the process. The instruments for measuring process capability measure the qualitative performance of a process based on a

comparison of the amplitude of the scattering amplitude of the tolerance of the process, summarizing the data in dimensionless quantities, easily interpretable and comparable.

The specification limits are usually set before the job is chosen, based on quantitative or qualitative characteristics that the customer, which will sell the output of the process, specifically requires, or are fixed by the management, designers, technicians, by staff on the basis of considerations relating to the operation of machinery and tools used, the characteristics of the process, the minimum expected level of quality. The specification limits are two:

- *Upper Limit Specificity USL,*
- *Lower Limit LSL Specificity.*

Both the specification limits and the limits of control are of great importance in monitoring the process, although, as mentioned, among them there shall no relationship. This statement is true but only from a theoretical point of view, the study of the capacity is based on a comparison of the two types of tolerance limits to relate to the specific nature of the business process, where natural tolerance means the range within which the process can fluctuate naturally, and is represented by its control limits. If the tolerance limits of both natural fall within the area bounded by the limits of specification, the process is in an ideal position, which guarantees a production with a compliance rate of 100% of the pieces, if one or both control limits fall outside the area, the process is stable but not capable.

The organization should seek to verify the causes, mainly due to:

- Specification limits are too close, so the process does not have a broad enough range of variation,
- Process is not centered, ie the interval between the limits of natural grace, though not exceeding the interval determined by the specification limits, is not centered with the latter, always generating a certain percentage of non-conforming.

To measure the ability of the process, the organization can use certain indices, calculable as long as the data are representative of the process and normally distributed and that the process is stable. The index Cp measures the potential of the process, determined by the ratio between the dispersion eligible for the trial, calculated as the difference between the specification limits, and the actual loss, represented by the value of natural tolerance:

$$Cp = (USL – LSL) / 6\sigma$$

2.3 The Analyze phase

To know the variability of CTQ taken into consideration and understand the causes that produce them, we analyze the data collected, with the primary objective of defining the areas in which to intervene during the follow-up activities. A time to Analyze develops simultaneously at the time of Measure, since the two phases are iterative and not linear. Set the optimal values of performance indices and expected capacity of the process, the use of data analysis tools allows you to focus on finding solutions to a limited number of detailed issues. Through in-depth analysis of processes, the organization must define the root causes of performance sigma detected, in order to gain useful information to act.

The Analyze phase is often considered the most important because it guides the team to generate ideas for improvement. Requires high skills and statistical knowledge, as it relies mainly on the process of statistical inference. The analysis process is a process crucial to ensuring a successful Six Sigma project, particularly if concentrated primarily on improving, rather than efficiency. This activity includes the mapping of the process to determine the critical points that determine high variability and strong points where there are more efficiencies.

A reliable and simple instrument is the *Flow-Chart* (or *flow diagram*), which provides an overview of the process, but also specifically defines the organization and operation. It is in fact a graphical representation in which all stages of the process and the paths are represented in a logical sequence from the start to finish, highlighting the flow of information and decisions that occur. The flow-chart express the impact of individual activities that make up the processes, representing the list of input and output.

Assuming that it is essential to maintain the same level of detail in writing a single diagram, there are different types, depending on the method of analysis:

- Flow chart of activities, analyzes the complexity of a process consists of a set of defined activities, and establish the degree of interrelation,
- Flowchart for function: it analyzes the changes of ownership of a process,
- Flowchart value-added activities that define the real impact on output, on which the organization must implement the improvement project (on other things the team needs to take action to improve processing time, doing the actions with the lowest possible time and resources).[45]

2.4 The Improve phase

The goal of a Six Sigma project focuses on what people should be really looking for: fewer defects, shorter cycle times, greater skills and capabilities, lower costs and higher revenues. A successful project gives companies saving large sums of money in the short term, thereby improving profitability and allowing long-term investment. In the simplest sense, Six Sigma is a highly disciplined approach to decision making that helps people to focus on improving processes with the aim of approaching the concept of "zero defects".

In the Improve phase the organization focused on operations to be performed in the process analyzed with the aim of reaching a permanent and continuous improvement, based on the current situation emerged. In fact, you have to identify possible solutions extending and applying a detailed action plan with the various activities and control points. Then the team shall test and verify the potential solutions, selecting the ones to implement. A high degree of accuracy in the Analyze phase ensures speed and efficiency in determining which solution to adopt, in a position to make "robust" process. The action definitely needs to improve the experience and professionalism of the *process owner*.

This phase is characterized by the use, as well as advanced statistical techniques, creativity techniques designed to generate a large number of alternatives in which then the search that combines efficiency and economy. It is needed to demonstrate operational staff to have a certain degree of creativity, openness and creativity, without neglecting the importance of communication and training. The organization must develop its own internal training group, as the group is a natural amplifier and accelerator of the creative process, enabling us to overcome difficulties in communication, improve relationships, and advance to smooth possible rivalry between the social inhibitions participants.

Human resources play a role of primary importance. The company needs to approach, and rigorous analysis, Six Sigma elements that have their roots in the culture of science and statistics. But at the same time requires awareness of the inherent complexity of things, in people, situations and exercise critical thinking, but elements that sink their roots in the literary humanities. The Six Sigma approach rewards excellence in fact, the tendency to perfection, the fluidity of communication, but it requires vision, guided by objectivity and methodological skills especially the ability to read the company in a systemic way. The Improve phase achieve the intended purpose if it is conducted and developed by people in possession of human qualities such as perseverance,

[45] www.six-sigma-material.com

determination, motivation and enthusiasm. It is crucial at this stage to manage the human side to prepare the people involved to change, taking into account three aspects:

- Communication: the information must be bi-unambiguous to develop understanding,
- Participation: we need to involve people,
- Education: You must give people the knowledge, skills and tools.

Searching for solutions, the goal is to create truly innovative ideas. In the Six Sigma approach the organization should aim to involve at least one fifth of the company staff, having patience and willingness of time for a change. Time is indeed a necessary factor to change, not easily predictable, but still programmable. The top management must demonstrate a positive and forward thinking, something that offers a rich opportunity to overcome their difficulties and obstacles that will inevitably encounter during the trip. In addition, Six Sigma projects always require a *critical mass* so that, after reaching the initial results, a process of self-supply.

These concepts within the *knowledge management* , that is a theory based on the creation, mapping, protection, development and sharing of resources in terms of knowledge; an organization that assigns strategic importance to the knowledge management ensures the killing of non-sharing of knowledge and / or of basic information between different departments and business functions, if not between the same management. The Improve phase is divided into three main activities: after having identified and generated solutions, the organization shall submit and extension, focusing on the following remedies to be implemented. Analyzing the causes, you have the tools to see if it makes sense to undertake activities to improve the existing process is appropriate or design a completely new type of process, setting the stage for a proposed *Design of Six Sigma*, which leads to a re-engineering process in order to achieve the target.

As mentioned above, a process is characterized by its variability, which may be common or special causes. The existence of a special cause leads to define the process out of statistical control, so that the organization should take action itself to remove the special cause variability, through the design of an experiment in which case this becomes a component of the project and the parameters of the process are the factors of the experimental model.

The tool for the design of experiments is the design of experiments, abbreviated by the acronym DOE, the mathematical model that takes care to ensure that a given sequence of experiments is planned, conducted, analyzed and interpreted to provide useful data for decision making without incurring high costs, relating the output variable Y with the input variables X[46].

[46] www.qualitiamo.com

DOE develops following six sequential step, who return to perform all possible instruments previously used:

1. Identification of the causes,
2. Test design,
3. Collection and analysis of data,
4. Identification of critical factors,
5. Testing the confirmation,
6. Process Improvement.

The main activity concerns the design of tests, which may appear in different types, of which here are presented the main features, always remembering the idea of will and power to implement these tools in the small to medium-spread in Italy.

The Improve phase also provides for the implementation of FMEA, analytical technique of prevention and aims to identify, evaluate, analyze any possible errors or malfunctions which may occur during the production process (in this case we speak Process FMEA), in the product (product FMEA), indicating the corrective actions. It is a complex methodology that requires a group of people with strong process and product skills. Once developed, it is a major corporate asset, provided that it is managed as an evolving document, constantly updated with the changing situations. You do not need to appear complete from the start, because the organization can complete it during the ongoing project and follow up. For each potential failure modes, the FMEA RPN provides an index of risk (defined in Italian Priority Risk GPR) calculated by the product of three indices:

- *Severity*: severity of the likely failure mode,
- *Occurrence*: probable frequency of the potential causes of failure,
- *Detection*: the likely effectiveness in preventing potential causes.

The practical realization of a FMEA is facilitated planning to follow the product along the single process activities. Called an explanatory legend of the possible situations, the organization assigns a numerical value for each index, and their reproductive value determines the RPN. Depending on the overall index of business expectations and achieved, describes corrective or preventive action to be taken to lower the calculated value.

The index RPN outlines the priorities of the interventions. Faced with high values must be defined and made design changes intended to reduce this value is shown under the minimum risk possible and judged acceptable by the organization. The countermeasures identified, which must be planned, mostly cover staff training, review of documentation, standardization of the method and its operational responsibilities. Do the countermeasures, the organization has to redefine the values of

the indices to obtain the new value of the index of risk, in order to verify the potential effectiveness of changes. The FMEA is a powerful qualitative tool that, through a mechanism of continuous improvement, can satisfy customer needs and market.

2.5 The Control phase

This step is to ensure firstly that the process has reached the expected level of improvement during the Improve phase and therefore is able to maintain over time the results achieved. This is accomplished through ongoing monitoring and systematic action to stop the process, once you reach the desired goal, that over time you have a degradation of the same. It states how to monitor the monitoring indicators that signal in a timely manner when the process is deteriorating, intervening in a targeted way to restore the desired operating conditions. In order to be sure that the solutions have achieved the desired result requires adequate feedback, obtained by analyzing the variables of the process, when they found the changes from the first phase, studying the trend over time.
Control phase is designed to ensure the sustainability of the improvements, is composed of linked activities, managed through the techniques of Statistical Process System (SPC), an instrument used in order to ensure that the new process performance are consistent with than expected and planned, proposing the use of statistical tools previously used to define, measure, analyze, improve the process.

1. *Preparation of management plan process.*

   The organization shall ensure that the improved process is defined, that responsibilities are clarified, that the measurements for continuous monitoring are established, that the action plan has been introduced. The ultimate goal is the definition of monitoring indicators, usually placed at the beginning of the process, starting with an update of the CTQ. For each control situation must be defined as a sampling plan having the objective of identifying the frequency of inspections and the minimum sample to be taken. Faced with the decision taken, you must do further analysis of the adequacy and accuracy of the measurement system, through studies of the Range Method. All measuring instruments must be calibrated against standards traceable to international standards and tested in accordance with procedures need to be performed periodic internal audits to verify whether the appropriate operators' ability to discriminate against non-compliant conforms product .

A tool for drawing up the plan of management is the PDCA.[47]

2. *Implementing a process control system.*

   The use of control charts allows you to continuously monitor the process, showing where improvements are still actually achieved over time in order to define any new control limits. The organization must be renewed preliminary studies aimed at identifying the best type of control charts to use, internal audits to make sure that operators know how to interpret control charts, sequences and trends of the controls.

3. *Characterization of the process and documentation of key-learnings.*

   The organization must demonstrate that they are clearly set out the factors that influence the size of the product and its sensitivity, formalized through the characterization of the process, by utilizing the methodology of Design of Experiments. The means of linear regression and logistic regression are proposed to identify the relationships between the parameters and define the magnitude of the sensitivity of the features in the face of variable factors. It is important that each disturbance is known about the characteristics and the effect is called the way of controlling.

4. *Planning and development of improvement actions.*

   After you define the procedures of screening and analyzing the results, after having recalculated the new sigma process capability indices and the organization must provide for an adequate response plan in the event of circumstances beyond control. Define the rules under which a process can be defined in statistical control, should be formalized appropriate means of intervention times the execution of timely adjustments.

The removal of the likely causes leads to the implementation of improvement actions. In particular, faced with a situation which does not comply, they must be identified corrective actions designed to handle it. Before selecting them, but it is advisable to check that solves the problem without creating others. Chosen actions, the organization must re-verify the effects, taking into account any sub-causes. Preventive actions are interventions to anticipate the formation of non-compliance. Actions of improvement should be defined in a specific implementation plan, which progress can be managed through the development of a Gantt chart. Do the appropriate actions, the organization endeavors to examine the effects and archive all documentation.

5. *Standardize the process.*

[47] L. Degan, "Design for Six Sigma", pag. 63.

Define the business operating methods, the new process should be formalized in special procedures and / or instructions documents, to ensure that it runs properly and in the best possible way. These documents should describe the making of the working, the mode of screening, the making of set-up phase, the inspection work, the methods of calibration and verification of measuring instruments, the method of operation of the analysis of the measurement system and the maintenance of machinery and equipment. As a result, it is appropriate to include an ad hoc training for all staff to transmit the new methodologies. Reduces the variance between the operators and provides the knowledge base, traces to solve the problems, methods to capture and maintain the knowledge, the information in the case of unusual conditions. The qualifications of staff must be properly recorded and used for the allocation of staff. It is important to continue over time the formation of various levels who must implement Six Sigma in the company, increasing the number of Master Black Belts, Black Belts and Grenn Belts.

6. *Closedown of the project.*

After the Six Sigma project, management must give due recognition to the team for the results obtained in the form considered most appropriate. In a bottom-up logic, the results should be conducted with precise objectives of the Strategic Planning (355). This final phase should be taken seriously in order to transmit and disseminate the results and the means of implementation through the appropriate check-list of closing that summarize the results achieved, lessons learned, the storyboard and complete documents, advice to the sponsor and the team leader, future goals.

After just reward personnel involved in the project, it is important that the results are considered as starting points for continuous improvement and not as an end point. The standardization of the process confirms that the methods used so far are the ones who gave the best results and then if they can invent and adopt new ones just if you can demonstrate that they achieve real benefits. But since everything is not perfect, we must seek new ways. Creativity and standardization concepts that are not in fact mutually exclusive, but complement each other.[48]

[48] A. Chiarini, "Total Quality Management", F. Angeli

Chapter 3 Six Sigma Deployment Plan for SME's

The deployment of Six Sigma into large organizations has been quite well developed over the past 10 years. These large corporations have the resources to launch full-scale into major change programs.

Small and Medium Sized Enterprises (SMEs) have unique constraints that limit their ability to initiate a large scale Six Sigma implementation:

- SMEs can't afford to have full-time Master Black Belt. For large corporations, there is typically one Master Black Belt for every 1,000 employees. For SMEs that range in size from 25 to 500 employees, that would work out to only a fraction of a Master Black Belt. It doesn't make sense to have a highly qualified Master Black Belt who would only be needed for a fraction of their time,
- SMEs don't have large reserves of excess cash to earmark for the massive training programs employed by the large corporations in implementing their Six Sigma programs,
- SMEs don't have the personnel with the skills and expertise to step into the role of Black Belts without extensive training.

To overcome these limitations, *Process Quality Associates* (PQA) has developed a Six Sigma Deployment Plan for SMEs. The highlights of this Deployment Plan are:

1. PQA will act as your Black Belt for the initial projects until you have generated sufficient savings to be able to provide some of those savings for training your own Green Belts and Black Belt. Your Six Sigma implementation is self-funding. As it generates more and more savings, you can increase the scope and velocity of its implementation.
2. PQA acts as your Master Black Belt. When you need guidance in any area of your Six Sigma implementation, and particularly when you need to conduct complicated design of experiments or other sophisticated statistical techniques, you call on us. The majority of improvement projects can to performed using less sophisticated statistical techniques.
3. Your senior management team becomes directly involved in developing, implementing and monitoring the Six Sigma program.

3.1 Six Sigma Training and Certification in SME vs Large Companies

A Six Sigma certification offers many of the same benefits for small and medium sized companies, as well as the traditional large companies that have been using this methodology for decades.

The biggest benefit is an improved bottom line. Most companies spend a large portion of their revenue on the cost of quality. When a Six Sigma certification is used within an organization, they experience a drastic reduction in the cost of quality.

Failure costs are usually the biggest expense for large organizations working toward quality. A small organization pays for failure also. Although smaller organizations do not pay as much money quantitatively, the percentage of revenues is usually equivalent.

When the Six Sigma methodology is used within an organization, failure costs turn into prevention costs, which are directed to the bottom line and reinvested in sales, boosting value-added activities. Resources can then be used to generate revenues.

Six Sigma deployment is the same whether it is within a large or small organization or company. In a large organization, the Six Sigma Master Black Belt might develop the infrastructure to support the program and apply the DMAIC approach. This infrastructure will include customers, employees, and the needs of shareholders. The project selection will include support systems to be established and endorsed by management. Large scale projects are usually broken down by certified Six Sigma Black Belts aligned with the strategic objectives of the business related to cost, quality, or revenues. They will oversee the work of the Six Sigma Green Belts, who are in charge of most of the actual Six Sigma work within the company or organization.

The biggest challenge for companies implementing the Six Sigma certification is the allocation of resources.

Smaller companies have a different infrastructure because it is usually flat. Employees have less skills and the support personnel are usually less qualified. Smaller organizations rarely have an employee with a Black Belt level Six Sigma certification.

The best way for a smaller organization to reap the same benefits of this type of training and improvement is to send their own management to Six Sigma training in order to gain these important skills. The cost of training should be looked at as a company investment, and usually proves to be well worth the expense, and in some operations, critical for survival.

Smaller organizations often don't feel they have the money to pay for Six Sigma certification. It is important to remember that this type of training will eventually pay for itself. If you have a lot of waste, it is important to implement changes to eliminate and reduce waste so you can experience higher revenues. Smaller businesses might even consider hiring a professional with a Six Sigma certification and experience to come into their business and provide consulting services if they do not feel they have the right personnel to send to training that they can depend on to lead the business to change.

Smaller organizations can actually have an advantage to a Six Sigma certification over large companies. This is due to the progression of positive changes that can be made:

- Cultural business issues can be addressed and changed much more quickly in a small organization;
- Teamwork is easier to implement, and employees appreciate management in smaller settings. If your business spends too much money on the cost of quality due to failure issues, it is best to implement a Six Sigma program within the business;
- It is well worth the cost, and you will experience higher revenues and a reduced bottom line, a end result that will benefit everyone involved.[49]

3.2 Six Sigma Deployment Plan for SMEs

Six Sigma projects can be successful if due consideration is given to management support, education and training, allocation of resources, and linking effort to compensation. For application in small companies there are a few things that should be present:

- *Management buy-in and support:* for small businesses, management can get involved in the activities related to Six Sigma training on a personal basis.
  It is easy to get people together and reach an agreement on issues that are comparatively difficult for a large company.
- *Education and training:* the cost of education and training in smaller companies is usually higher. This is because the investment covers a smaller number of personnel, and smaller companies have fewer chances of getting discounts as a bigger company would. Any time put in for training is time lost on production - and eventually, the revenue generation process. This training and education can be useful to sustain Six Sigma training in the long run.
- *Committed resources:* committed resource availability becomes an issue for smaller companies. However, the availability of employees as a resource is important. Though there

[49] www.sixsigmaonline.org, Six Sigma Training Assistant

may seem to be a shortfall in their availability for other functions, the benefit of involvement of resources is visible in the long run.

- *Linking efforts to compensation:* in a small business, the Six Sigma project team can be compensated according to their efforts.

  Formal appraisals can be undertaken, and results of initiatives will be easily identified and appropriate compensation linked to these efforts.

There are other aspects that should be considered. To bring in change successfully, three important requirements need to be met:

- *Increasing tolerance to variations:* when small businesses undertake a project, there should be tolerance in the system to variations that the changes may cause.

  Care should be taken before deployment to ensure that project consequences do not affect customers adversely. Any variations should be dealt with care, and a safe path followed for further changes.

- *Spare Resources and Redundancy:* change agents have to spare sufficient time on project development. Small businesses have to put in extra efforts; they may get assistance from bigger organizations or outside consultants. Small businesses cannot afford to undertake project for longer periods of time; thus, they must choose projects carefully.

- *Identification and selection of Six Sigma projects*: in order to answer the first research question, the research team carried out a literature review regarding tools and methodologies to identify and select/prioritize Six Sigma projects. Throughout the Six Sigma literature it is often reported that the identification and selection of the projects correspond to the most important task in the whole DMAIC.

The Six Sigma Deployment Plan for SMEs is divided into four phases: Measure, Analyze, Improve, Control.

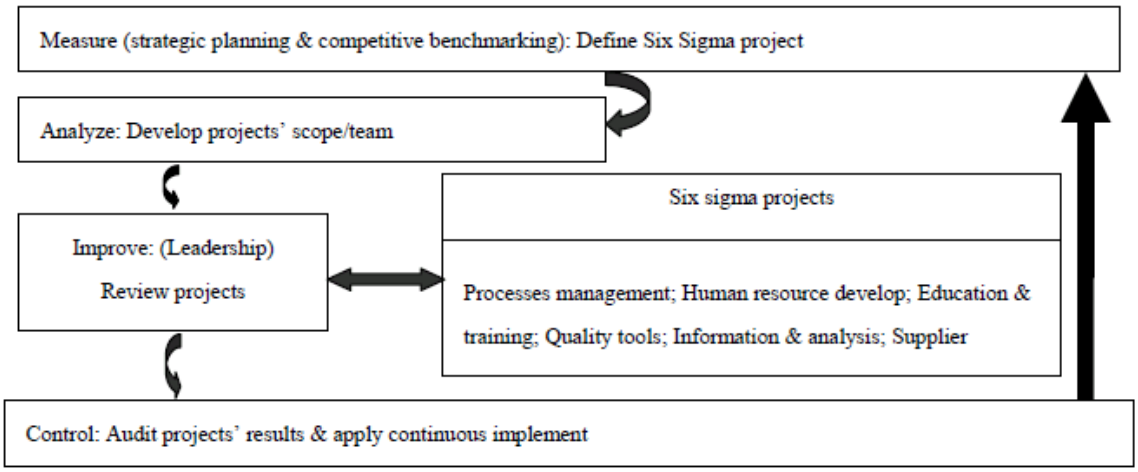

Illustration 3.2.1: The Six Sigma framework for SMEs

- ***Measure***: Senior management not only initiate Six Sigma deployment, but also have to play an active role in the whole deployment cycle. Thus, the initial phase of the implementation process requires the development of an awareness and commitment to the need for quality improvement. In this initial phase, you must develop an infrastructure to carry out the deployment, and manage the implementation process. This phase should be developed as follows:

  a) Establish leadership commitment and involvement
     - The Six Sigma implementation must be driven from the top level. Top management must fund this effort and allocate the appropriate resources. They must express commitment toward this effort to the entire organization and should be involved throughout the implementation process.
     - Senior management will lead the Six Sigma implementation. They have the responsibility of developing and managing the Six Sigma implementation and to ensure the organization's readiness for the implementation

  b) Team up with outside quality facilitators
     - The assistance from experienced outside quality facilitators is essential to Six Sigma implementation.
     - The Core Team has the responsibility of developing and managing the Six Sigma implementation and to assure the organization's readiness for the implementation.

  c) Provide Six Sigma deployment training
     - Senior Management should attend an overview on Six Sigma to gain an understanding of the benefits and the general approach of Six Sigma implementation.

  d) Schedule periodic senior management reviews
     - During the initial stages in defining, developing, and implementing the Six Sigma program, it is important that senior management schedule frequent reviews with the quality facilitator to keep yourselves informed of the activities involved in the Six Sigma implementation.

Measure

1	Leadership	Management provides personal leadership and commitment for quality improvement
2	Customer Focus	Marketing/Sales and customer satisfaction. Information is used to target potential market segments and customers
3	Education & Training	Education system balances short-term and long-term organizational and employee needs
4	Information and Analysis	The needs for quality tools in facilitating job performance are identified
5	Process Management	Key business processes are identified, improved and monitored
6	Strategic Planning	Establish a quality steering committee to develop short-term and long-term strategic plans to ensure quality improvements
7	Supplier Management	Key performance requirements are incorporated into suppliers' process management
8	Quality Tools	The needs for quality tools in facilitating job performance are identified
9	Human Resource Development	A variety of methods are designed and used to measure employee satisfaction
10	Competitive Benchmarking	Marketing, new technology, and competitor benchmarking information is obtained

Table 3.2.2: How to apply the Measure phase in the Six Sigma MAIC discipline

- ***Analyze***: The main objectives of the second phase are to identify the gaps between current processes performance and the business goals, transform the gaps into improvement projects, and establish an integrated system to support the implementation.
  a) Define business goals, based on organization strategic plan.
     - Senior management must have a clear understanding of the organization's purpose, structure, and flow, including interfaces with other organizations and primary customers.
     - Determine and understand corporate policies and procedures that affect the Six Sigma Quality Management System (QMS). Any applicable corporate policies or procedures must be incorporated or referenced within the QMS, as appropriate.

b) Based on the organization's strategic plan, Senior management must define the short-term and long-term business goals. Your quality facilitator may be able to help you in this regard.

c) Identify existing processes performance
   - Identify the overall process of the organization, showing how products or services are created and supplied to the customers.
   - A high-level “gap analysis” is performed by the Core Team.

d) Define Six Sigma improvement projects.
   - Based on the “gap analysis”, define the scopes and goals of Six Sigma improvement projects.
   - Involve your quality facilitator in determining which projects to select initially.

e) Create performance measures for all Six Sigma projects
   - Based on the results of “gap analysis”, define the detailed performance measures for all Six Sigma projects.
   - Incorporate these performance measures into an organizational information system.
   - Enhance the organizational information system in order to provide the information about individual project progress and the overall Six Sigma implementation performance.

f) Establish an incentive/recognition system
   - An incentive/recognition system is essential to Six Sigma implementation.
   - Senior management is responsible to design a system to motivate employees to be involved in and dedicated to the Six Sigma implementation.

Analyze

1	Leadership	Management communicates organizational policies and performance expectations to employees
2	Customer Focus	Complaints received from customers are aggregated and analyzed for use in overall organizational improvement
3	Education & Training	Management and employees are trained to obtain problem-solving skills, and equipped with quality-related knowledge
4	Information and Analysis	Analysis results of measurables are linked to work units and functional-level operations
5	Process Management	Project related training system is in place
6	Strategic Planning	Strategic plans are translated into executable action plans for all business units
7	Supplier Management	Working with suppliers towards long-term partnerships. Suppliers selected on the basis of quality aspects
8	Quality Tools	Training on quality tools is provided to management and employees
9	Human Resource Development	Recruitment plan is aligned with strategic plan
10	Competitive Benchmarking	Benchmarking information is analyzed and used to identify strategic opportunities

Table 3.2.3: How to apply the Analyze phase in the Six Sigma MAIC discipline

- ***Improve***: This phase begins the process of actually composing the improvement project teams and providing Six Sigma and project-related training to the team members. Then, while the projects progress, the management should constantly monitor the status of each project.

  a) Form the Six Sigma project teams

  - Senior Management is responsible for composing the Six Sigma project teams.
  - The Six Sigma project teams are responsible for the delivering of the project goals assigned to each project.

- For the initial project(s), the quality facilitator will act as the Black Belt, leading the project team members through the Six Sigma process. A portion of the savings generated by these initial projects will provide the funding for the future training.

b) Plan and provide Six Sigma training to members of project teams
   - Develop a training plan and strategy, and provide the appropriate training to all members of Six Sigma project teams.
   - The training plan should focus on: Six Sigma overview, measure-analyze-improve-control (MAIC) discipline, and utilization of quality tools.
   - The initial training will be for Green Belts, with the quality facilitator acting as the Black Belt for additional projects until the savings generated by these projects provides enough to fund training of your own Black Belt(s).
   - When your own Black Belt(s) has been trained, your quality facilitator will act as your Master Black Belt only, providing support to the Black Belt(s) for the more sophisticated statistical techniques (e.g. complicated design of experiments), and additional Six Sigma training.

c) Implement the Six Sigma projects
   - Project teams should evaluate the existing processes and proceed with the MAIC discipline:
     - Measure: Measure the existing systems. Identify and describe the potential critical processes/products.
     - Analyze: Analyze the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal.
     - Improve: The improved outcome is measured to determine whether the revised method produces results within customer expectations.
     - Control: Control the new system and keep the original problems from recurring.

d) Monitor and review the status of each project
   - Keep the Core Team informed of the activities involved in implementing the Six Sigma projects.
   - Obtain their inputs on an ongoing basis.
   - Senior Management provides directions and support to the Six Sigma project teams.

Improve

1	Leadership	Management acts as key driver in continuous improvement. Management regularly reviews quality performance measures
2	Customer Focus	Processes are established to ensure customers' complaints are effectively resolved. Follow up with customers on recent transactions is undertaken in order to receive prompt feedback
3	Education & Training	Knowledge/skill sharing system is established across work units. Continuous learning is provided through education & training
4	Information and Analysis	Integrated performance information is provided to management to review overall organizational performance
5	Process Management	Systems and procedures for quality assurance are implemented. The accessibility and utilization of information systems are improved
6	Strategic Planning	Allocate human and financial resources to accomplish action plans. A recognition/reward system based on quality performance is established so as to facilitate attainment of the business objectives
7	Supplier Management	Suppliers are actively involved in quality improvement activities. Supplier performance audit and evaluation are important activities to be conducted
8	Quality Tools	Quality tools are used in production and non-production related functions for improvement activities
9	Human Resource Development	Job advancement system is provided. Communication methods (such as newsletter, meetings) are implemented. Work environment is conducive to the well-being of all employees
10	Competitive Benchmarking	Benchmarking information is used to drive improvement

Table 3.2.4: How to apply the Improve phase in the Six Sigma MAIC discipline

- ***Control***: The main objectives of the fourth phase are to assess each project's gains in improving processes performance, determine the success level of each project, continuously adjust the business strategic plan, and re-start the implementation cycle.

a) Audit the projects' results.

- The projects are completed, the results are audited by senior management and confirmed with the projects' goals.

b) Maintain the improved systems

- Institutionalize the improved system by modifying policies, procedures, operating instructions, and other management systems.

c) Apply the incentive/recognition system

- Based on the project performance, the appropriate incentive and recognition will be applied to the project team members.

d) Apply continuous improvement mechanism

- The organization strategic plan and related action plans will be revised according to the project performance. Then, the new Six Sigma projects are derived from the revised strategic plan.

Control

1	Leadership	Management audits the execution of results of each action plan
2	Customer Focus	Customer satisfaction levels are measured and controlled
3	Education & Training	The performance and process of the training systems are evaluated by management
4	Information and Analysis	Information analysis results are used to monitor improvement activities
5	Process Management	Work unit performance measures are identified and used to control and evaluate the improvement process
6	Strategic Planning	Define performance measurements for tracking progress relative to action plans
7	Supplier Management	Suppliers' quality performance levels are measured and monitored
8	Quality Tools	Quality tools are used in management processes
9	Human Resource Development	The measures for employee performance are clearly defined and have been communicated with employees
10	Competitive Benchmarking	The process for selecting benchmarking information is evaluated

Table 3.2.5: How to apply the Control phase in the Six Sigma MAIC discipline

3.2.1 The major advantages for SMEs in implementing Six Sigma

SMEs not only may introduce Six Sigma but also have many advantages in contrast to large corporations in implementing Six Sigma. The major advantages include following several aspects.

- The advantage one: top management commitment and involvement. Because SMEs are smaller in scale and more agile in mechanism than large firms, it is much easier to buy-in management support and commitment, which are considered as the most important factor of Six Sigma success, and the top-down approach can ensure favouring implementation of Six Sigma. In SMEs context, once an owner of the business is convinced of the advantages conferred by Six Sigma and visualizes the benefits, it is much easier to implement Six Sigma and realize its benefits.
- The advantage two: stronger, more intimate relationships with customer. SMEs have a much closer proximity to customers. This proximity not only made it easier that the customer voice can be incorporated without prolonged and formalized, but also may let SMEs have higher degree communication with key customers than large companies. The success of Six Sigma depends on reliable ways of collecting the voices of the customer and translating these into critical-to-quality-requirements of products.

Obviously, this close relationship and high degree of communication with key customers are significant advantages of SMEs.

- The advantage three: rapid execution and implementation of decisions. It is easier to implement Six Sigma in SMEs than in large firms because the power of decision making in SMEs does not depend on extensive hierarchies but lies within the owner managers, therefore, the decisions can be rapidly and effectively execute and implement and gain benefits as quickly as possible which will encourage employee's fervor of Six Sigma.
- The advantage four: low resistance to change. Implementation of Six Sigma must be a great change to any organization. However, where there is a change, there must be a resistance, and the resistance's intensity determine change' success or fail.

3.2.2 Obstacles and challenges for SMEs in implementing Six Sigma

Although SMEs have a lot of advantages in implementing Six Sigma, they also have to face some disadvantages which restrict the implementation of Six Sigma.

- Firstly, the limited available resources are the greatest challenge to SMEs. In the SMEs environment, there is little spare resource. Every employee has a key role and usually

several. In addition, financial and technical constraints along with the lack of management experience also are main problems that SMEs have to face. Due to the available resources is limited, SMEs do not have the slack to free up top talented people to engage in training followed by execution of Six Sigma projects as they are crucial to the day-to-day operations and problem solving within the company. So the education and training component is much harder for SMEs.

However, training and education is a key success factor in implementing Six Sigma projects successfully.

- Secondly, it is different for SMEs to find competent consulting companies to help them implementing Six Sigma. To implement Six Sigma, SMEs usually have to fall back on external consulting service providers which should differ significantly from those usually found in the marketplace working for larger corporations due to the lack of management experience and knowledge on Six Sigma. However, it will be quite difficult in finding a good consulting company to help implementing Six Sigma because a majority of consulting companies provide consulting service with traditional six sigma implementation approach which requires millions of dollars investment, dedication of their best people on six sigma projects. Incorrect direction will seriously influence the success of six sigma implementation in SMEs.
- Thirdly, the backward management system is another major obstacle and challenge. The reliable data are the base of Six Sigma implementation. However, most SMEs don't perform perfect data collection and analysis system to find root cause of poor qualities. In general, their formation of strategy process is intuitive rather than analytical. Besides, process thinking which considers all activities as processes and stresses that process is the base of management is very important in Six Sigma approach

3.2.3 DCMCR Model

According to the SMEs characteristics and to the milestones, the DMAIC approach could be modified in order to furnish an easy and effective tool. The proposed Six Sigma model for SMEs, named the DCMCR framework (Define, Collect, Manage, Classify, React), arises from the DMAIC methodology but differs from it, as illustrated in Illustration 3.2.

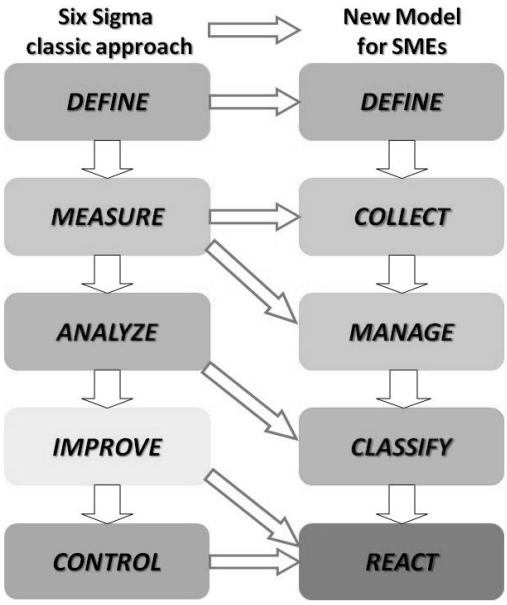

Illustration 3.2.6: The new DCMCR model for SMEs.

A brief description of the DCMCR phases follows:

- *Define*: the define phase is still the same of the DMAIC approach. Thus in this phase the identification of the SS project, the preliminary analysis, the allocation of the resources and the entire SS problem are defined.
- *Collect and Manage:* the main changes introduced by the DCMCR model are related to the Measure phase, that has been split in two distinct phases, named Collect and Manage: this is because SMEs could not carry out advanced measures due to the lack of funds and, consequently, investments in Information and Communication Technology, or resources in general for data analysis (Antonelli and Parbonetti, 2002; Barnes et al., 1998); another emerged weakness of SMEs is the lack of knowledge of the statistical tools used in the classic Measure phase of the DMAIC approach (Antony et al., 2005). Thus, the Measure phase will be limited to a collection of already existent data (taken from databases, digital or paper archives) as well as a data manipulation and management through simple statistical tools (histograms, cause-effect diagrams, Pareto, etc.);
- *Classify:* the Manage phase is necessary for data classification through specific criteria (Classify phase), once information have been extrapolated, using methods and tools tailored to the specific SMEs' needs.
- *React:* the React phase merges the DMAIC Improve and Control phases: in this activity data are used to get the corrective actions, in order to make the process under statistical control.

3.3 The characteristics of an improvement program actually be implemented in a SME

Before attempting to discuss the features that should have an improvement program to be actually implementable in a SME, I want to briefly discuss the critical success factors of Operations Improvement methodologies.

3.3.1 Critical success factors of a program to improve operations

Studying the most successful applications of Lean and Six Sigma methodologies, we realize that all of them have in common certain characteristics:

- Improvement programs "company-wide" (at a level of the entire firm) integrate quality processes and business functions rather than maintaining it as a separate entity,
- In the most successful implementations, the application of improvement methodologies has been extended over the whole company; it would be a mistake to limit the implementation to some relevant components,
- Lean and Six Sigma programs require the involvement and support of management. It is essential that the management of the company put quality as first priority,
- Successful programs are those that focus on specific objectives, numerically measurable. Often it is involved the finance department with the task to validate the saving achieved in the various improvement projects,
- The organizational structure of Six Sigma is based on specific roles (Green Belt, Black Belt). It is essential to draw on the best talents of the company and use the results achieved within the project Six Sigma criterion as the basis of career promotion,
- Also in Lean methodology applications are beginning to see well-defined roles (eg. Lean Expert).

3.3.2 Prerequisites for the implementation of an initiative for improvement in an Italian SME

The light of those discussions can take a step forward to understand what are the prerequisites for the implementation of an initiative for improvement in an Italian SME.
The most common obstacles to the success of an improvement initiative such as Six Sigma or Lean Thinking must certainly remember the excessive costs for employee training, the difference towards

a methodology that comes from afar, the lack of adequate involvement and support from direction, the involvement of people unsuited to the task, unclear or unrealistic goals.

How can methodologies developed by large companies such as Fiat, Telecom or Whirlpool, be successfully applied to a small business like Staccata Srl (Small-Medium Enterprises, SMEs), operating in a manufacturing sector or in a service sector?

In a nutshell, the prerequisites for an effectively implemented methodology are:

1. *Culture change*: Strong customer orientation,
2. *Involvement of management,*
3. *Involvement of the best resources in the project,*
4. *Assessing the return of investment:*
    - focus on areas of greatest interest,
    - request modest investments,
    - use of concrete and practical tools and interventions,
    - strong orientation to results in the short term.
5. *Current and widespread education:*
    - lean training, practical and tailored to specific needs of enterprise programs,
    - broad and flexible "toolbox", but contains simple tools and easy to apply,
6. *Clear objectives:*
    - thinking big, starting small,
    - generalized approach: applicable to a wide range of situations and business problems.

1. Culture change. The most important obstacle to overcome during implementation of the methodology, is represented by a great distrust of the workers, who see improvement programs such as loss of time that distract them from daily activities.

A cause of difficulty is the resistance within the company, usually people tend to prefer the method of work that have always adopted during their career. Persuade them to adopt a different approach is not easy.

Often the biggest change is that all business functions must be guided by a strong customer orientation.

Customer orientation is one of the fundamental concepts of Total Quality Management, and it can be understood as a constant voltage of the organization towards the continuous improvement of the relationship with the customer.

It is a value that must be shared by all human resources and which must guide the actions of all components of the organization, with a view to spread responsibility, in order to obtain the satisfaction of needs and outside customer expectations.

Customer orientation is used as a model for relations within the organization.

This is a true cultural change takes time and significant efforts by the management and the Human Resources Department. In particular, the next point, involvement of management, is essential to support cultural change.

2. ***Involvement of management.*** To ensure the successful implementation of the improvement program, it is required a strong involvement and leadership by the absolute property of the company (for companies in "master" character) or by the top management in order to break down the organizational inertia and traditional prejudice against any kind of improvement program.

   In the case of companies still led by the businessman, the best advice I can give is that the businessman is the first that have to show confidence in the methodology and he is the first that have to "lead by example", participating as first person at a training course on Lean and Six Sigma. This will not only have the benefit of involving directly the leader in quality improvement project, but will give the right signal of confidence to the team involved in the initiative.

3. ***Involvement of the best resources in the project.*** The improvement initiative may require that some resources could be drawn from the function / department of belonging and completely dedicated to the activity of improvement. Particularly in the Six Sigma, Green Belts figures spend an average of 20% of their time on the improvement initiatives and the remaining 80% on the routine operational tasks, while the Black Belts devote 100% of their time on projects to improve Six Sigma.

   Generally the role of Black Belt has a duration of two years, after which it is expected that the person returns to occupy managerial or operational roles within the business functions.

   Participation in Lean / Six Sigma projects should be viewed as an excellent breeding ground for mold managers, enabling to have a knowledge of cross-functioning of organizations to the involved resources. This allows them to develop a vision for a broad spectrum of management activities, creating the conditions for a fast career progression.

   Only with this perspective, the improvement program will rely on the best resources.

4. ***Assessing the return of investment.*** Companies often complain, as a rock to the introduction of an improvement program, the high costs of training and resources devoted to the methodology. The costs are not so high and the time needed to repay the initial investment is surprisingly fast. The staff to devote full time to the improvement program should be scaled using the rule of 1% of total workforce. This is certainly a small numbers for SMEs. A company with fewer than 100 employees dedicated to continuous improvement should be at most one full-time resource.
   Particularly small businesses, could have part-time roles or alternatively to rely on external consultants (for the roles of Black Belt or Lean Expert) who are able to manage the team consisting of internal staff. The team in this case may consist of one internal working part-time on the project, able to interpret collection of data more efficient than external consultants. This solution would allow a SME to support a great deal lower cost of training and improvement initiative focusing only on areas of particular strategic and economic importance.
   In extreme substance to be attractive to small businesses, and ensure a rapid return on investment, the improve methodology should:
   - Be focused on areas of greatest interest,
   - Require modest investments,
   - Propose concrete and practical tools and interventions,
   - Have a strong orientation to results in the short term.

5. ***Current and widespread education.*** Within a continuous improvement program, education and training play a vital role as continuing activities aimed at firm growth. The methodology should be characterized by slender training and practical programs, (“hands-on” training, with workshops, work group , field projects), adapted to the specific needs of the company (customized).
   Training programs should include an extensive collection of instruments as to provide to the operators a broad and flexible "toolbox", but contains simple and easy to apply tools.
   Training courses should be through "awareness" courses (aimed to provide at least the basics of Lean Six Sigma) and through actual practice on the job, as to understand the importance and benefits that technology can bring .

6. ***Clear objectives: thinking big, starting small.*** Without putting in place ways to measure customer satisfaction, companies have claimed to know and meet their needs. Clarity of objectives is a basic prerequisite in Lean and Six Sigma methodologies.

In order to "thinking big, starting small", the methodology should be "generalizable": applicable to a wide range of situations and business problems.

In this way, several companies have begun to streamline production processes by applying the principles of lean thinking, but they apply the same methodology to the offices and processes "transactional" such as administrative procedures, payroll and travel organization in a short time.

3.4 Prerequisites that must exist in the company because it is ready to implement the methodology

3.4.1 Self-assessment checklist for minimum prerequisite for implementing an improvement program

To see if an SME is ready to implement an improve program as Lean or Six Sigma, it is proposed a check-list based on four critical factors:

- The involvement and support of top management,
- Previous experiences with other improve programs/initiatives,
- Process approach, used to measure performance and customer orientation,
- Availability of resources to be allocated to the initiative for improvement.

3.4.1.1 Commitment of Top Management

Support and involvement of management may provide a stimulus and a mainspring to the organization when it comes useful to implement significant changes. The level of commitment of top management can be measured by checking if there are members of senior management involved in the improvement program, and thus evaluate their responsibilities and the time they will dedicate to the program.

3.4.1.2 Experiences with improvement initiatives

Prior experience with other quality improvement is a good starting point for a Lean Six Sigma project. There are different types of improvement initiatives that can help to create a mindset and a corporate culture oriented to quality and have positive and long lasting.

There are two prerequisites to consider relevant a past experience:

- The initiative must have provided a number of training / education,
- Employees were somehow encouraged to contribute to the success of the initiative.

If the organization has no experience with quality programs or have had a negative experience, it is essential to create awareness of the importance of quality for the company and to motivate and prepare employees to the implementation of Lean Six Sigma program.

3.4.1.3 Performance measurement and customer orientation

The understanding of how processes and the ability and the habit of measuring the performance of the processes are crucial in the phase of the improvement of program setting.
Performance indicators should not only measure the efficiency of internal processes, but also their effectiveness in terms of customer impact. Consequently, the system of performance measurement have being taken into account feedback from the market. One of the basic principles of Six Sigma methodology is listening to the voice of the customer and focus on meeting market expectations. It is necessary to know its own customers, approach them correctly and measure their satisfaction.

3.4.1.4 Resources availability

Herein is referenced to resources as a technical support and organizational structure.
First, the availability of people (employees or external consultants) with a good knowledge of basic disciplines (eg. statistical foundations for Six Sigma) is a prerequisite before starting the implementation of the methodology of quality improvement and to support the development over time. Minimum basic knowledge and adequate technical support may facilitate implementation. In addition, an organizational structure is essential to enable effective management of change.

3.5 Practical advice for implementation

3.5.1 Starting from the self-evaluation

They suggest to the managers of a company to launch an initiative of quality / operations improvement to proceed first with a complete self-evaluation, following the checklist proposed in

the previous paragraph.
Depending on the results, along with a decision Go / No Go, the result of self-evaluation will also set a realistic target for improvement obtained by the object of analysis.

3.5.2 Starting from achievable goals and manage the process of continuous improvement

The cases of successful deployments of Six Sigma in Italy and abroad teach: objectives should give easy access in the short term alongside very ambitious target in the long run. Too rapid a departure would be likely to fail the entire project.
To avoid having to surrender at the first set, the Italian SMEs should start slowly and with small steps, but maintaining consistency with the goal of widespread implementation and to support it in the long-term.
The management of continuous improvement have to be done through the following steps:

- Prioritization by management,
- Link priorities with business processes,
- Identification of a portfolio of specific actions for improvement (for every action must correspond a project),
- Prioritization of projects / planning of projects also to successive waves (when the number of projects is already high),
- Operational projects directed by senior management.

In the first 12-18 months of implementation, attention must be paid to the choice of simple, short and easy task projects. This would achieve tangible results in the short term, and the euphoria of the project team.
In the medium-long term become possible to extend the application of the improvement program to all areas of business, integrating individual improvement projects, first alone and focused on individual problems, in a single overall design of business process reengineering aimed by the excellence.

3.5.3 Barriers to improvement are not insurmountable, if it is taken appropriate and structured actions

It is important to spread to all levels at least a basic knowledge of techniques and tools used. The way of improvement passes through a major change or through an ex-novo redesign of business processes, which can only happens if you can have a large number of employees who know the methods of improvement and that they are urged to apply.
The choice of projects must follow a proper methodology, which avoids the risk that these are conducted with great difficulty, on long time resulting in a likely failure.

3.5.4 Companies in which all hierarchical levels have a Six Sigma training, produce a greater number of improvement projects.

With extensive training at all levels of the hierarchy, a larger number of people in the organization can identify and report cases that hamper value creation, providing the impetus for the implementation of numerous improvement projects.
Companies that restrict training to higher levels of hierarchy, may have greater difficulty to implement the projects because the front lines need to identify the causes of inefficiencies, to contact at the operational level who are familiar with the process. These that do not have a Six Sigma training and therefore lacking a mindset oriented to improvement, hardly will have a proactive attitude towards problem resolution.
Training must be conducted to educate operating figures, which are in direct contact with individual portions of the process, they know it thoroughly and they are the real driving force of improvement culture.

3.5.5 The training effort for continuous improvement programs decreases with the increase seniority deployment in company

Initially implementing an improvement program requires substantial efforts by the company. It is required a massive training for the preparation of the Black Belt and the Lean Expert, which will be working in turn to raise awareness of the methodology to various corporate levels to the lowest, in order to overcome the resistance that may encounter when is deployed a new methodology.
The operatives support the implementation of improvement projects in specific areas, with the added advantage of being able to continue working within their function, they dedicated only

partially their time to improvement projects (unlike the Black Belt that in the Six Sigma implementations area, the resources are dedicated full-time to the improvement of the projects).[50]

Chapter 4 Staccata Srl: an Italian SME

In this chapter the interest is to demonstrate the positive influence of Six Sigma approach in a Small Medium Enterprise like Staccata Srl.
These benefits come from the improvement of the process by identifying and removing the causes of defects and variability.
Little research has been carried out for verifying Six Sigma compatibility and appropriateness in Staccata Srl.

4.1 Staccata Srl History

Cavadini1960 & Staccata s.r.l.

In 2007, Cavadini's family meet Marco Colombo, founder and watch designer of Meccaniche Veloci. Meccaniche Veloci in only 2 years become one of the most famous Italian watch brand.
In 2009 Marco left his own company to create a new brand with Alessandro Cavadini and his brother Matteo.
Staccata s.r.l was born in March 2010.
The idea is to create new way of marketing with new concept using watches.
Basically the mission is oriented to cars and bikes customers.

Staccata srl has created 2 brands:

- The first was "Quarto Di Miglio" and
- The second was "1/4".

Quarto Di Miglio means "400 meters" and it used in accelerations test.

[50] "L'organizzazione snella per le PMI", Luca Cagnazzo e Alessandro Brun

In only 5 months, Staccata climbing some very prestigious target in terms of licensing like SBK. SBK, after Formula1 and MotoGP, is also the most famous championship in the world.
The product launch happened in September during the Imola Grand Prix (Italy).

Illustration 4.1.2: SBK Watches

Illustration 4.1.3: TT Assen Watch dial

4.2 Quarto di Miglio

QUARTODIMIGLIO
QM

Illustration 4.2.1: Watches brand of Staccata

Quarto di Miglio is one of many examples of an Italian business success, with the dream of turning the passion for motor into items wrist. The team is composed by Marco Colombo, Alessandro and Matteo Cavadini. Alessandro and Matteo Cavadini belong to an historical family of

watchmakers who, for more than 50 years, designing instruments for measuring time to the best-known worldwide watch brands. The idea that moves them is innovative and exciting at the same time because it is reflected the momentum attractive into watches that are in motion and machine enthusiasts. The whole project starts from the use of materials recovered in the machine shop and garage, never apart from the basic concept such as aesthetic appeal. The tie that binds every fan to your cult object is tight and each watch has itself a strong reminder of content: The case is molded from a real carbon brake, the dial is the faithful reconstruction of a brake on wet MotoGP, the most prestigious circuits screwed into the dial and the strap is a slick tire. The shapes, colors and materials had never seen before in watchmaking world, no one before the creative genius of Marco Colombo was able to concentrate so hard the key features of cars and motorcycles in an instrument so small and so precise. It is thanks to a substantial amount of Alessandro and Matteo Cavadini that innovative ideas are transformed into Marco's concrete objects. The ingredients because Quarto di Miglio becomes another success seem to be all and are also curiously mixed. A group of boys who enjoy aesthetically innovative forging specimens using precious materials, but all with a smile on their face and hands stained with grease.[51]

[51] www.quartodimiglio.it

Illustration 4.2.2: Quarto di Miglio Watch

4.3 The Six Sigma methodology in a Brand New Business like Staccata Srl

When small businesses first start up it would be difficult to measure the first step of the Six Sigma method, which is defining loss or defining waste. A business on average should be open at least six months before beginning to see a waste or loss pattern, however the company can begin designing with data showing varying trends.

A weakness is in the data and analyzing sector of the Six Sigma method for a business just starting out.

The company has not been open long enough to have such data to analyze yet, so trying to analyze profit and margin the first month would be difficult if not impossible. What a new business can do

is to look at other data, such as data from other businesses, to see what other companies are carrying and possibly make a decision to carry the product or not.

One step that will work for a brand new business, like Staccata Srl, is the *Improvement phase*. Because the company is a brand new, of course there will always be weekly if not daily changes to improvements from customer base to product base there is always need for improvements.

The final step of the process, *Control phase*, will also work for a brand new business as they can now control what they currently have versus what they do not have at the end of the week or quarter depending on when such records are kept. After a month or so of operation, the business owner can start to see a profit or a loss on his new company so controlling what is lost is the most important thing he can do.

Parts of the Six Sigma method would work for a brand new business but not all parts would be beneficial to a new business as certain and very important information cannot be obtained so early in a company's history.

4.4 Six Sigma and DMAIC approach in Staccata Srl

The main problem that can be found in *Staccata Srl* is the relationship with suppliers.

This problem, implies also another problem at the organization level.

The procurement of materials is done through two main suppliers: one Italian and one in Hong Kong.

The relationship between suppliers and Staccata, triggers the onset of problems / different advantages:

- The procurement by an Italian supplier, allows the direct monitoring of the practices of the supplier. In the event of changes you can contact your provider and work with him to ensure that specific requirements are fully met.

  The disadvantage implied by the procurement from an Italian supplier is the cost of the material. The cost of the material itself and also the labor costs are certainly much higher compared to Chinese.
- The procurement by an Hong Kong supplier, does not allow the direct monitoring of the practices, which implies that many times the company supply materials that do not meet the required specifications.

  The advantage implied by the procurement from an Hong Kong supplier is undoubtedly the low cost of materials and labor.

If it is analyzed the relationship between cost and quality, one realizes that it can be seen as a double edged sword because the quality of the product, for a company like Staccata, is crucial.
Applying Six Sigma methodology, it is possible to reduce cost, improve quality, reduce waste and speed delivery by reducing process variability and defects in order to increase the customer satisfaction (as we can see in the Illustration 4.4.1 below).

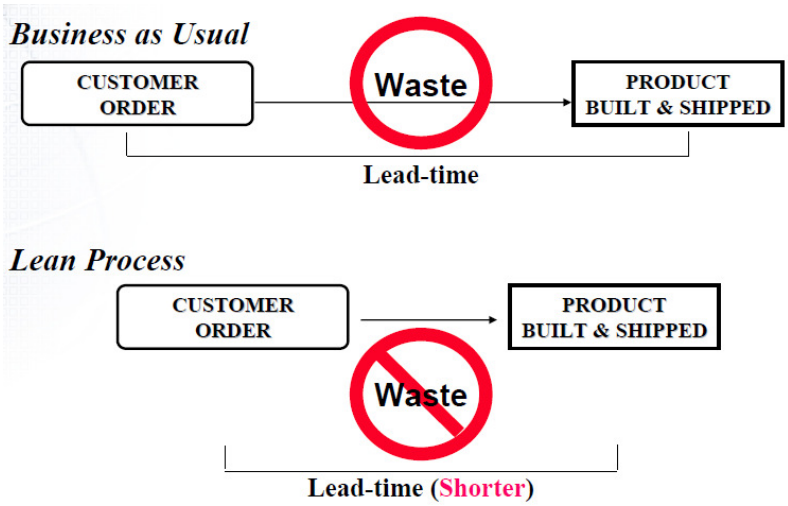

Illustration 4.4.1: The difference in waste between business as usual and lean process

Illustration 4.4.2: Example of defects on the case and on the glass of the watch

In order to implement this critical aspect concerning the procurement, it is implemented the DMAIC approach.

During the ***Define*** phase, the project has already been identified, we need to define what are the problems we want to focus on, how we plan to improve the actual situation and what the targets are.
The problems that we analyzed are the relationship with suppliers, how to control the quality of the supplied products and how these two issues impact the firm creating additional problems in the organization.

The most important aspects of a supplier are:

- Respect precisely the product specifications;
- Guarantee high product quality and effective quality control.

To define how we want to structure and manage our project, we applied the *Project Charter*.
The *Project Charter* makes it possible to plan activities in a structured and controlled way, through basic project management techniques. This instrument was the first step towards the organization of a team;

Project Charter

Project Information

Project start	April 2010
Project end	October 2010

Team members

	Alessandro Cavadini Matteo Cavadini Marco Colombo Michela Cavadini

Process Start point

Start point	Relation with suppliers and organization problem

Project Goals

	Improve the quality of the product and the quality of the process

Project Time-Frame

Milestone	
Date	11 April 2010

Illustration: 4.4.3 Project Charter

This tool enables:

- The clear definition of objectives, resources, time, cost and quality;
- The planning of activities;
- The development of criteria for monitoring and evaluation.

At the center of Staccata's business model there is the customer.

Optimizing internal processes and improving product quality, Staccata aims to guarantee a high level of customer satisfaction even with a wider product platform and a larger organizational structure.

All customers are important, but some are more important because of the magnitude of the turnover, the prestige of the brand and the potential acquisition are the main variables for establishing a sort

of hierarchical classification of customers. Each of them is available in order to purchase a particular kind of product and wants a particular service. The products that the customer receives, reflect the outputs to determine which are the key business processes.

It is essential to define the customer's requirements, in the way that the organization can set the performance standards required. Customer requirements play a key role in communicating the correct specifications of the product to its suppliers.

The needs of the customers imply more attention by Staccata to be competitive on the market and to meet the consumers' expectations. For this reason Staccata takes into account:

- *The explicit requirements*: expectations, the basic features offered by the company to be competitive, taking these as part of the product. If Staccata does not meet those expected standards, the customer tends therefore to seek elsewhere;
- *The implicit requirements*: it is all that customer expects to be satisfied. These are the standard required that the organization has defined and seeks to respect the proper use of the product;
- *The unexpected requirements*: the characteristics that make unique the product, is the plus that comes as product, until it becomes a standard where meet the favour of customers.

During the development of the Six Sigma project, the basic assumption is the recognition that every activity is measurable.

The organization, after assessing the process to be worked on, after setting the values on which work in a way of improvement and after an exhaustive data collection, undertook the identification of the most representative indicators for measuring the process.

The benefits that we can derive from the application of the Six Sigma methodology are:

- Cost efficiency due to waste reductions;
- Optimization of internal processes;
- Customer satisfaction.

The objective of the ***Measure*** phase is to assess the current level of process performance and/or products in respect of the identified requirements in order to define the gap between the "status quo" of the process and the goals for improvement.

In creating the team devote to the project, we focused immediately on the ultimate goal: improving the effectiveness and efficiency of the experienced process to achieve the full satisfaction by the

customer. In particular, the effectiveness of the output refers to the important measures for the customer, requiring a certain level of efficiency by the suppliers.

Efficiency measures, however, are related on what happens in the process, relate to the amount of time, cost, labour and the value that occurred between the start and stop points identified in the process map.

In this phase it has been identified the critical variables in order to define how they should be measured. To do this, it has been made a *Brainstorming* among the team members.

During the brainstorming session, the team recorded many ideas as possible concerning the problem to be measured. This group activity has been successful because each member of the team used its experience and creativity with the scope to reach the benefit for all and to create new ideas.

This activity was conducted:

- Involving all members of the group;
- Showing all the ideas that emerged without criticizing the views of others;
- Clarifying the questions;
- Building, on the ideas generated, the development of the best idea.

During this phase, it has been established a *Cause-Effect Diagram* (*Fishbone Diagram or Ishikawa*).

It has been a useful tool that allowed us to identify all the factors that cause the main problem on the relation.

The diagram has been drawn based on the customer-supplier relationship, trying to find all the variables related to this type of process:

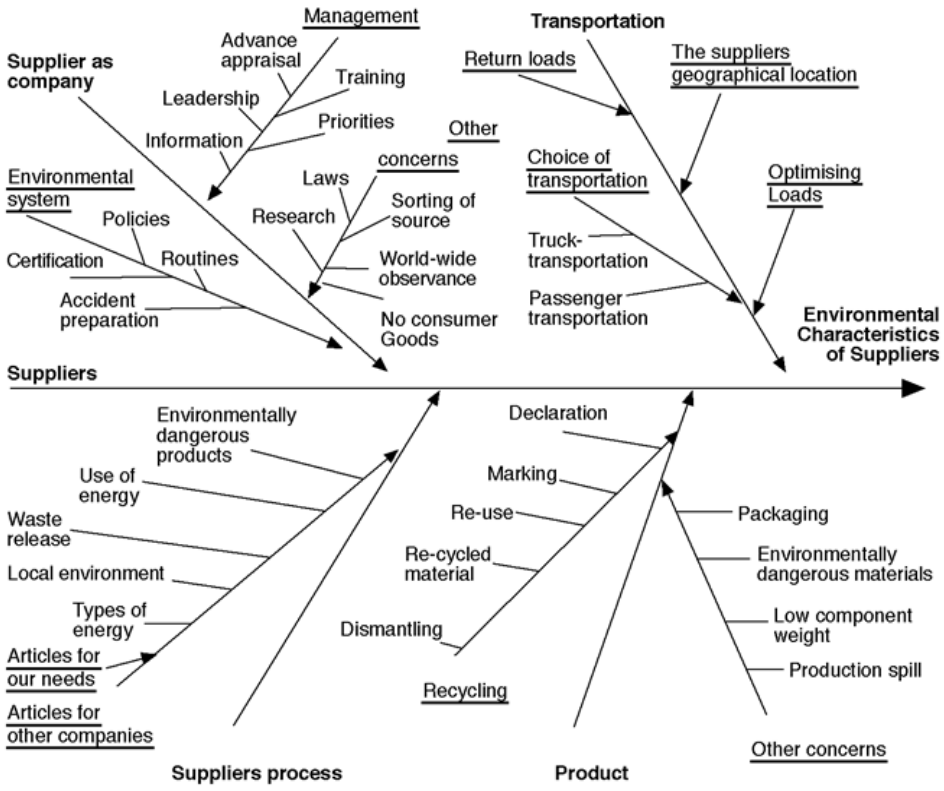

Illustration 4.4.4 Fishbone Diagram

In order to know the variability of CTQ we have been taken into consideration and have been understood the causes that produce them; we analyzed the collected data, with the primary objective of defining the areas in which intervene during the follow-up activities.

The ***Analyze*** phase was developed simultaneously at the time of Measure, because the two phases are iterative:

- Set the optimal values of performance indices and expected capacity of the process;
- The use of analytical tools that allowed us to focus on finding solutions to a limited number of detailed issues.

Through an in-depth analysis of processes, Staccata defined the underlying causes of observed performance, in order to gain useful information to act.

The Analyze phase is often considered the most important because it guides the team to generate improvement ideas.

The analysis of the process is a crucial part to ensuring a successful Six Sigma project, particularly if it is primarily concentrated on improving, rather than efficiency.

This activity has involved the drafting of a detailed mapping of the process, in order to determine the critical points that lead to a strong variability and to strong points are where you find more efficiencies.

A simple and valid tool that was used is the *Flow-Chart*, which provided an overview of the process, and defined the organization structure and operation.

It is in fact a graphical representation in which all stages of the process and the paths are represented in a logical sequence from the starting point to the ending point, highlighting the flow of information and decisions that occur.

The Flow-Chart made possible to explain the impact of individual activities that make up the processes, representing the list of input and output.

It allows to understand the main process from making the order to the merchandising of the product.

As we can see, it is implemented the Quality Controller figure (Michela Cavadini) during the main quality control process.

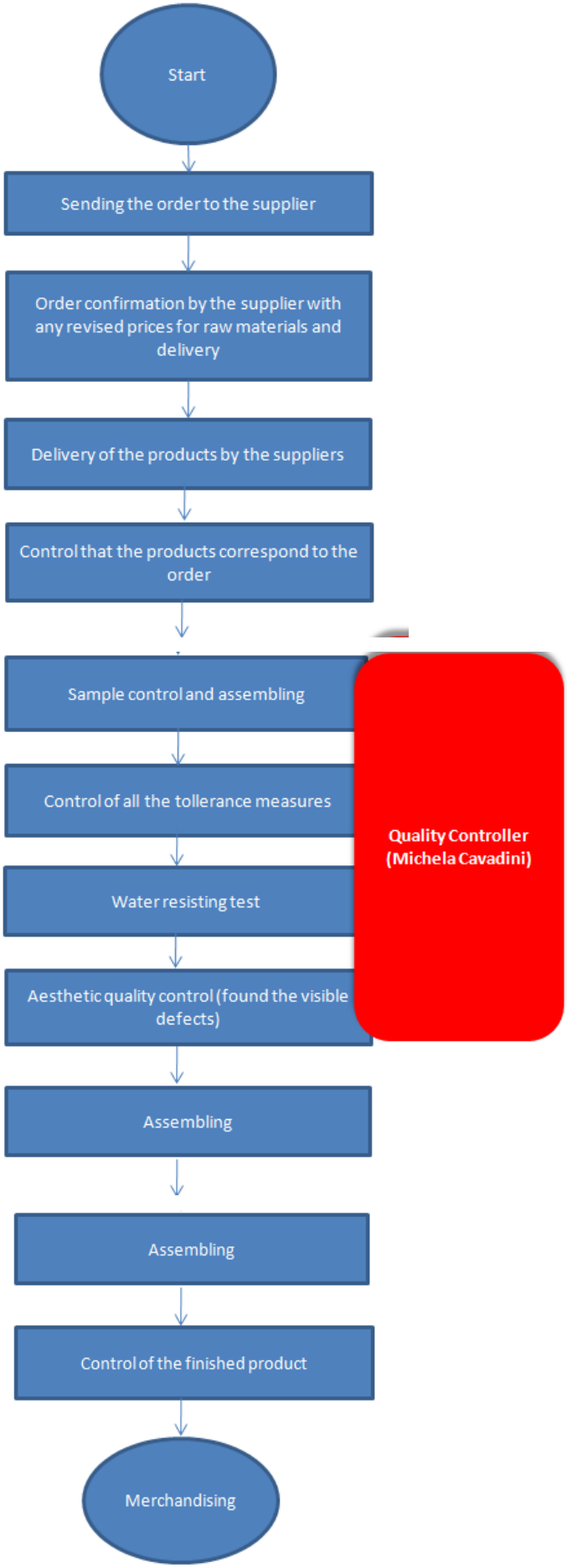
Start
Sending the order to the supplier
Order confirmation by the supplier with any revised prices for raw materials and delivery
Delivery of the products by the suppliers
Control that the products correspond to the order
Sample control and assembling
Control of all the tollerance measures
Water resisting test
Aesthetic quality control (found the visible defects)
Quality Controller (Michela Cavadini)
Assembling
Assembling
Control of the finished product
Merchandising

Illustration 4.4.5: The Flow Chart

The goal of Staccata is achived by the implementation of a Six Sigma project was to end up with:

- Fewer defects;
- Shorter cycle times;
- More skills and capabilities;
- Lower costs and higher revenues.

In the ***Improve*** phase the organization has been focused on the operations to be performed in the process analyzed with the aim of reaching a permanent and continuous improvement, based on the current situation emerged.

In fact, we had to identify possible solutions extending and applying a detailed action plan with the various activities and the control points.

A successful project gives to the companies the saving of large amount of money in the short term, thereby improving profitability and allowing long-term investment.

In the simplest sense, Six Sigma is a highly disciplined approach to decision making that helps people to focus on improving processes with the aim of approaching the concept of "zero defects".

The team took steps testing and verifying the potential solutions, selecting the ones to implement.

The Six Sigma approach has required vision, guided by objectivity and methodological skills and especially the ability to read the company in a systemic way.

During the Improve phase, it has been possible to achieve the desired objective because the project has been developed by people (such as Matteo, Alessandro and Marco) in possession of human qualities such as perseverance, determination, motivation and enthusiasm.

It has been therefore very important, at this stage, prepared people involved in change, taking into account three aspects:

- *Communication*: the information must develop the understanding;
- *Participation*: we needed to involve people;
- *Education*: it was necessary to provide people with knowledge, skills and tools.

After defining the criteria, we got an optimal solution, which has been shared by the whole team.

The action of improvement has been helpful in bringing the character of CTQ within the limits of specific programming required.

Once identified the optimal solution, to improve the process, it has been planned the implementation scheduled by defining:

- *The tasks and the timetable*: we planned the activity in order to eliminate the waste of time and in order to reach a high level of organization.
- *The budget and resources*: we implemented Michela Cavadini in the quality process as Quality Controller qualification. Staccata accepted to use a part of their profit for the implementation of the methodology, because it understood the importance to reduce the product and process defects.
- *Methods of inspections*: Staccata planned the methods of inspection whether with the suppliers or into the organization process.

The ultimate goal for the company, is to procure materials to suit the characteristics of product without error and to introduce a person as a QC in a clear and bright environment work, without being under pressure. This is very important in terms of saving time, material, and money.

The ***Control*** phase is useful to ensure firstly that the process has reached the expected level of improvement during the Improve phase and therefore is able to maintain over time the results achieved. This is accomplished through ongoing monitoring and systematic action to stop the process, once you reach the desired goal, that over time you have a degradation of it.
Through the Control phase we ensured the sustainability of improvements by deciding and structuring the following activities:

- *Elaboration of the management plan process*:

  The organization has defined the process improved:

  - Relationship with suppliers, the quality control of the supplied products and how these two issues impact the firm creating additional problems in the organization;

  Clarified the responsibilities of team members:

  - Alessandro Cavadini as Managing Director;
  - Matteo Cavadini as Watch Product Manager;
  - Marco Colombo as Chief Executive
  - Michela Cavadini as Quality Controller.

  Established measures for the continuous monitoring after which the company introduced the plan.
- *Characterization of the process and documentation of key-learnings*: the organization has clearly defined the factors that influenced the size of the product and its sensitivity, formalized through the characterization of the process.

It has been important to explain to all the members of the team that for every disturbance factor must be known the effect on the characteristic, and must be define a way to control it.

- *Planning and development of improvement actions*: the organization has established a plan for responding to circumstances beyond control.
- *Standardization Process*: it has been appropriate to include an ad hoc training for all staff to transmit the new methodologies and this has reduced the variance between the operators and has provided the basic knowledge and traces to solve the problems.

  The qualifications of the staff have been properly recorded and used for the allocation of staff. In this case Staccata decided to train some people who are able to change roles and to buffer for emergencies.
- *Project closure*: after the Six Sigma project, the management has given recognition to the team for their performance. In a bottom-up logic, the results have been conducted with specific objectives by the strategic planning.

  Once rightly rewarded the staff involved in the project, it has been important to understand that the results are considered as a starting points for continuous improvement and not as an end point.

The development of the project took place gradually. This road appeared to be the most suitable, as found by the theory part regarding SMEs, since it is less traumatic in terms of investment and provides a natural fit, "on the job", including corporate organization and methodology.

5. Conclusion

In the organization and management methods are developing techniques based on the Total Quality Management, which provide brilliant results in the medium to long term, as described in Chapter 2 of this document, and these techniques enable companies to face a competitive environment in continuous changing, influenced by competition and exasperated by substantial progress in technology and communication.

Within this context, the concept of quality is greatly developing: the theoretical aspects are always provided on the basis of any work to ensure an excellent level of quality, but companies need to demonstrate excellent production which aims to evolve, transforming these traditional approaches

as a view-oriented methods of Total Quality Management, characterized by complex operating procedures and advanced tools.

All companies that are able to receive and implement these information flows in its own reality can achieve important results that are reflected in customer satisfaction: the primary aspect to get returns in terms of revenue growth and value of the company.

After having briefly presented the distinctive Total Quality features, we focused in more detail on Six Sigma, which is the most powerful tool of Total Quality Management, as evidenced by the success achieved by the interviewed multinational companies:

- FGA Group SpA;
- Telecom Italia SpA;
- Whirpool Corporation SpA.

These company have made their strength point in managing processes; it is undoubtedly one of the most pragmatic and successful methodologies on the international scene, although, from the literature seems that our country has a timid approach to Six Sigma and represents a fall in an international environment that is much more dynamic.

Italy is characterized by an high influence of small businesses that represent the main component of the industrial fabric of the country and its wealth: in terms of employment, turnover and value added product.

The high presence of SMEs and, within these, the strong presence of small and medium enterprises operating in traditional sectors, is the main feature of our business system.

The comparison between the different weight of small and medium sized enterprises than large one can show that SMEs are clearly held back toward new opportunities, adopting an heavily oriented outcome on short-term cost control and therefore, the difficulties to invest time and money in improvement activities that require a geared mindset to innovation and strategies based on the vision of the medium to long term.

As described in detail in previous chapters, these are the features at the base of Six Sigma: powerful technique that, although born and spread within large corporations, is a flexible tool that can also be extended to different types of organizations, provided that they focus on the successful reproduction of the conditions that are necessary to achieve benefits, both in the short term and in the medium-long term.

In Italy, only in recent years, has been developed the Six Sigma methodology, a sign that today our country is still trying to open up new opportunities to ensure full compliance of its products and/or services to customer requirements, finally looking outside their own country to win the international competition.

The study of the Six Sigma methodology, conducted in a small company like Staccata, has brought important benefits in terms of product and process.

We focused on two critical aspects of the organization such as the relationship with suppliers and the subsequent restructuring of business processes, focusing on the quality field.

The company proves that it implement the Six Sigma methodology among its management enterprise tools though its small size.

It is also evident that the Six Sigma can be a successful tool in many areas, although it concentrate its focus on manufacturing sectors, with a easiest collection and analysis of measurable data.

When examining the factors that influence the success or failure of Six Sigma training and Six Sigma certification in Stacatta Srl, it could be observed that the company found that Six Sigma implementation has been easier to implement in some ways and more difficult in others. Another area where Staccata enjoyed an advantage in Six Sigma training, certification and implementation is the relative ease of passing along the savings realized by Six Sigma methods in the form of compensation. In a smaller company there are fewer barriers to awarding immediate promotions and pay raises as a direct result of measurable process improvements.

There were some obstacles that made it slightly more difficult to implement Six Sigma training, certification into Staccata: training costs per employee will be higher.

Training time that pulled personnel from their primary job has been temporarily a negative drag on the bottom line.

Staccata was likely to suffer temporary reductions in productivity when just a few of their employees were occupied in training situations that take them away from their normal work.

Alessandro Cavadini, Matteo Cavadini and Marco Colombo were very pleased and excited about the benefits brought by this methodology, reason why the company will continue its management with the intention to focus on the critical issues that might acting as a primary target for continuous improvement of processes and products.

Appendix

Interviews

I.1 FGA (Fiat Group Automobiles) S.p.A

Fiat è stata fondata l'11 luglio 1899 a Palazzo Bricherasio; lo stesso anno è stato firmato lo statuto di "Società Anonima Fabbrica Italiana Automobili Torino".
Tra i membri del consiglio di amministrazione, Giovanni Agnelli si è distinto nel gruppo di investitori e ha vinto il riconoscimento per la sua determinazione e visione strategica. Nel 1902 diventa Amministratore Delegato della società.
La fabbrica del Lingotto nel 1916 inizia la costruzione del Lingotto, sotto la direzione di Giacomo Mattè Trucco. La fabbrica, la più grande in Europa, occupava cinque piani ed era una pista futuristica di prova sul tetto. Divenne ben presto l'emblema dell'industria automobilistica italiana e fu completata nel 1922.

I.1.1 Programma Six Sigma in FGA S.p.A

Nella visione di FGA, il Six Sigma è visto come un Problem Solving classico, che rispetto ai 7 strumenti ha il vantaggio di trovare una giusta causa al problema.
L'utilizzo del Six Sigma viene effettuato per affrontare i problemi in modo differente rispetto altre metodologie, in quanto comporta anche un cambiamento culturale nelle persone che con questa metodologia iniziano a vedere le cose in un'ottica differente.

Il programma Six Sigma in FGA è stato avviato per raggiungere degli obiettivi concreti:

- Accelerare il processo di miglioramento presso i fornitori;
- Gestire situazioni complesse (interazioni tra i componenti e tra i componenti e i diversi sistemi dell'auto);
- Aumentare il bagaglio tecnico e la competenza statistica dei Supplier Quality Engineers (SQE) soprattutto nelle interazioni con i fornitori (capacità di interpretazione, filtro dei dati di processo / prodotto, discussione tecnica, ecc.).

Il piano Fiat Auto 2005-2007 è stato il seguente:

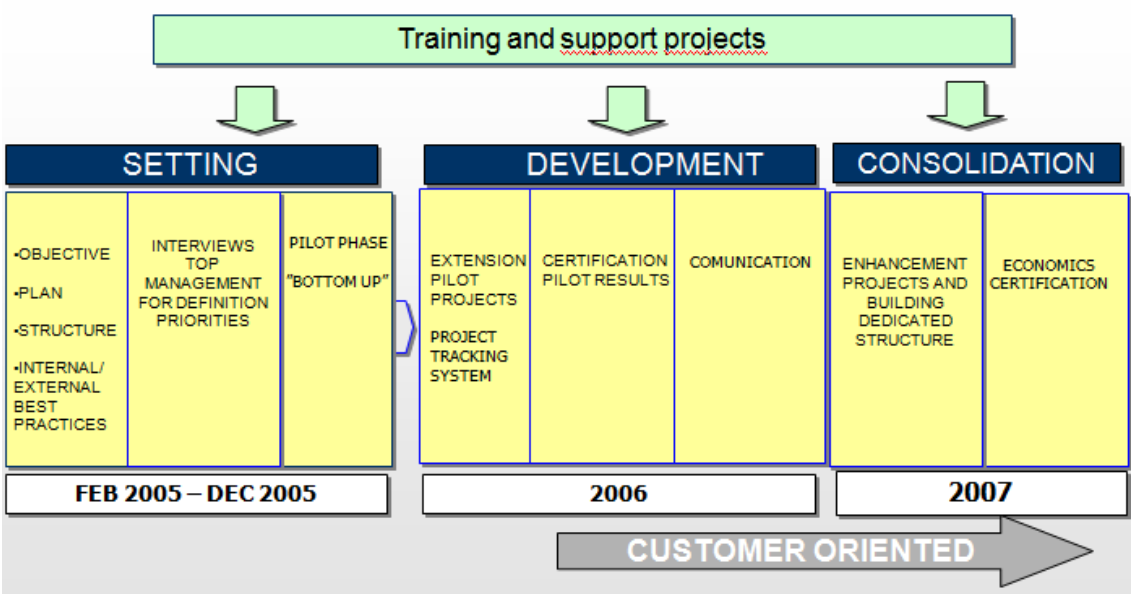

Illustration I.1.1: Training and support projects

Le aree coinvolte nella realizzazione e nell'implementazione della metodologia Six Sigma sono state:

- Manufacturing: qualità prodotto, logistica di stabilimento, materiali ausiliari e risparmi energetici;
- Engineering & Design: standardizzazione componentistica;
- Supplier Quality: qualità componenti e controllo di processo;
- Customer Care: qualità e tempi del servizio, miglioramento dei touch-point,;
- Parts & Services: ottimizzazione magazzini e flussi, gestione obsoleti e materiale di confezionamento.

I.1.2 Formazione

Dal 2005 si è avviata l'impostazione del programma Six Sigma in FGA.

L'obiettivo del responsabile della qualità è stato quello di implementare la metodologia per poter migliorare il livello qualitativo dell'azienda, e per questo si è iniziato a reclutare persone che potessero essere utili al fine di raggiungere gli obiettivi preposti.

Nell'ambito di tale percorso sono state individuate due persone (Dott. Montagna e Dott. Salomone) come Master Black Belt.

Il percorso formativo è strutturato con le seguenti caratteristiche:

Corso Green Belt:

- Durata: 8 giorni (64 ore) erogati in 4 sessioni di 2 giorni / cad. (aree tecniche), 7 giorni (56 ore) (aree non tecniche);
- Frequenza: richiesta la partecipazione completa a tutte le giornate del corso;
- Contenuti: 60% erogazione contenuti tecnici, 40% esercitazioni e discussione progetti;
- Modalità: il primo giorno di corso i partecipanti devono avere assegnato un progetto Six Sigma (concordato con Sponsor, Owner e Master Black Belt), la formazione si svolge parallelamente allo svolgimento di un progetto operativo, lo svolgimento del progetto fa parte integrante della formazione, le Green Belt vengono assistite da una Master Black Belt a garanzia della corretta applicazione delle metodologia (per i primi 2 / 4 progetti);
- Calendario tipico corso Green Belt.

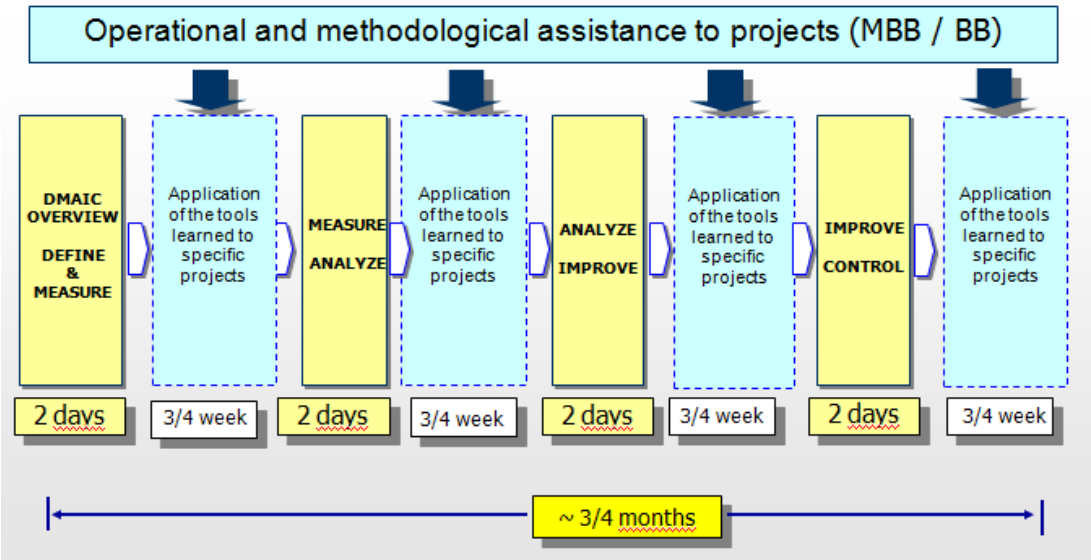

Illustration I.1.2: Operational and methodological assistance to projects (MBB/BB).

- La certificazione a Green Belt: il percorso Green Belt prevede un momento di certificazione del raggiungimento di un livello adeguato di competenza / operatività con la metodologia Six Sigma. La certificazione risponde ad un duplice scopo:
    1. Motivazionale attraverso il riconoscimento in azienda del raggiungimento di un livello di competenza specifico;
    2. Garanzia e presidio delle competenze che una Green Belt deve possedere.

I criteri di certificazione mirano a verificare l'acquisizione di competenze non solo sulla metodologia, ma anche sulla capacità di utilizzarla correttamente nell'attività operativa, completando con successo un progetto di miglioramento Six Sigma.

- Criteri per Certificazione Green Belt: completamento training Green Belt (con rigoroso obbligo di frequenza), superamento del Test di Apprendimento a fine corso (soglia di accettabilità: 80% di risposte esatte), 1 progetto completato, con chiusura e risultati consolidati:
    - Risultati mantenuti entro il valore obiettivo per almeno 6 mesi;
    - Risultati certificati da Master Black Belt, Owner e Sponsor del progetto;
    - Risultati certificati in Quality Staff Meeting.

Corso Black Belt

- Durata: 12 giorni (96 ore) erogati in 4 sessioni;
- Frequenza: richiesta la partecipazione completa a tutte le giornate del corso,;
- Modalità di svolgimento: 60% erogazione contenuti tecnici e 40% esercitazioni e discussione progetti;
- Calendario tipico corso Black Belt:

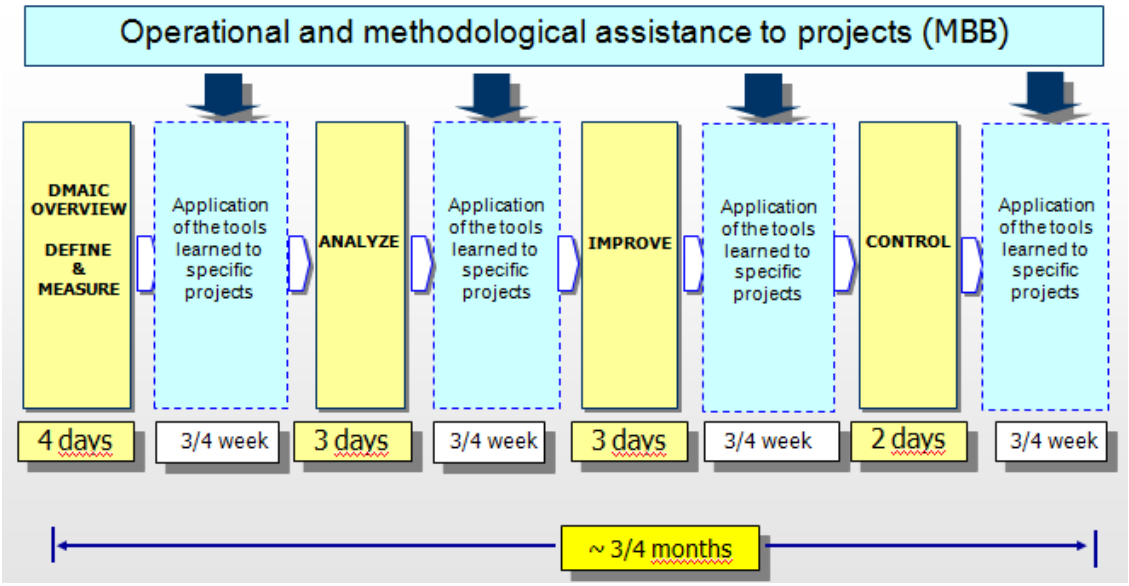

Illustration I.1.3: Operational and methodological assistance to projects (MBB)

- Criteri per Certificazione Black Belt: completamento training Black Belt (con rigoroso obbligo di frequenza), superamento del Test di Apprendimento a fine corso (soglia di accettabilità: 80% di risposte esatte), 2 progetti completati, con chiusura e risultati consolidati:
    - Risultati mantenuti entro il valore obiettivo per almeno 6 mesi;
    - Risultati certificati da Maser Black Belt, Owner e Sponsor del progetto;
    - Risultati certificati in Quality Staff Meeting.

- Tutoring ad almeno 10 progetti Green Belt , formazione su corsi Green Belt con erogazione diretta di almeno 8 ore di formazione in qualità di docente.

I.1.3 Timeline dell'implementazione Six Sigma

La modalità utilizzata per poter realizzare il programma Six Sigma è stata resa possibile grazie ad un'attività di formazione a partire da gennaio 2006, rivolta a 21 SQE e al responsabile dell'area (coinvolti in 4 eventi formativi), dall'avviamento di progetti operativi in parallelo con la formazione, dalla definizione di gruppi misti FIAT AUTO / Fornitore per ciascun progetto avviato con modalità operative tipiche del Process Improvement e grazie alla condivisione degli obiettivi di miglioramento con il fornitore.
Il 2006 è stato l'anno dello sviluppo nel quale si è iniziato a lavorare su progetti operativi e dove si è iniziato a spingere sulla formazione delle persone (corsi di formazione durante l'anno nei quali le persone delle aree aziendali iniziavano il corso di Green Belt).
Il 2007 è stato l'anno del consolidamento dove c'è stato un cospicuo aumento nel numero dei progetti e le aree aziendali erano strutturate in modo migliore.
Il 2008 è stato un anno di crisi e di sopravvivenza in cui il Six Sigma è stato visto come una metodologia di Problem Solving su richiesta, senza percepire l'entusiasmo che c'era inizialmente.
Con gli anni la situazione è migliorata e i risultati ricevuti da questa impostazione dell'utilizzo della metodologia Six Sigma sono stati principalmente tre:

- Per i progetti chiusi o in fase di consolidamento i miglioramenti sono dell'ordine di una riduzione di almeno l'80% della difettosità presso il fornitore;
- Gli indicatori più veloci (ad esempio la difettosità in accettazione) forniscono indicazioni di miglioramenti dello stesso ordine di grandezza;
- Un risultato molto importante riguarda una migliorata capacità dei Supplier Quality Engineer di poter discutere sulla base di dati statistici le problematiche di qualità / affidabilità.

I.1.4 L'organizzazione dei progetti Lean Six Sigma

Date le caratteristiche di complessità aziendale e della capillarità della presenza Fiat su territorio nazionale (e internazionale) e la necessità di gestire numerose riunioni con soggetti diversi, particolare importanza è stata data all'organizzazione dei singoli progetti di miglioramento avviati.
Infatti l'organizzazione tipo di un progetto è:

- Program Office: Master Black Belt Centrali con ruolo di coordinamento, training, coaching e crescita delle risorse;
- Stabilimenti: indicativamente 5 - 8 risorse per stabilimento;
- Enti Centrali: Soluzione mista (Black e Green Belt);
- Supplier Quality: Green Belt, a tendere alcune Black Belt con ruolo di coordinamento nell'area.

La gestione di un progetto Six Sigma può essere riassunta in questo grafico:

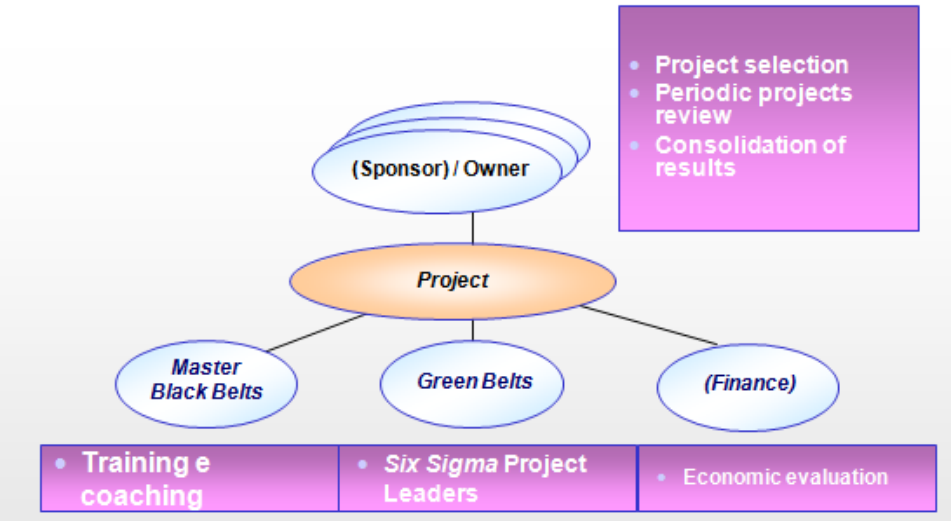

Illustration I.1.4: Management of Six Sigma projects

I progetti vengono assistiti con frequenza settimanale/quindicinale dalla Master Black Belt, l'Owner verifica l'avanzamento con cadenza mensile (almeno).

Il modello organizzativo

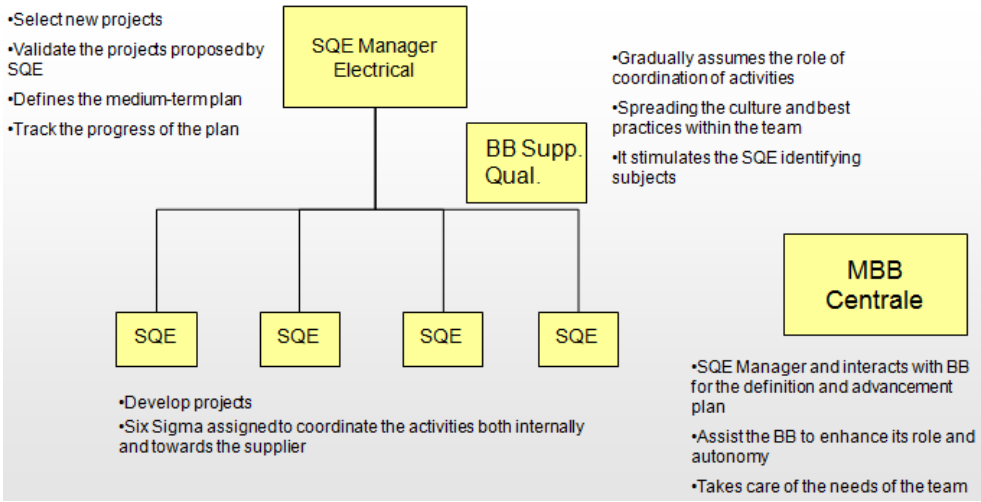

Illustration I.1.5: Organizational model

I.1.5 Supporti informatici alla metodologia Six Sigma

I.1.5.1 Project Tracking System

Il Project Traking system è un sistema di monitoraggio e condivisione dei progetti Six Sigma avviati e chiusi, disponibile per tutte le risorse coinvolte nell'attività Six Sigma.
PTS costituisce inoltre un archivio sintetico di tutti i progetti Six Sigma, attraverso l'utilizzo di templates predefiniti che facilitano la raccolta delle informazioni chiave del progetto.
La finalità di questo sistema è quella di favorire il più ampio processo di knowledge sharing (interfunzionale e interplant) attraverso la condivisione delle informazioni relative ai progetti DMAIC in corso e chiusi.
Il PTS permette di conoscere se il problema da affrontare è già stato oggetto di uno o più progetti, se progetti simili a quelli in corso sono già stati fatti e se le cause da rimuovere sono già state risolte in altri progetti.
Il Project Tracking System è costituito da due archivi di dati (gestiti centralmente presso il Program Office):

1. Il data base delle informazioni generali di progetto (project charter), che permette la ricerca e la visualizzazione dei dati di base (in inglese e in lingua madre del Plant);
2. Il data base dei progetti veri e propri, contenente le presentazioni in formato standard.

Il data base è accessibile in lettura a tutte le Green / Black Belt presenti nell'archivio del Program Office e la manutenzione generale del data base è di sola competenza del Program Office stesso.

I.1.5.2 Database Risorse Six Sigma

Il Database Risorse Six Sigma è un archivio che contiene le informazioni sintetiche sulle Belt presenti in FGA, in particolare:

- Dati anagrafici di riferimento (Cognome, nome, ente/funzione, sito),
- Formazione (in corso o completata, e anno nel quale la formazione è stata erogata),
- Certificazione SI/NO (e riferimenti al progetto con il quale si è ottenuta la certificazione).

Illustration I.1.6: Resources database of six Sigma

I.1.6 Six Sigma nelle PMI

Sulla base dell'esperienza del Dott. Salomone, si è potuto avere consigli riguardo l'applicazione della metodologia Six Sigma all'interno delle PMI.

Considerando aziende di piccole (10-15) o semi piccole (50-70) dimensioni, per l'applicazione del Lean Six Sigma vi possono essere alcune soluzioni proponibili:

- Cercare di proporre la metodologia Six Sigma come uno strumento di Problem Solving evoluto (in una logica di analisi causa effetto devo usare strumenti qualitativi che mi permettono di essere confidente nella gestione del problema, si capisce il grado di efficacia del problema e si agisce sui difetti);
- Cercare di togliersi da una situazione di incertezza cercando di ridurre il più possibile gli errori;
- Si deve cercare di puntare sulla formazione degli strumenti da utilizzare e cercare di scegliere progetti pilota da portare avanti;
- Scegliere un progetto che abbia valore per l'azienda e che serva all'azienda in modo costruttivo;
- Il fenomeno in esame deve essere misurabile;
- Bisogna applicare la metodologia in modo corretto e rigoroso senza utilizzare scorciatoie.

LA SVOLTA DELLA FIAT
IL MIGLIORAMENTO DEI PROCESSI

Il numero uno del Lingotto ha rilanciato l'utilizzo della formula del «Sei Sigma» per aumentare l'efficienza

Sono le politiche a guidare le azio

La sfida dell'auto senza difetti

Così Marchionne punta a tagliare costi inutili ed errori di produzione

Fran co Vergnano
TORINO. Dal nostro inviato

Ti piace la statistica? Sei un giovane che ha dimestichezza con la matematica e ama sognare con i numeri? Allora è il momento giusto per farsi assumere in Fiat. Il gruppo torinese sta infatti valorizzando gli specialisti che sanno «prendere le misure» precise, e rigorose, a tutti i processi organizzativi: in fabbrica, nei servizi, nei rapporti con i fornitori che oggi producono materialmente il 70% di un'auto. L'ingresso sarà presso il Motor Village di Torino, alle spalle di Mirafiori, sono stati premiati i migliori esperti dell'anno e festeggiate le nuove "Black belt". Il riconoscimento, molto ambito, qualifica le persone che hanno conquistato la "cintura nera" nella lotta ai costi, agli sprechi e ai difetti che un ergono nei processi produttivi o nei rapporti con i clienti.

Non per niente ieri a Torino erano almeno 150 i giovani manager che hanno partecipato al primo «Six Sigma Day» della Fiat Auto, un incontro voluto dal top management per sottolineare i cambiamenti strategici che la società deve fare. E il clima che si respirava era quello, spumeggiante, dei grandi sfide che si è in grado di affrontare e vincere con entusiasmo.

L'obiettivo, dichiarato, del gruppo guidato da Sergio Marchionne (che è anche il numero uno operativo dei tre marchi Fiat) è quello di arrivare a produrre automobili con zero difetti. Un semplice slogan? Niente affatto. In tutto il mondo, a cominciare da Ila Motorola e dagli straordinari successi ottenuti da Jack Welch alla General Electric («che in un solo anno risparmiò 6,6 miliardi di dollari), l'espressione «zero difetti» indica un'azienda che lavora nel "world class "Sei Sigma dove gli errori di qualità sono contenutissimi in parti per milione. In particolare, la lettera greca pretenduta dal «6» significa che ci pos sono essere al massimo 3,4 difetti per ogni milione di operazioni.

Tra le prime cose che Marchionne ha fatto quando è arrivato in Fiat, nel giugno del 2004, c'è appunto stato il rilancio in grande stile della metodologia Sei Sigma, già in fase sperimentale nello stabilimento di Tychy (Polonia). L'impulso dato dal nuovo vertice ha così permesso di fare passi da gigante. Oggi nel gruppo torinese ci sono già un centinaio di specialisti destinati a triplicare sino a fine anno.

Quello che gli addetti ai lavori chiamano approccio Six Sigma, cioè una rigorosa metodologia statistica per tagliare gli sprechi e i costi, è già stato applicato con successo da importanti società multinazionali (Motorola, General Electric, Caterpillar, Citigroup, Johnson & Johnson, Dow Chemical, Aviva, ecc.). Il nobile cuore strumento manageriale si è rivelato utile fattore determinante per elevare il livello delle performance nelle diverse aree aziendali. Dal punto di vista operativo, il Sei Sig-

VIA LE IMPERFEZIONI
Il responsabile della qualità Richard Schwarzwald: «Rigore, metodo, competenze e motivazione dei collaboratori sono i perni della nostra attività»

PRIORITÀ ALLA PREVENZIONE
Il sistema «6S» consiste nell'intervenire sulle cause dei malfunzionamenti e non sugli effetti, quando il danno è ormai avvenuto

ma è un sistema con numerose caratteristiche. Ecco le principali: le attività di miglioramento sono collegate alla strategia e al business plan aziendale decisi dal top management; i progetti vengono gestiti da una struttura dedicata. Ce così dette "Master Black belt", "Black belt" e "Green belt", cioè le risorse junior) con personale altamente qualificato; il sistema si applica per migliorare le performance dei processi esistenti sia per disegnare nuove attività; l'interazione con il cliente e il mercato è costante (si usano strumenti quali survey, focus group, interviste dirette, ecc.) e fornisce i feedback sull'efficacia delle azioni di miglioramento nel confronti del cliente; si definiscono con attenzione i meccanismi per sostenere nel tempo i benefici; i manager intervengono sui progetti con sistematiche revisioni; la funzione finanziaria è molto coinvolta per valorizzare i risultati; l'approccio fortemente orientato alla misura delle variabili in gioco e allo studio delle relazioni tra le variabili stesse (rigore scientifico), consente miglioramenti molto significativi delle prestazioni.

Questo sotto l'aspetto tecnico. Ma che cosa significa, e qual è la filosofia, del Sei Sigma applicato in Fiat Auto?

Lo ha spiegato lo stesso Richard Schwarzwald, 53 anni, vice presidente Quality della Fiat Auto, entrato nel gruppo dal 2004 dopo esperienze internazionali in Volkswagen, Gm e importanti fornitori del settore automotive: «Vernee il programma Six Sigma rappresenta un passo importante sulla strada del miglioramento continuo, come leva per la competitività. Rigore, metodo, competenze e motivazioni dei collaboratori sono gli assi portanti delle attività che stiamo sviluppando. E con la forza dei numeri, e un atteggiamento costante al rigore metodologico, che puntiamo a raggiungere l'eccellenza dei processi, per i quali ci attendiamo performance in linea con le crescenti esigenze dei nostri clienti».

Ecco perché il top management Fiat ritiene, anche in chiave di cultura d'impresa, che il Sei Sigma sia la risposta adatta alle nuove sfide competitive e che pertanto debba diventare un impegno per tutto il gruppo.

«La parola chiave — aggiunge Schwarzwald — è: "coinvolgimento". Che per noi significa grosso in carico in prima persona della responsabilità di risultato. Per fare questo siamo partiti con una strategia "bottom-up", cioè dal basso verso l'alto, affinché l'impegno di leader di riferimento sul campo (che noi chiamiamo sponsor), pronti a sostenere i progetti nelle rispettive aree».

Un elemento chiave del metodo Sei Sigma è la "quantificazione" di un determinato processo. Ma, per non essere dispersivi, che cosa si deve "misurare" esattamente?

«La nostra scelta — spiega ancora Schwarzwald — è stata quella di porre in primo piano i cosiddetti Kpi (Key performance indicators), cioè quegli indicatori di prestazione tecnica fortemente correlati alcliente, con i tichei benefici economici. Il target prioritario per molti programmi "6S" avviati negli ultimi anni) siano una diretta conseguenza della nostra azione di miglioramento. Ecco perché dopo esperienze significative nel manufacturing, nell'ingegneria e nel customer care pensiamo di estendere nel 2007 il Sei Sigma in tutte le aree del l'azienda».

Il Sei Sigma è uno standard internazionale di efficienza noto in tutto il mondo per la sua straordinaria efficacia, come dimostrano, oltre ai risultati ottenuti da big mondiali, anche le storie di miglioramento raccontate qui sotto. Alcuni critici sostengono però che questa metodologia sia difficile da applicare, perché un po' sofisticata. Ma è veramente così? «Non direi proprio. Anzi. Io non sono un ingegnere — spiega Patrizia Tomasoni, 43 anni, direttore Quality management & Strategy della Fiat Auto — ma sono ammettere che con il Sei Sigma abbiamo raggiunto ottime performance. Indubbiamente questo strumento manageriale è una tecnica robusta di miglioramento strutturale dei processi organizzativi, dei prodotti e dei servizi. Certo, noi abbiamo dovuto impegnarci a fondo per abituare le persone a lavorare con "metodo scientifico" anche sulla linea di montaggio. Siamo però riusciti ad accelerare in maniera significativa la velocità di risoluzione e di problemi che via via incontro in fabbrica». Conclude Maurizio Montagna, Program manager e Master Black belt, un dirigente di 52 anni approdato in Fiat di recente dopo essersi fatto le ossa nella consulenza (Gruppo Gallgano e Ibm Business consulting services) con clienti del calibro di General electric, che con altri colleghi ha messo a punto una "guida Fiat", una specie di "via italiana al Sei Sigma": «Può sembrare banale, ma solo attraverso le "misurazioni" si hanno dati certi. E solo con statistiche precise si può intervenire, ma lizzando le cause di "non conformità" e promuovendo le azioni di miglioramento. Il segreto? E il diagramma di Ishikawa, detto anche "Fishbone". In sostanza si tratta di agire sulla prevenzione, di giocare d'anticipo. La chiave di volta del metodo consiste nell'intervenire sulle cause dei mal funzionamenti e non sugli effetti cioè sugli errori, quando i danni sono ormai stati fatti.

Design

I componenti standard non uccidono la fantasia

Supply chain

Forti guadagni di filiera dalla riduzione degli scarti

Customer

Le r son

Illustration I.1.7: Article "IlSole24Ore"

I.2 Telecom Italia S.p.A

Il Gruppo Telecom Italia rappresenta una grande realtà nel settore delle ICT a livello nazionale, operando nelle telecomunicazioni fisse e mobili, Internet e media, attraverso brand noti per competenza, affidabilità e familiarità come Telecom Italia, TIM, Alice, Virgilio, La7 e MTV Italia.
Inoltre, il Gruppo TI è presente nel campo dell'*office and system solutions* con il marchio Olivetti, ancora oggi simbolo di tecnologia e design italiano nel mondo.
Infrastrutture e tecnologie all'avanguardia, know-how differenziati e inseriti in un modello organizzativo "customer centric" per aderire al meglio alle richieste della clientela sono alla base della strategia di crescita del Gruppo, che punta sull'offerta di nuovi servizi, sulle funzionalità della banda larga, sui business innovativi in settori adiacenti (IPTV, ICT, *online advertising, digital home, mobile broadcasting*).
Al centro dell'attività di Telecom Italia risiedono servizi di comunicazione convergenti per i consumatori e soluzioni ICT avanzate per il business.
Oltre alla leadership sul mercato domestico, il Gruppo Telecom Italia vanta un'importante presenza in America Latina, dove TIM Brasil è fra i principali operatori del Paese.

I.2.1 Six Sigma in Telecom Italia S.p.A (riferito a Luglio 2010)

Orientamento al cliente, attenzione ai costi e alla produttività e ottimizzazione dei processi richiedono, oltre a un profondo cambiamento culturale nell'approccio e nel *modus operandi* di tutti i dipendenti, "strumenti di lavoro", e know-how specialistici, in grado di leggere e interpretare realtà complesse e articolate come quelle presenti in un grande Gruppo. Questa consapevolezza ha portato il vertice di Telecom Italia alla ricerca di un approccio metodologico capace di supportare e sostenere gli obiettivi di semplificazione dei processi e *rightsizing* contenuti nelle linee guida strategiche.
Il Lean Six Sigma ha rappresentato la scelta di Telecom Italia, rispondendo pienamente alle esigenze espresse e agli obiettivi preposti. Si tratta infatti di una metodologia, già applicata in numerose esperienze di successo in contesti organizzativi complessi, che consente il miglioramento dei processi sia dal punto di vista del livello di qualità erogata e percepita dai clienti interni ed esterni, sia da quello dell'efficienza, espressa in termini di riduzione delle difettosità e degli eventuali sprechi associati.

L'approccio adottato in Telecom Italia nell'applicazione del Six Sigma è stato conseguente ad una visione top-down basato sul lancio operativo di più progetti di miglioramento, questo ha permesso di avere molti riscontri immediati che hanno potuto rafforzare la credibilità del programma.
A capo del programma è stato dedicato un dirigente senior dell'azienda certificato Master Black Belt.

I.2.2 Formazione

Dal 2009 sono stati avviati due percorsi di formazione volti ad incrementare la conoscenza e l'implementazione della metodologia Lean Six Sigma in sette progetti aziendali. Nell'ambito di tali percorsi i partecipanti hanno conseguito la certificazione di Green Belt e Black Belt.

Il percorso formativo aveva le seguenti caratteristiche:

- Una durata di 5-6 mesi, progettato prevedendo fasi d'aula (2 giorni al mese) e progetti da implementare in parallelo;
- I partecipanti dovevano essere Professional (sesto/settimo livello) provenienti da tutte le funzioni aziendali (il primo percorso è stato riservato alla funzione HR);
  Telecom ha posto una grossa enfasi sulla formazione delle persone, infatti l'aumento degli skills dei professional certificati, oltre ad aumentare le competenze personali, ha fortemente favorito l'implementazione della metodologia;
- Le risorse certificate lavorano part-time sui rispettivi progetti dedicando 40/50% del tempo per quanto riguarda le GB e 60/70% per quanto riguarda le BB;
- Al termine dei due percorsi avviati Telecom oggi conta 35 Green Belt e 6 Black Belt.

I.2.3 Timeline dell'implementazione Six Sigma

Telecom ha iniziato l'implementazione del Six Sigma in due ondate.
La prima ondata è iniziata nel Marzo 2009 assegnando i certificati nel Luglio 2009.
Le GB certificate sono state 20 tutte appartenenti alla funzione HR.
I progetti assegnati ai team sono stati 3, focalizzati sul miglioramento di processi in ambito gestione crediti, sulla manutenzione rete trasmissiva e sulla gestione degli accertamenti manuali in ambito amministrazione. Tali progetti sono stati seguiti dai team con il supporto della consulenza esterna e della Master Black Belt aziendale (Ing. Gallarà).
La seconda ondata è partita nel Dicembre 2009 e ha assegnato la certificazione nel Luglio 2010.

In questa seconda fase è da sottolineare che sono state certificate 21 nuove GB (10 appartenenti alla funzione HR e 11 alle altre funzioni) e 6 nuove Black Belt scelte tra le Green Belt dalla prima fase 2009.

I progetti di questa seconda fase sono stati 4 inerenti al miglioramento dei seguenti processi:

- Il miglioramento della manutenzione della rete d'accesso;
- Il processo di back office consumer mobile;
- La razionalizzazione del ciclo attivo in particolare focalizzata sull'abbinamento manuale degli incassi;
- Razionalizzazione del ciclo passivo focalizzato sul miglioramento delle fatture manuali.

In questa seconda ondata i progetti sono stati gestiti in maniera ottimale, oltreché dalla consulenza e dalla Master Black Belt, soprattutto dalle nuove Black Belt.

I.2.4 L'organizzazione dei progetti Lean Six Sigma

Date le caratteristiche di complessità aziendale, della capillarità della presenza Telecom su territorio nazionale e la necessità di gestire numerose riunioni con soggetti diversi (spesso in video conference), particolare importanza è stata data all'organizzazione dei singoli progetti di miglioramento avviati. Infatti, per la seconda fase, l'organizzazione tipo di un progetto era:

- 1 team leader del progetto;
- 4/6 nuove Green Belt in formazione;
- 1 Black Belt in formazione;
- 1/2 Green Belt già certificate.

Inoltre per ogni progetto era previsto il supporto organizzativo delle line con la seguente organizzazione:

- 1 sponsor del progetto (top manager della funzione interessata);
- 1 owner del progetto (manager responsabile diretto del processo di miglioramento);
- 1 o più referenti di line che garantivano le informazioni di contatti necessari all'implementazione del progetto e l'accesso ai data base per l'estrazione dei dati necessari.

I.2.5 Six Sigma nelle PMI

Sulla base della loro esperienza, i due intervistati (Ing. Gallarà e Ing. Perrone), ci hanno dato consigli riguardo l'applicazione della metodologia Six Sigma all'interno delle PMI.

Considerando aziende di piccole (10-15) o semi piccole (50-70) dimensioni, per l'applicazine del Lean Six Sigma vi possono essere i seguenti:

I.2.5.1 Punti di debolezza:

1. Scarso numero di persone da coinvolgere come Green Belt e/o Black Belt con la conseguente impossibilità di lavoro in team,
2. Mancanza di budget per la formazione delle persone,
3. Poca disponibilità di tempo da investire nell'attività per le persone selezionate (chiave),
4. Scarso ricorso alla misura dei processi aziendali (data base strutturati).

I.2.5.2 Per questi punti alcune soluzioni proponibili potrebbero essere:

- Richiedere supporto a consulenti esterni, dedicando un budget specifico e/o ad un rapporto intellettuale ad hoc (tipo facoltà scientifiche),
- Chiedere supporto a consorzi o creare iniziative condivise con altre realtà similari (di piccole medie aziende) per la formazione e per la consulenza,
- Ricorso a raccolta di dati ad hoc per la misura dei processi (KPI o SLA), con il rischio di un allungamento dei tempi.

I.2.5.3 Punto di forza delle PMI

1. L'organizzazione è snella e i tempi di decisione si riducono,
2. Facilità nel creare commitment,
3. L'implementazione delle soluzioni è più rapida viste le dimensioni.

I.3 Whirpool Corporate

Whirpool Corporate è una società multinazionale fondata nel 1911, leader nella produzione e nella vendita di elettrodomestici, che garantisce oggi un fatturato annuale per un valore pari a circa 19 miliardi di dollari; l'assetto societario, basato su di un numero di addetti superiore a 73.000 e su più di 72 centri di ricerca tecnologica e produttiva nel mondo, comprende Whirlpool, Maytag, KitchenAid, Jenn-Air, Amana, Brastemp, Bauknecht e altri importanti brand diffusi e conosciuti in diverse parti del mondo. La piattaforma globale di Whirlpool Corporation detiene risorse e competenze uniche e gestisce le proprie attività di sviluppo di prodotti e tecnologie con l'obiettivo di ridurre i costi, migliorare l'efficienza e introdurre continue innovazioni per i propri clienti.
Azienda che offre ai propri clienti una gamma completa di grandi elettrodomestici e di accessori da cucina ispirati al mondo professionale, basati sull'unione perfetta tra design e tecnologia.
Nel 2007 il fatturato ha raggiunto il valore record di 19.4 miliardi di dollari, con un guadagno netto pari a 640 milioni di dollari; l'aumento del 7% del valore del fatturato risulta così suddiviso:

- 60% nel Nord America
- 20% in Europa
- 18% in America Latina
- 2% in Asia

La strategia globale consiste nell'introdurre nuovi prodotti innovativi, aumentare la fidelizzazione dei clienti verso il brand, espandere la presenza nei mercati stranieri, accrescere la piattaforma commerciale, migliorare la qualità totale, effettuare acquisizioni strategiche e investimenti.

I.3.1 Six Sigma in Whirpool Corporate: Il programma OpEx (Intervista con P. Bayle)

Nella sua forma effettiva, il Six Sigma non può essere considerato come una road map o un set definito di strumenti, ma è un appropriato insieme di metodi, strumenti, conoscenze e abilità mescolate per ottenere efficientemente soluzioni a medio-lungo termine. Le competenze ingegneristiche e le conoscenze specifiche di prodotti e processi sono il punto di partenza necessario per poter utilizzare ogni strumento identificato nella metodologia, e da esse dipende la scelta circa i piani di acquisizione dei dati, i fattori che devono essere inclusi nello studio, le analisi tecniche e le interpretazioni dei risultati.
Whirlpool identifica quindi tre fattori chiavi per ottenere il successo nel processo di progettazione gestito tramite il Six Sigma:

- Senza modelli analitici di simulazione il team di lavoro non è in grado di misurare verosimilmente le risposte e le reazioni necessarie per comprendere gli aspetti fisici sottostanti al progetto e/o prodotto e le loro strutture causali.
- Senza metodi statistici non è possibile capire sconosciute fonti di variabilità del sistema; essi rappresentano l'efficiente metodologia per adoperare le reazioni generate dalle simulazioni analitiche allo scopo di generare nuove intuizioni.
- Senza specifiche e consolidate conoscenze ingegneristiche non possono venire sviluppate simulazioni ed esperimenti di alcun genere. Il team non risulterebbe in grado di analizzare i risultati per identificare le soluzioni finali da apportare al progetto iniziale.
- Il successo di Whirlpool aiuta a chiarire gli aspetti primari che un'organizzazione deve garantire quando decide di impostare la metodologia Six Sigma con l'obiettivo di apportare interventi nel processo di progettazione dei propri prodotti, volti a garantire l'eliminazione della variabilità in produzione e di conseguenza la riduzione di sprechi e difetti e il raggiungimento della massima soddisfazione del cliente.

Va dato pieno merito al gruppo di avere scommesso sul Six Sigma, investendovi ingenti somme e adattando gli strumenti standard e la metodologia secondo le proprie necessità, con la creazione del programma OpEx, (Operational Excellence) che oggi rappresenta il punto di partenza e di arrivo di ogni attività di Whirlpool.

I.3.2 Timeline dell'implementazione Six Sigma

Whirlpool Corporate ha deciso di sviluppare la metodologia Six Sigma nel 1996, distinguendosi subito per la decisione strategica di non seguire l'approccio DMAIC, focalizzandosi invece sul Ciclo PDSA, in quanto tale modello di miglioramento, più flessibile, risultava maggiormente adatto per le operazioni aziendali.

Il ciclo PDSA risultava per il Top Management lo strumento più idoneo per raggiungere questi scopi, il punto di partenza dal quale l'organizzazione ha poi sviluppato nel tempo l'Operational Excellence (OpEx), che è divenuto fin da subito il marchio che contraddistingue Whirlpool agli occhi del cliente, e che aiutò la società a rialzarsi da un periodo di difficoltà guidandola e mantenendola nell'attuale posizione di leader di mercato.

L'allora Senior Vice Presidente J.C. Anderson, il quale godeva di una notevole credibilità, dopo numerose attività di benchmarking sul campo, suggerì al Presidente di investire dieci milioni di dollari nel Six Sigma, argomentando la propria richiesta con convinzione e passione. Pur riconoscendo lo sforzo richiesto ingente, in particolar modo se inserito nel contesto dell'epoca, si

sentì sicuro di garantire un ritorno economico pari a dieci volte tanto la cifra investita inizialmente, convincendolo ad accettare il progetto.
L'azienda ha cercato nel tempo di adattare il Six Sigma al proprio ambiente di lavoro, focalizzandosi sulle reali esigenze aziendali e sull'insieme di risorse di cui la società disponeva e dispone, concentrandosi sulla necessità di sfruttare al meglio le loro caratteristiche per praticare una metodologia garanzia di successo in ogni progetto.
Da quando si sono sviluppate le prime iniziative inerenti il Six Sigma, le strategie organizzative, i concetti e anche gli strumenti stessi sono diventati sempre più variabili. Questa è una caratteristica potenzialmente positiva, in quanto sarebbe impensabile sostenere che una singola strategia di sviluppo risulti ugualmente adeguata in ogni tipologia di processo e organizzazione, o che solo un set specifico di strumenti risulti necessario per tutti i processi e prodotti.
La scelta dell'adozione delle differenti strategie di sviluppo dovrebbe essere guidata dai bisogni della singola azienda e organizzazione.
Affinché un approccio Six Sigma diventi sostenibile, deve infatti esserci alla base la consapevolezza che i metodi statistici sono più utili quando si fondono insieme le teorie di ingegneria, la conoscenza dei prodotti e dei processi, i metodi e i pensieri statistici, mentre troppo spesso si pone eccessiva fiducia sull'applicazione statistica trascurando gli aspetti fondamentali relativi alla capacità ingegneristica e alla conoscenza di prodotti e processi. Una convinzione comune si basa sull'errata ipotesi che i metodi statistici possano trasformare scarse conoscenze di ingegneria in utili informazioni.

I.3.3 Formazione

L'approccio al Six Sigma differiva dalla tradizionale metodologia principalmente per tre motivi:

- L'attività di formazione per le Black Belts, sebbene in linea con l'approccio standard caratterizzato da corsi intensivi di una settimana al mese per quattro mesi, combinava sia gli strumenti del Six Sigma che gli strumenti per il Design For Six Sigma DFSS.
- Gli ingegneri formati per divenire Black Belts non lasciano mai il loro lavoro regolare. La compagnia non vuole avere un modello di *Swat Team* nel quale le Black Belts siano impegnate in una singola area di lavoro per la risoluzione di un unico problema identificato.
- I candidati al ruolo di Black Belts sono scelti con cura, e sono sempre considerati parte integrante del loro dipartimento di origine.

L'azienda, che effettua ogni anno più di 20 classi di formazione Black Belts in tutto il mondo, ha formato quasi 2500 Black Belts e più di 60 Master Black Belts.

Per quanto riguarda Europa, a partire dal 2005, sotto la spinta del primo Sponsor, si sono introdotte attività di training di una settimana per livelli superiori occupati da Direttori e Top Management; dal 2007 invece tutte le figure operative vengono coinvolte in un corso di formazione di 5 giorni totali in cui apprendono i concetti basilari dell'OpEx. Il training è in continua crescita, grazie all'appoggio significativo apportato dal nuovo Sponsor, subentrato nel 2008.

I team di lavoro vengono arricchiti con laboratori addizionali, consulenti e virtuali risorse ingegneristiche, al fine di aumentare l'esperienza e il livello di conoscenze.

Gli strumenti del Six Sigma acquisiti durante la formazione, utilizzati da persone dotate di profonde conoscenze dei prodotti, permettono di analizzare il problema da un punto di vista diverso rispetto al processo standard di progettazione e riprogettazione di un prodotto; tramite simulazioni e sviluppi del DOE, il team di lavoro può focalizzarsi sugli aspetti nascosti, identificando il sistema di cause comuni dei fattori causali e al contempo analizzando le irregolari fonti di variazione che determinavano i fallimenti dei prototipi precedentemente progettati.

Ponendo attenzione sul processo di progettazione, nei primi anni di implementazione del Six Sigma vengono avviate per gli ingegneri dell'organizzazione del Nord America attività di training per Black Belts tramite 4 settimane di training e Master Black Belts attraverso corsi di formazione di 2 anni, ma in poco tempo Whirlpool espande il programma agli ingegneri in Europa, America Latina e poi Asia. L'obiettivo iniziale era formare il 60% degli ingegneri attraverso un programma di training di quattro settimane. I Black Belts che dimostravano di applicare gli strumenti appresi nel loro lavoro per almeno un anno venivano candidati per essere sottoposti al programma di formazione volto a creare Master Black Belts.

Le prime 14 classi di Black Belts venivano gestite da una società di consulenza esterna, 6 Sigma Associates, che metteva a disposizione professionisti esperti e competenti, dopo di che tutti i programmi di formazione vennero tenuti internamente dai Master Black Belts.

A differenza del tradizionale approccio, l'addestramento OpEx inizia con le classi Black Belts, in seguito vengono pianificate attività di training di venti settimane in due anni per formare Master Black Belts selezionate con cura. Il Master Black Belt è un titolo dedicato al Six Sigma che richiede l'impegno nell'applicazione dell'OpEx per il 100% del proprio tempo; il Black Belt è un ingegnere, non è una funzione, che adopera il Six Sigma nel quotidiano svolgimento delle proprie attività.

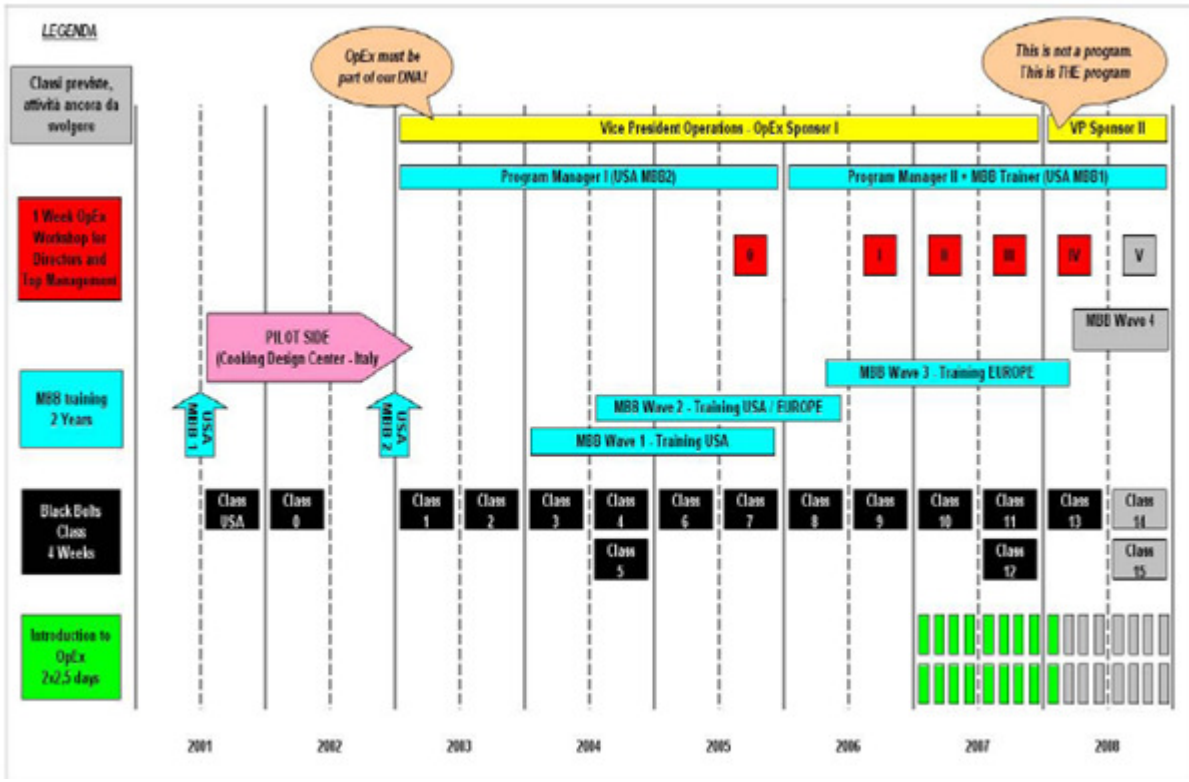

Illustration I.3.1: OpEx training program in Whirpool Europe (Documento: P. Bayle)

Il programma di training, come riepilogato nella figura 38, è stato fortemente implementato anche nella divisione Whirlpool Europe, tramite un ciclo di addestramento iniziale tenuto negli Stati Uniti, a cui hanno aderito quelli che sarebbero divenuti i massimi esponenti dell'OpEx per l'Europa; oggi il training è gestito da Pierre Bayle, Ingegnere Senior in Whirlpool Corporate.

E' evidente da questa figura l'importanza assegnata al ruolo dei Master Black Belts; essi, attraverso un intenso programma di formazione di 2 anni, diventano coordinatori nel proprio sito, nel quale spendono circa il 60% del loro tempo per lo sviluppo del Six Sigma (formazione di Black Belts e attività di supporto continuo).

Durante il training, le persone apprendono dall'inizio funzionalità e contenuti del DOE, strumento che viene sempre utilizzato qualora l'obiettivo sia la comprensione di ciò di cui necessita il cliente, in quanto aiuta gli ingegneri a identificare le richieste e fare analisi più intense dei fattori che interessano i processi di progettazione. Oggi il DOE viene adoperato costantemente e gli strumenti di Six Sigma risultano essere parte dei sistemi di progettazione aziendale.

Gli ingegneri di Whirlpool hanno fin da subito adottato un approccio top-down, focalizzandosi sulla raccolta e gestione dei dati dal ciclo di progettazione e sviluppo del prodotto, implementando nel contempo i giusti modelli di performance e facendo uso di virtuali prototipi ogni qualvolta risultasse possibile.

Identificati i fattori di influenza attraverso complesse analisi computazionali dinamiche e fluide, questi fattori vengono usati per l'esecuzione di DOE analitici e fisici. Facendo leva sul suo potere globale, Whirlpool ha selezionato e acquisito esperti in tutto il mondo, aventi il compito di svolgere simulazioni e altre analisi.

Il Top Management deve selezionare le figure migliori da dedicare al progetto.
Whirlpool ha predisposto un semplice strumento per riepilogare le caratteristiche richieste, al fine di valutare quale persona all'interno dell'organigramma del singolo fornitore rappresenti il candidato ideale al ruolo di Black Belt, assegnando una votazione per ognuna delle seguenti voci:

- livello di conoscenza dei processi e dei prodotti,
- grado di competenze della statistica di base,
- livello di conoscenza dell'organizzazione ed esperienza acquisita,
- capacità di comunicazione,
- grado di motivazione,
- grado di apertura mentale,
- capacità di sviluppare nuove idee,
- desiderio di guidare il cambiamento,
- capacità di lavorare in gruppo,
- grado di rispetto dimostrato verso gli altri,
- capacità di inseguire i risultati,
- livello di inglese.

I.3.4 L'organizzazione dei progetti Lean Six Sigma

Attraverso la discussione di aspetti teorici, lo scambio di domande e risposte e la condivisione delle conoscenze, gli ingegneri individuano le relazioni potenziali esistenti tra i fattori chiave che influenzano la variabilità nel processo produttivo. Le decisioni basate su pure decisioni statistiche possono spesso indurre a cambiamenti irrealizzabili o lontanamente ottimali; solo attraverso un'analisi statistica critica basata sulla ricerca di domande formulate con un punto di vista ingegneristico si individuando le sottostanti cause reali.
Recepite le informazioni dalla fase di analisi, la simulazione è lo strumento che permette di verificare gli interventi da attuare nel progetto per ridurre la variabilità e garantire al tempo stesso la robustezza del processo, a patto che si combinino modelli analitici con modelli sperimentali, studiati con il pensiero critico che le persone hanno sviluppato durante il training e lo scambio di conoscenze. Uno studio sperimentale può catturare componenti della variabilità che non sono capiti

o spiegati, laddove la simulazione analitica contiene fonti di variabilità che sono specificamente introdotte nello studio.
Riprogettato il nuovo disegno, si potrà lanciare in produzione un prodotto caratterizzato da una drastica riduzione della variabilità, con risultati ottimali analoghi a quelli ottenuti nella simulazione e nella relativa discussione dei dati di output ricavati dal DOE.
Whirlpool focalizza la propria attenzione su questi aspetti; ogni prodotto aziendale viene oggi progettato seguendo questo approccio, facendo leva su team di ingegneri formati, professionali, competenti e coinvolti, i quali dimostrano di aver ormai recepito pienamente la metodologie e le tecniche per il suo ottimale utilizzo.
In particolare, Whirlpool Corporate applica la metodologia focalizzandosi sui *design processes,* punto di forza della società e base per la differenziazione rispetto ai concorrenti.
Il punto di partenza di ogni progetto consiste sempre nell'osservare, comprendere, focalizzarsi su come i clienti effettivamente utilizzano un prodotto e come sono recepite le sue performance in differenti condizioni. Quindi gli ingegneri possono concentrarsi sull'analisi delle fonti interne di variazione nel processo produttivo. Quando si riesce a far corrispondere questi due aspetti contemporaneamente, si ottiene un prodotto che risulta robusto in termini di variabilità e al tempo stesso incontra i bisogni del cliente.

I.3.5 Six sigma nelle PMI

La società si è trovata nelle condizioni di poter investire parte del proprio ricco fatturato, rivolgendosi anche a professionisti esterni, e detiene al proprio interno un ricco patrimonio di risorse umane con competenze uniche nel campo dell'ingegneria e della statistica, e di infrastrutture e tecnologie all'avanguardia.
Come può invece una società medio-piccola di progettazione, ma soprattutto di produzione (di prodotti ma anche di servizi), creare e recepire internamente le condizioni base per inserire nel proprio sistema tecniche di Six Sigma? Quanto può un'azienda di questo tipo investire nell'implementazione di tale metodologia? E' garantito il successo finale?
Whirlpool sta seguendo tale via di sviluppo, con l'idea di trasmettere il proprio approccio ai sub-fornitori principali; per fare ciò, è necessario identificare le possibilità di sviluppo, per concentrarsi sulle attività da intraprendere al fine di portare il livello di requisiti richiesti e necessari verso un valore ottimale.

I.3.6 Le possibilità di sviluppo presso i fornitori (Intervista con Paolo Crucitti)

Nel programma di formazione del Six Sigma rientravano fin da subito anche i fornitori, ai quali la società offriva training per formare Black Belts ed eventualmente Green Belts presso di loro, fornendo quindi gli strumenti per garantire un monitoraggio e un miglioramento della qualità ben più evoluto rispetto ai loro sistemi interni, che portasse a ottenere nel medio-lungo periodo una significativa riduzione dei costi, dei difetti, degli sprechi. Si trattava prevalentemente di medio-piccole organizzazioni che lavoravano quasi esclusivamente per Whirlpool, focalizzate sulla produzione di componenti e semi-lavorati.

I corsi per Black Belts erogati per i fornitori si mostrarono non all'altezza delle aspettative: solo 4 figure su 25 formate dimostrarono di avere acquisito le competenze per ottenere la certificazione; in tutti gli altri casi la metodologia fu solo parzialmente appresa, ma le persone formate non riuscirono a trasmetterne l'applicazione all'interno delle proprie aziende.

Whirlpool analizzò questo insuccesso, decidendo di bloccare anche il training per Green Belts, ponendo come motivazione principale lo scarso interesse da parte del Management dei fornitori che non effettuava un'adeguata selezione del personale interno su cui investire nella formazione Six Sigma. L'idea era quella di selezionare le persone che avevano maggior tempo da dedicare ad attività formative, specie per il ruolo di Green Belt, senza considerare aspetti più importanti, quali i requisiti e le conoscenze di partenza, l'importanza della propria funzione operativa nei processi produttivi, la mentalità volta all'innovazione e la capacità di apprendere nuove tecniche da portare sul campo.

Oltre il 70% del valore e della qualità di Whirlpool deriva dai componenti esterni prodotti dai fornitori, i quali devono dimostrare di sapersi muovere da un approccio volto alla soddisfazione dei requisiti verso un approccio focalizzato alla soddisfazione del cliente.

Appare subito evidente come l'obiettivo del progetto sia quello di migliorare l'efficienza produttiva nei processi che coinvolgono i prodotti di Whirlpool; allo stesso tempo, per evitare le situazioni verificatesi nel passato, sono selezionati solamente i fornitori strategici, ai quali viene chiesto di identificare e proporre progetti relativi a processi chiave su cui impostare un programma di Six Sigma.

La giusta selezione dei processi è il punto chiave iniziale per garantire lo sviluppo della metodologia. Definita la vision, Whirlpool formalizza gli aspetti del proprio piano di diffusione dell'OpEx presso i fornitori:

- Definiscono i requisiti per la selezione dei fornitori a seconda della dimensione e della classe di appartenenza della criticità del processo;

- Sviluppano attività di training sia per ingegneri responsabili dei processi produttivi che per gli ingegneri che lavorano per la progettazione del prodotto;
- Coinvolgono fin da subito il management con un training preliminare chiamato *1Week OpEx Workshop to Directors and Managers* necessario affinchè i massimi esponenti aziendali possano conoscere in generale il programma OpEx, capirne il significato, riflettere sulle persone migliori da dedicare a questo progetto;
- Offrono supporto e mentoring continuo ai candidati Black Belts, oltre alle infrastrutture informatiche mancanti necessarie, tenuto conto che un fattore che ha condizionato in negativo l'esito del piano di sviluppo presso i fornitori impostato nel passato è stata l'assenza del supporto da parte di Whirlpool una volta terminate le attività di training; in questo modo i fornitori non riuscendo ad applicare con efficacia il Six Sigma e non potendo osservare risultati oggettivi, non ricevevano informazioni di ritorno sugli aspetti da migliorare o implementare ulteriormente;
- Vogliono fornitori che abbiano reali possibilità di raggiungere processi con livelli del Sigma pari o prossimi a 6.

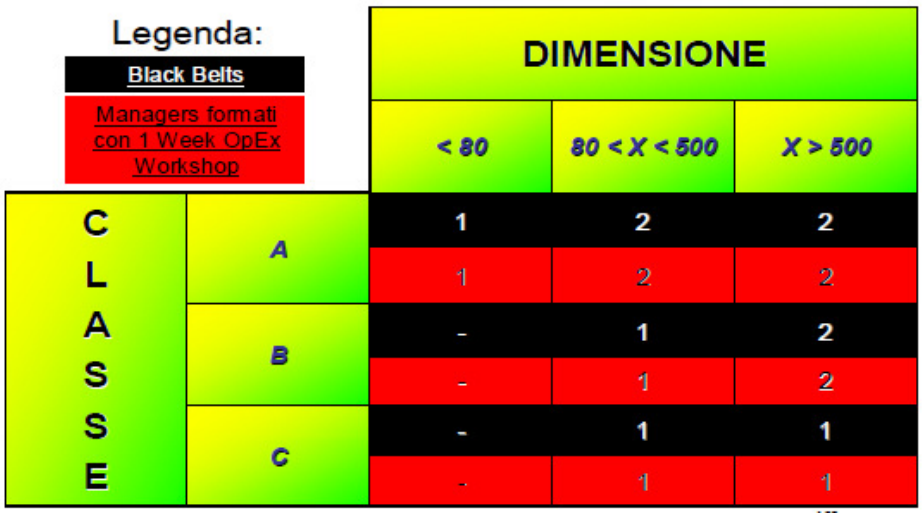

Illustration I.3.2: Piano di sviluppo del 1 week Workshop per i fornitori. (Documento P. Crucitti)

Per evitare di diffondere il Six Sigma in organizzazioni poco idonee allo sviluppo di tale metodologia, Whirlpool provvede oggi a includere nel proprio programma fornitori con specifiche caratteristiche:

- Devono infatti produrre componenti critici per la qualità, che richiedono processi complessi e attività di un certo valore riconosciuto;
- Devono garantire di lavorare all'interno di organizzazioni adeguate a garantire il successo;

- Devono dimostrare di avere lo stesso modello di business e la stessa vision di Whirlpool, con la quale mantiene una forte partnership.

In questo modo è possibile sviluppare strategie comuni di medio-lungo periodo, durante il quale proporre nuove idee da condividere e su cui discutere.
Nel 2008 Whirlpool ha avviato un nuovo progetto per i propri fornitori:

- La società ha pianificato un programma di training per 100 candidati totali in un periodo di 3 anni;
- Il gruppo garantisce attività di sostegno e mentoring nella diffusione dell'OpEx, dedicando tempo ed esperienza per attività continue post-corsi.

Per aiutare i propri fornitori nella selezione dei progetti ottimali, Whirlpool trasmette loro i requisiti che identificano la possibilità di concreto sviluppo del Six Sigma per monitorare i processi e migliorarli in termini di efficienza sostenibile:

- E'importante valutare il trade off tra l'impegno richiesto in termini di tempo e risorse e l'impatto sul business;
- La durata ottimale di una progetto va dai 4 ai 6 mesi;
- Bisogna privilegiare le attività che hanno il massimo impatto sulle caratteristiche critiche per la qualità CTQ espresse dal cliente;
- Il Six Sigma è *data-based*, motivo per cui è fondamentale lavorare con dati quantitativi raccolti da risorse motivate.

E' importante che i candidati abbiano la massima flessibilità in termini di tempo da dedicare al Six Sigma, sia durante l'attività di training (almeno 4 settimane di formazione), sia quando ritorneranno nel loro stabilimento, dove dovranno poter lavorare liberamente sul progetto, dedicandovi minimo una settimana intera per ogni mese di durata del corso. In questo modo sarà possibile cambiare la propria mentalità in maniera progressiva, cosicché tale metodo di lavoro diventi una costante nel sistema aziendale.
Questi aspetti vengono preliminarmente trasmessi al Top Management dei fornitori, i quali partecipano alla presentazione iniziale dell'OpEx; nell'occasione Whirlpool richiede espressamente come requisito prioritario il massimo impegno e un forte senso di responsabilità nella selezione dei migliori ingegneri e nel supporto che deve essere fornito durante il comune percorso di crescita, garantendo un regolare avvio e la conseguente conclusione dei progetti intrapresi; in questo modo si crea nell'organizzazione una mentalità volta al miglioramento continuo. Il Management deve dare

ai candidati Black Belts la possibilità di lavorare sul progetto almeno per il 50% del proprio tempo e rendersi disponibile per incontri periodici all'interno dello stabilimento, informandosi sullo stato di avanzamento, su quanto appreso durante il training, sul grado di consapevolezza e commitment, verificando e diffondendo i risultati che si stanno raggiungendo. Durante la presentazione vengono inoltre definite e trasmesse le condizioni per implementare con successo il Six Sigma nelle proprie aziende:

- Il training e la consapevolezza deve svilupparsi secondo un approccio top-down;
- Almeno il primo candidato al ruolo di Black Belt deve essere la miglior risorsa possibile;
- Il cuore del Six Sigma non è il training, ma i progetti;
- E' un dovere trasmettere a tutti i livelli organizzativi obiettivi e risultati;
- Il Six Sigma non deve essere visto solamente come un insieme di metodi e strumenti, ma un cambio di mentalità nel modo di lavorare.

Confronto Caratteristiche Aziende Intervistate

		FGA	Whirpool Corporation	Telecom Italia
Vision of the methodology		Bottom Up	Top Down	Top Down
Training	*Resources involved in the implementation*	Sponsor, Owner and MBB	Sponsor, external consultants, MBB	External consultant, 1 MBB, new BB, Sponsor and Owner
	Business areas involved	Manufacturing Engineering & Design Supplier Quality Customer Care Parts & Services	BB should not be involved in a single workspace	Coming from all business functions (initially by HR)
	Working time devoted to projects	100% of working time spent on training	Master Black Belts: 60% of work time spent on training	Part-time: 40/50% GB, 60/70% BB
	Number of trained resources		20 Black Belt training classes around the world: almost 2500 more than 60 BB and MBB	1 MBB, 35 GB, 6 BB
Implementation Timeline		- The year 2006 is the beginning of work on operational projects and training of persons - 2007 is the year of consolidation: substantial increase of projects and improved structure of the business areas - 2008 is the year of crisis and survival Development methodology since 2005 - For implementation have been identified two MBB GB course - Duration: 15 days in 4 sessions - 60% theoretical, 40% exercises and discussion of projects - Certification BB course - Duration: 12 days in 4 sessions - 60% theoretical, 40% exercises and discussion of projects - Certification - Tutoring at 10 GB projects, training courses on GB with direct delivery of at least 8 hours of training as a teacher.	Development methodology in 1996 - PDSA cycle: a tool for development starting OpEx - Since 2005, one week of training activities for Directors and Top Management - Since 2007, all figures are involved in operating a training course of 5 days Training for 4 weeks - 14 BB classes: managed by external consultants and the MBB Training of 20 weeks in 2 years - Training of MBB	First wave: March 2009-July 2009 - 20 HR Green Belt certified with the development of 3 projects - Supported by the presence of an external consultant and a MBB Second wave: December 2010-July 2010 - 21 GB (10 HR, 11 other functions), - 6 BB certified with 4 active projects
Projects Organization	*Projects organization*	- Program Office:Central MBB with coordination role, training, coaching and grouth in resources - Plants: approximately 5 to 8 resources for plant - Central Government: Mixed solution (BB and GB) - Supplier Quality: GB and BB with some coordinating role Assisted project on a weekly / fortnightly by the MBB; the Owner shall monitor the monthly progress	- Theoretical and then simulation projects - Application of the methodology by focusing on design processes - The starting point is always observing, understanding, focus on how customers actually use the product and how they are implemented its performance in different conditions	- 1 team leader of the project - 4/6 new information GB - 1 information BB - 2 GB already certified Organizational support of the line - 1 sponsor of the project (top managers of the relevant function) - 1 owner of the project (manager directly responsible for process improvement) - 1 or more of line contacts to ensure contact information and access to the DB
Implementation in SME's	*Weaknesses of SME's*	- Low number of people to be involved as GB e/o BB with inability to work as a team - Lack of budget for training of persons - Few time available to invest in the activity for the persons selected	- Low number of people to be involved as GB e/o BB with inability to work as a team - Lack of budget for training of persons - Few time available to invest in the activity for the persons selected	- Low number of people to be involved as GB e/o BB with inability to work as a team - Lack of budget for training of persons - Few time available to invest in the activity for the persons selected - Poor use of the measurement of business processes (structured DB)
	Strength of SME's	- Organization and lean times of decision will be reduced - Easier to create a commitment to medium-small (you can focus on the forces) - The implementation of the solutions is faster in terms of scale	- Organization and lean times of decision will be reduced - Easier to create a commitment to medium-small (you can focus on the forces) - The implementation of the solutions is faster in terms of scale	- Organization and lean times of decision will be reduced - Easier to create a commitment to medium-small (you can focus on the forces) - The implementation of the solutions is faster in terms of scale
	Proposed solutions	- Provide Six Sigma as a tool for advanced problem solving - Take off from a situation of uncertainty, trying to minimize errors - Encouraging the formation of the instruments used and try to select pilot projects - Choose a project that has value for the company and to serve the company in a constructive manner - The phenomenon in question must be measurable - Apply the methodology correctly and rigorously without using shortcuts	- Transmit the implementation of the approach also to sub-suppliers - Support from external consultants, dedicating a specific budget	- Support from external consultants, dedicating a specific budget - Support initiatives by consortia or shared with other similar training and consultancy - Heavy use of ad hoc data collection for the measurement of processes (KPI or SLA)

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