QUALITY AND COMPETITIVENESS: A LEAN SIX SIGMA APPROACH

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Abstract
Originally developed to improve the quality and production efficiency, Lean Six Sigma is now widely adopted in other non-manufacturing sectors such as financial, trade, services, etc. Lean Six Sigma is a hybrid of two concepts: lean manufacturing - to reduce waste, and Six Sigma - to reduce errors, and thus to help companies to achieve faster production processes with low cost and higher quality. From our research we've found that despite its increasing popularity and impressive results at some companies, Lean Six Sigma often fails to deliver expected results. However, research carried out has shown that the service companies analyzed, that operate within courier activities (unloading activities, data entry and labeling of shipments at the start) has succeeded in realize the benefits in terms of productivity and competitiveness by creating added value.

Keywords
Lean Six Sigma model, waste reduction, DEMAIC model, competitiveness, quality, Value Stream Mapping, Total Savings

JEL Classification
L87, O14

Introduction

The Lean Six Sigma is increasingly used as a methodological approach for the proper sizing of the corporate staff as: a) measure objectively process inefficiencies; b) identifies activities that consume time and resources without adding value and at the same time improves the quality levels of the output processes.
The Lean Six Sigma is a methodology practically hybrid derived from the *Six Sigma* model of Motorola General Electric (Pande, Neuman, and Cavanagh, 2000) which is a largely focus on performance and scientific management to achieve reducing errors and the *Lean* model of Toyota (Taiichi, 2004) whose main goals are customer-oriented and a lean structure and fast to reduce Lead-time.
From the Six Sigma model that is a not oriented to the speed and to the creation of a lean company to Lean model that does not pursue the reduction of product/process defects we come to Lean Six Sigma model that instead seeks a lean management, customer-oriented and performance, to reduce waste (Lapre', Mukherjee and Wassenhove, 2000), errors and speed of response, by sizing the workforce and overcome the limits of source models, highlighted above.

1. Research Methodology

The Lean Six Sigma is a methodology for optimizing process, that starting from the voice of the customer (VOC), research the most efficient way to meet through the reduction of variability in each stage of the process, whether referred to the production of a product, and the provision of a service.

By applying Lean Six Sigma methodology in the context of a service company-a subsidiary of TNT Italy, with statistical data and contribution of Lean Six Sigma expert Charrey - through the systematic reduction of process variability, it is obtained simultaneously achieving two strategic goals of the company, apparently antithetical: improve the quality levels of products and services and, at the same time, dramatically reduce costs (waste) of processes. The methodological approach of Lean Six Sigma (Aggogeri and Gentiles, 2013) is based on rigour, systematic nature and method and is based on the use of data and statistical analysis.

2. Quality and productivity

Muda is a technical term of industrial production, which translates as "loss" or "waste", and is one of the "3 M" that should be avoid: *muda* (7 wastes, loss); *mura* (unevenness, interruptions) and *muri* (overburden) - (excesses, strenuous work, or slowed down).

Losses occur because of the traditional production system, in which defective parts are many. Only in a Six Sigma quality system can be prevented the production of defective parts and preventing those subsequent processes are started.

The Muda can be classified into Muda of 1 Type, which concern all those activities that do not directly increase the value of the product, but are currently required the performance of value activities: quality control (QC), Human Resources, Accounting, Administration, Tooling, Technical Assistence and Maintenance, etc. The other category are the Muda of Type 2, or the seven wastes that represent the operations that can be immediately removed (Fig. 1), without creating any problem to the other activities.

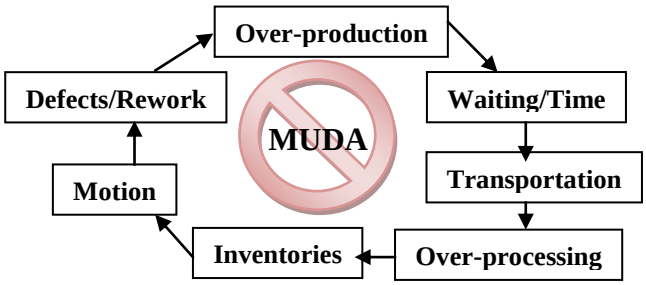


Fig. no. 1 The 7 Deadly Wastes (muda)

Among these operations are highlighted:

Inventories: Generate from raw materials, semi-finished products, etc, including warehouse stock and production parts between two process steps (Work in Process - WIP).

Motion: unnecessary movements that do not add value, run quickly or slowly or even at different rhythms between operators.

Defects = non-compliance / non-quality: Wastage related to the cost of non-quality in materials, processes, customer complaints and repairs.

Transportation: Wastes resulting from: move, transfer, take / lay, stacking or moving parts unnecessarily generated by problems related to distances, flows and transport speed.

Waste in the process itself: unnecessary activities and operations deemed traditionally necessary.
Identified Muda there is the problem of how to intervene to improve quality, increase productivity, reduce inventory and WIP, to shorten production lines, reduce downtime and set-up, reduce the space, and shorten processes. Table 1 shows some of the concepts that can be adopted providing ideal working conditions to which add also technical solutions and design.

Table no. 1 Some key concepts of Muda

Employees	without looking - without walking - without trying - without stopping
Plants	without cutting the space - without roller conveyor - without set-up - without presses
Materials	without bolts and screws - smudging off - without waiting - without stock
Methods	without bottlenecks - without large batches - without stock

3. "Gemba" analysis to improve productivity

It is also important to focus on the recovery of even minimal time when performing repetitive operations. The identification of waste can start from anywhere, even from the recovery of minimum times, analyzing on-site operations that take place during work ("Gemba" in Japanese). We can consider two types of minimum time that must be treated differently, ie:

1. The time lost for unnecessary operations during the stages of production.
2. The time lost for "going around in circles", i.e. the time that staff spend looking for material that is not in its place, or equipment that should be available and/or lifting equipment that are occupied by others.

The timing of the second type are by far the biggest between the two and depends mainly on the type and size of the workshop. Then, the on-site analysis to reduce the time lost should start not so much from the analysis with the stopwatch of timing and methods, but from the observation of time lost for excessive errors of organization. And organizational problems can be even more, also because, *not always look means seeing*. Therefore it would be interesting to see also (Swan, 2014):

- methods of materials handling;
- with an analysis undercover, find the time that the bridge crane (if it exists) is inactive in half an hour of observation; repeating for a few days the controller can have data statistically more correct. A serious data collection can be a tool on which to base the opportunity to purchase an instrumental asset;
- the times of the "going around in circles" of operators who are away from work to go to retrieve tools, materials, information from the head, etc. constitute another important element of the assessment percentage of this time on total working half hour observed;
- the time of a format change of the machines / lines.

According to the Leanthinker's consultant Santambrogio (2012) the milestone starting point in a workshop to introduce lean production (Graham and Barry, 2011) is the analysis of quick change over. The reduction in format changeover times can improve the production planning system to the Heijunka which involves chopping of the production minimum batch dictated by "having to" produce many pieces (massively increase the Work-in-Process-WIP). Often, the time of mold change (which can last hours) does not cover the cost if you make only a few pieces, so it "should do so many pieces to put in stock and save on the cost of single piece". This sentence is still too often pronounced. But, in the context of the principles of lean production, instead of lean thinking (Womack, and Jones, 2008;

Khoo, 2005), it is very important to analyze the waste of time, since the competitiveness of a company starts from finding lost time, not only of the maximum ones but also of the minimum. Apart from the change of the format that offers great potential for savings, and indeed the Organization's transformation to lean, analyzing the "going around in circles" you can find important information:
1. how could it be modified (reconfigured) the layout of the machinery to avoid unnecessary paths of people and materials;
2. find out the crossings of flows hazardous for the safety of workers: avoid bumping and hurting with forklift the people who are passing, by moving storage areas;
3. to evaluate the inadequacy of technical equipment which in addition to transportation means also includes work tools, avoiding the going around in circles of the workers, whose cost would be significantly higher than that of a possible purchase;
4. another phenomenon, responsible for minimal losses but constants, concerns the breaking of a tool that, often the worker shows only at the moment of re-use it and having to mending or to borrow it;
5. emerge also other negative reasons, other than those related mainly to the work tools, are lack of technical information that the department head must give the operator (drawings, instructions, specifications of the customer).
In pursuing economic efficiency is important to deepen the lack of organizational nature and work in all directions to improve the management of product/service quality according to ISO 9001 and in particular of paragraph 8.5.

4. Lean Six Sigma model: case study

As a structured approach, DMAIC (Define-Measure-Analyze-Improve-Control) (Table 2) provides a business with a line up solutions. This helps the business to solve problems from start to finish while producing bottom-line results. Moreover, DMAIC supports an analytical approach, allowing the business to use the collected data. This helps the business to ensure accurate baselines.

Table no. 2 DEMAIC model

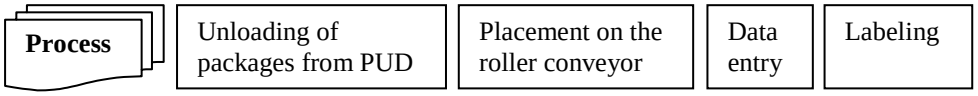
Phases	**D**efine	**M**easure	**A**nalyze	**I**mprove	**C**ontrol
Activity	Define of current situation ↓ Defining the desired situation	Identification of potential causes ↓ Quantification of the problem	Analyze of potential causes ↓ Selecting the initial causes	Identification of potential solutions ↓ Selection / implementation of solutions	Monitor the effectiveness over time ↓ Implementation of means of control
Results	- Problem definition. - Potential advantages	Starting point of the problem and list of causes	Selected quantified causes and initial ones	Pilot and final implementation solutions	- Control and monitoring processes. - Advantages confirmed

How does the evaluation using the DEMAIC model, and the use of the DEMAIC model as a theoretical framework based on the theorization of the Lean Sigma Institute. This methodology is use when improving existing processes, as DMAIC allows a business to quantify improvements and find answers to complex problems.

Focus on Lean: Achieve perfect workflow and minimizing waste by working with people

Focus	Eliminate the non-value added activities for the customer
Process	Create process workflows and reduce variability
Teamwork	Working with people on the floor
Sustainability	Achieve the Continuous Improvement culture
Local	Simple solutions designed by local teams
Intelligence	Work smarter instead of working more

Using the DEMAIC model you proceed, then, to the definition of the scope of action. The process took into account concerns: unloading activities, data entry and labeling of shipments at the start.



Includes: all domestic traffic departing, envelopes and packages picked up by the PUD (Pick-up and Delivery-owner-operators).
Excludes: international shipping management and domestic packages handled as "Matches" (collection service dedicated to large customers).

"Departure"- Process problem definition

Current state
- Operational efficiency of the labeling process of packages departing picked up from PUD is currently insufficient with a productivity of about 300 packages/hour per location.
- This inefficiency is likely to impact on scheduled hours generating delays in the departure of the lines.
- All this leads to completion operations related to Departures until 22:00.

Desirable state: Improve the flow of processing of packages departing in order to have a completion of activities within the hours 21:30.

The conceivable Benefits of the project for the process:

ϕ The closure of the activities related to Departure Process within the hours 21:30 with an advance of half an hour compared with the current situation;

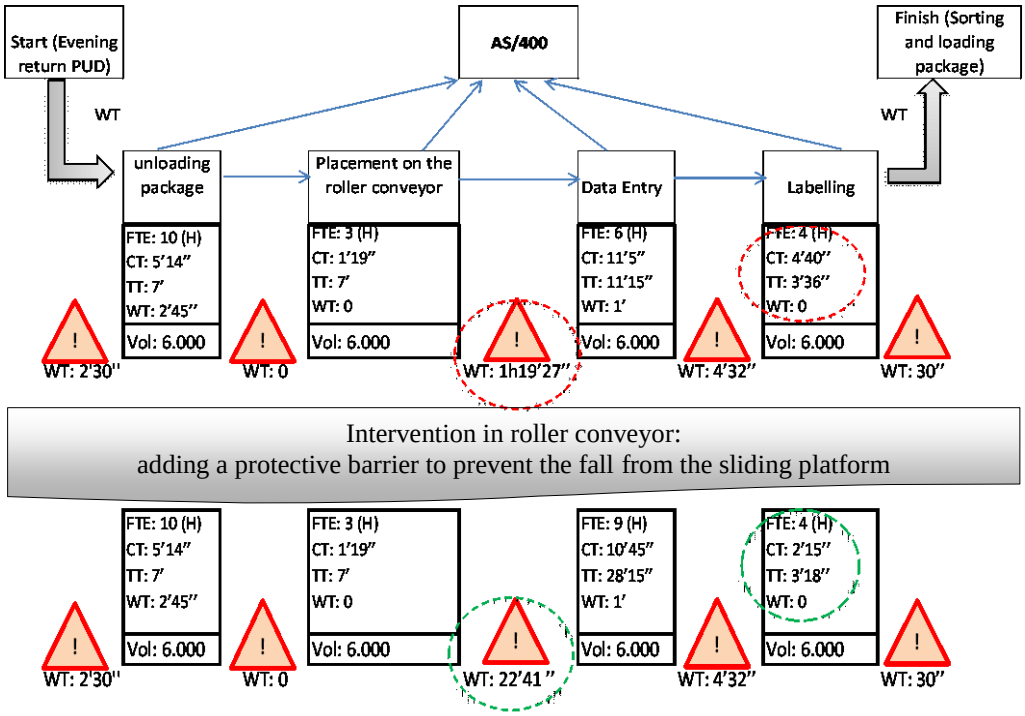
ϕ A minimum saving of about 10 working hours of handling relatively to this process.

The phase *Analyze* revealed the reasons that cause errors:

1. Processing folders in LIFO (stands for last-in, first-out), Processing of pallets in FIFO (first-in first-out);
2. Non-value added activity between a folder and the other (fax, photocopies, etc.)
3. Processing of 2 folders at a time with waiting times higher for the 2nd folder;
4. Waiting unloading of the platform for the arrival time of the 1st package at Totem for verification of data entry took place;
5. Unloading of PUD on both sides of the warehouse did not allow to optimize workloads and times;
6. Failure to schedule labeling for start time and order of unloading packages on roller;
7. Excessive handling of packages Specials (before and after labeling);
8. Data Entry Bottleneck determined by resource shortages;

9. Some packages were falling from the roller conveyor blocking the flow and therefore the process.

In the context of the Improve phase were identified the following solutions:
1. Keep working folders according to order of arrival (FIFO)
2. Processing folders only one at a time
3. Non-value added processing postponed after Data Entry
4. Loading packages on roller conveyor while keeping order of arrival at the Branch
5. Unloading PUD unified on only one side of the warehouse
6. Anticipate start labeling: 1st 17:30 h; 2nd 19:00 h
7. Labeling packages in the order of placement and Data Entry
8. Installed a protective barrier on the roller conveyor to prevent the fall of packages and the next block



Legend:
CT: value added times (Cycle Times)
WT: non-value added (wait) times
TT: Total Cycle Time
FTE: full-time equivalent
T = TNT Workers
H = Handling Workers
P = PUD Workers
PUD: Pick Up and Delivery

Fig. no. 2 Value Stream Mapping (own elaboration on the basis of Storch, 2010; TNT Italy)

There are two critical aspects of process mapping and regard:
1. Draw the process map exactly as it exists. If you create the map from the office at your desk, it is likely to miss key elements of the process, such as any redundant work or rework loops.
2. Always *walk the process* to validate the correctness of the of process mapping.

In the phase *control* is realized the verification of the achievement of the results

Sub Process	Part of sub process	CTQ	Specifications	Measuring Method	Sample size	Frequency	Who measures	Records data on
return PUD	Unloading PUD	Return time	By 20:00	Employee fills in the form the lap number and PUD schedule returning after 20:00	All late PUD	daily	Employed to delivery of pass	Specific Excel sheet
Start	Departures	Number domestic Packages at the start	Not applicable	Data collection from branch statistics (source check-in)	The whole activity is analyzed	daily	Departures Coordinator	Specific Excel sheet (control plan)
Start	Data Entry	Number shipments handled	Not applicable	Data collection from branch statistics (source check-in)	The whole activity is analyzed.	daily	Departures Coordinator	Specific Excel sheet (control plan)
Start	Labeling	Start time and end x each totem	Large Customers 16:30 to 20:.30. 1st Totem: 17:30 to 20:30 2nd Totem: 19:00 to 20:30	Taking over manually the start and end times for each location (Totem)	All emplacements are analyzed	daily	Cooperative's referent of Departure warehouse	Specific Excel sheet

Floor control in which all metrics are provided for:
− Verify the correct achievement of project objectives;
− Keep tabs on the process.

Results achieved in the implementation of the model, it can be summarized as follows:

Items of Project	**Before implementation**	**After implementation**
Productivity of Bill of lading Data Entry x h	900	1.318
Productivity of Bill of lading D.E./ employee	160	219
Labeling productivity x h	300	540
End Time activities	22:00	21:27
Recirculation packages x h: %	> 50%	1%
Recirculation packages x h: number	> 400	9
Amount of hours days	133	- 117,5
Saving hours days	0	**15,5**

Saving hours (cycle time reduction):

(15,5 h/day x 12,5€/h x 250 workdays) → 48.438 Euro

Lowering of the unsendable packages number:

(10 packages /day x 20€/ package x 250 workdays) → 50.000 Euro

Total Savings → 98.438 Euro

Conclusions

The Lean Six Sigma goes beyond the Fords' concept of organization no longer vertically but horizontally integrated to process and not for functions. This organization and the development of a culture of quality, determines a positive impact on the product or service. The introduction of automation and digitalization has made a substantial contribution to the Lean

Six Sigma system to achieve process control, eliminate waste and defects, to meet customer demand as user of products or services with the goal of Total Customer Satisfaction.
In the study of the company's services taken into consideration, we analyzed the working method, the current organization and existing studies on the subject (mathematical and statistical), reaching to an assessment of current level of the process performances.
The study highlighted in the business structure organizational deficiencies due to repetitive processes, non-value added activities, lack of work planning in the various steps of the production process. For these deficiencies have been identified some solutions to give a rational work organization, to better respond to customer demand, increase business efficiency, with benefits on competitiveness in a global market.
The indications, compared with the required standards, demonstrating the validity of the Lean Six Sigma project by identifying possible improvements and solutions to be adopted.
As specified to the beginning of this paper, the Lean Six Sigma concept was first applied in industry, but can be implemented successfully in services, as we have tried to demonstrate in the present research. Our purpose is to apply the Lean Six Sigma model in the tourism domain.

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