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Introduction of Lean Six Sigma principles into Plant Maintenance Work Order Cycle Time

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Abstract

To improve the performance of a process and ensure on time delivery there are numerous different approaches available nowadays. Lean Six Sigma is a physical transformation to the processes and it is a transformation of any organizational cultural .Lean offers a unique method that helps identify possible improvement areas. In addition, Six Sigma offers a unique approach that is widely used in plants in order to improve the process and thereby reduce the number of defects. Either Lean or Six Sigma used separately can result in dramatic process improvement. However both methods used in combination can address all types of process problems with the most appropriate toolkit and a high level of result. The Lean approach can be used to reduce or even eliminate waste and thereby ensure on time delivery of products. A value stream mapping is one of the main tools of lean that can be used to represent the flow of materials and information. It can be utilized to identify areas where improvements can be incorporated for a smooth flow of products. DMAIC (Define, Measure, Analyze, Improve and Control) is a five step approach that utilize different six sigma tools to generate ideas and collect data then to analyze and come up with improvement plans in order to improve the process under study. The methodology of Lean and Six Sigma integration was proposed and tested in Riyadh Refinery Plant. The study involves the plant maintenance work order cycle time from creation to closer. Improvement opportunities were identified from a high –level value steam map. The DMAIC approach was utilized to address the identified opportunities for improvement. The results indicate that the lead-time was reduced from 214 days to 95 days.

Keywords
Lean Six Sigma, Cycle Time, DMAIC, value stream mapping

1. Introduction

Background

'We are witnessing a major change in maintenance. It is moving from an equipment repair service to a business process for increasing equipment reliability and ensuring plant capacity. Its practitioners are trading their reactive cost center mentality for a proactive equipment assets management philosophy' (Robert C. Baldwin, Former Editor). Once cannot discuss maintenance planning without first considering an overall perspective of maintenance itself. Moreover effective maintenance reduces overall company cost because production capacity is available when needed. The company makes a produce with this capacity to sell at a profit. This explains the reliability cost relationship: focus on overall cost reduction and reliability gets worse, but focus on reliability improvement and overall cost goes down. All plants require some maintenance and planning can help maintenance efficiency. Some of the primary aspects of planning are well known. Maintenance planning involves identifying parts and tools necessary for jobs and reserving or even staging them as appropriate. The common perception of planning is that after someone requests work to be done, a planner would simply determine and gather the necessary parts and tolls before the job is assigned. Hence, the inadequate stereotyping of maintenance planning and work planning will end up with the right maintenance but with the appropriate results in term of planning effectiveness and work order turnaround time. The issue of maintenance work order has a direct and indirect impact of planning and effectiveness along with planning compliance. This paper describes the incorporating of Lean Six Sigma into Maintenance Work Order Turnaround time

Lean Six Sigma

Lean tools focus on improving product flows and standardizing work processes. The traditional view of Lean tools has been to focus on eliminating non-value added activities (waste) in a process with goal of reducing process cycle times and cost and improving on-time delivery performance. The traditional view of Six Sigma has been to measure and reduce process variation and achieve improvements in service, quality and cost. Today we often use the term ‘Lean Six Sigma’ which really represents a powerful combination of increased speed and reduced variation to achieve optimized processes and effective business management.

2. Project Case Study

Case facts: the following discussion is related to a green belt project and represent the work order cycle time reduction can be done using lean six sigma methodology. Our story takes place within Saudi Aramco, Riyadh Refinery plant, by applying Lean Six Sigma process to over than 2,000 work orders for the year of 2008 with an average turnaround 214 days.

Work Order Fundamentals

The objective of the plant maintenance work order system is the most valuable tool for improving maintenance effectives and productivity. Basically the work order helps maintenance personnel obtain necessary origination information and control all the work. The work order avoids an inconsistent utilization of verbal statement, electronic mail. Past-it’s and phone calls. The foundation of the work order is the consistent format for information and designated follow for work to process.

Work Order Turnaround Time

The work order Turn around Time measures the number of days taken to complete the execution of work order or work request. Most plants measure Turn Around time as the number of days from the Release Date to Reference Date of the work order and not the duration of administrative tasks such as waiting for materials, waiting for lat invoices, etc. the target settled by Saudi Aramco is less than 60 days and the objective is to measure the time to execute Craft work within a maintenance facility and to highlight areas of bottlenecks where delays are identified and remedial action to alleviate such delay are taken. (Saudi Aramco, Corporate Maintenance Council)

Project Statement

Data collected from Oct 08 to Oct 09 showed that the average cycle time for work orders from initiation to closing is 214 days (St. Dev = 171), 73% of the work orders did not meet corporate target of 90 days, and 48% of the work orders took more than 180 days to close against a corporate target of 10%.This resulted in customer dissatisfaction due to long delivery timings. Although the affected equipment were vary from critical to normal (Figure 1)

Project Objective

The objective of this project is to reduce the percentage of work orders taking more than 90 day from 73% to less than 35% & work order taking more than 180 days from 48% to less than 25% in order to achieve the company guidelines and international best practices.

Achieving success using Lean Six Sigma in Maintenance Work Orders

Six Sigma focuses on reducing the variation in processes. Basically everything we do can be considered a process or part of process and every process can be characterized by Average Performance and Variation. Processes are performing optimally when the result of the process is at expected value, meaning there is minimal variation. Let’s study the Work Order process from Creation to closer. The process begins when the notification is processed by proponent and changed to an Order and then material procurement followed by execution. Cycle time will be counted once the order is initiated which means the time for the equipment out of service or the equipment is working but suffering from leaks, vibration or any other chronic problems.

3. Proposed Methodology

The methodology proposed here is an integrated approach of lean and six sigma. To start with, a high level should be developed for the process under study. Possible improvement opportunities can be identified from this value stream map. All possible opportunities should be identified here, irrespective of the nature of the problem. DMAIC should be used for working on these opportunities. Since DMAIC is a systematic approach it keeps the project on track. Based on the nature of the problem, any of the available six sigma tools or lean or both together can be used the methodology followed in this case study is Lean Six Sigma.

DMAIC Phases

Phase 1: Define (see Figure 1)

General Overview: During this phase of the DMAIC process, the critical performance variables of work order cycle time was defined. In addition, all related performance specification associated with each causes were defined and established. That means the critical to quality characteristics (CTQs) of a deliverable was well known as well as their perspective performance expectation. We defined all our causes through process mapping and brain storming sessions which we conducted more than three times. (See Figure 3) which is the Fishbone diagram or Cause and Effect Diagram, it is a brainstorming tool used to look for the root cause, or cause and effects problems. Each "bone" represents a category that impacts the problem, match expectations. To further go to the root cause, we carried out statistical Process Control for mach expectation. As shown on Figure 4. This resulted in identifying main defaulter. It is clear from the figure that (WP) welding procedure, Mechanical Seal Refurbishment, and Planners Location have the highest variation. Then we continued studying each variable by statistical and hypotheses tools.

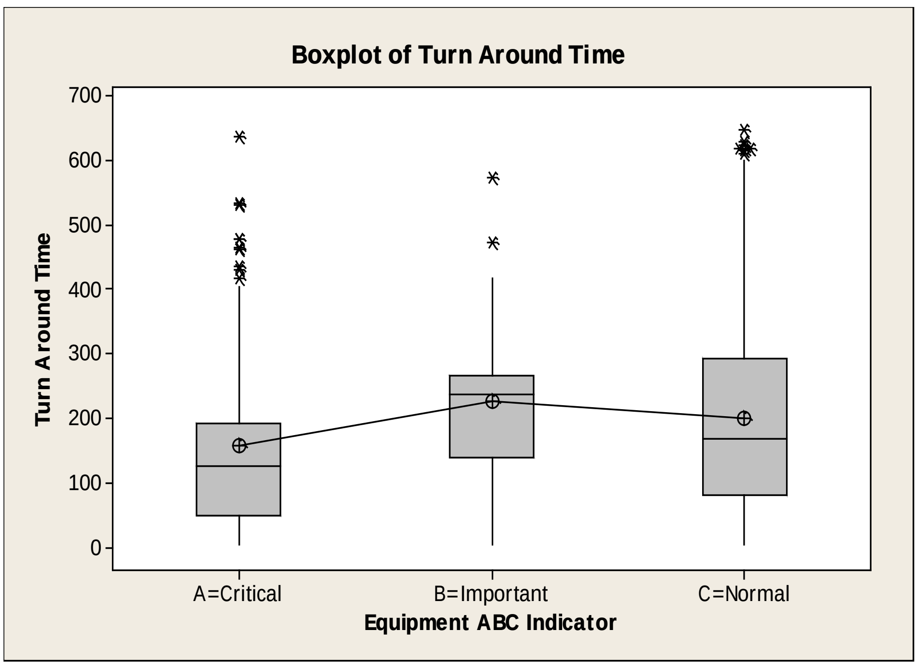

Figure 1: Equipment Indicator

Phase 2: Measure

General Overview: During this phase of DMAIC process, each CTQ is measured so we could establish a performance baseline. In this phase we must remember, "You cannot manage what you cannot measure". On this phase, we collected the data about the current process and confirm the customer needs, wants and expectation and eventually validating the measurement. There are some tools being used to measure each of the causes. This is including the usage of the Minitab software. This software is of importance on the project.

Phase 3: Analyze

General Overview: During this phase of the DMAIC process, the focus in on analyzing the performance gaps related to each one of the CTQ's. Of course, the intent of this phase was to separate where the problems "is and "is not". We looked for patterns of poor performance as well as patterns of good performance. Such patterns can provide great insight into how to the improvement effort should be continued and guided. In addition, we considered every difference within and among the CTQ's. Furthermore, we narrowed the focus to specific issues and developed a mechanism to analyze the whole data. Then we identified what is causing defects, was and variation. (See Figure 5) for one of the analyze phase statistics which was the turnaround time by object type. And Figure 6 is for the number of days waiting by user status.

Phase 4: Improve

General Overview: During this phase of the DMAIC process, we seek to improve the capability gap of each CTQ by close examination and improvement of the critical process. In addition, we validated all hypotheses about the root cause of the problem and we identified any alternative solutions in the same time we determined the optimal solution. Our recommendations started to take place on this stage which we started on February, 2010. The major recommendations were as follow:

- Relocation of planners and Area Supervisor's Offices to Plant Shops
- Assign a designated person to hold all of the Mechanical seal Storage
- Assign additional Area Planner for Crude Stabilization Unit
- Generate a weekly report for all work orders above 120 days
- Reject any Direct Charge for Control Valves without an ISS sheet
- Awareness sessions for all planners for the right work order closure through SAP\
- Urgent notifications to be created by Operation Forman only.

Phase 4: Control

General Overview: During this phase of the DMAIC process, we seek to control the optimal setting of each optimal solution. The performance of each CTQ can be made stable over time and "robust" to normal nonrandom low grade errors in process centering. Moreover, we had to ensure the corrective actions are taken and transition the control of the new process to the process owner. And we also provided outstanding techniques to sustain the process improvement along with monitoring the performance, this done by adding all work orders above 120 days on the quartile KPI with the revision of the plant manager. In addition, the corrective actions were documented for future reference. The corrective actions are controlled and monitored by the Project champion and the Department manager who is following each recommendation by a bi-weekly report of each recommendation.

4. Results

We focused on the main defects with high variation which was, the Welding procedure, Planners, Area supervisor's office location, Mechanical Seal Refurbishment, Planners awareness of the right work order planning procedure. We started implementing the recommendation by January 2010; we could be able to successfully reduce the turnaround time to less than 550% within the next five months as shown on (Figure 7). This means reducing the average cycle time from an average of 214 days to 107 days! Moreover, we have improved on the Urgent Priority for Plant Notifications which was one of our obstacles for the turnaround time, see (Figure 8) and to track our improvement and success, we created a ranking system for all areas at our plants in order to verify which area we still have to improve more and to make in-depth research. But with some type of resistance to change which is common for any change in any organization.

5. Conclusion

In summary, Lean Six Sigma is not a magic stick that you can use for overnight success. It is a methodology, which has to be slowly incorporated into the culture of the organization. It can be applied to any process and we as Maintenance Plants need to make the best out of this methodology.

References

1. Khurana, Gurpreet Singh. [Online] AmeriHealth Mercy Family of Companies, May 2008. [Cited: 13 September 2010.] http://www.ism.ws/files/Pubs/Proceedings/ALTKhurana.pdf.
2. Institute, Marshal. *Effective Planning & Scheduling for Today's Maintenance.* Raleigh : Marshall Institue, 2000.
3. Susan Gebelein, Kristie J. Nelson, Carol J. Skube, David G. Lee, Lisa A. Stevens, Lowell W. Hellervik, Brian L.Davis. *Successful Manager's Handbook.* USA : Previsor, 2004.
4. Palmer, Doc. *Maintenance Planning and Scheduling Handbook.* USA : McGRAW-HILL, 2006.

5. [Online] [Cited: 1 September 2010.] http://www.ahrq.gov/downloads/pub/advances2/vol3/advances-hurley_55.pdf.
6. Dept, Organization Consulting. *Lean Six Sigma*. Dhahran : Aramco, 2008.

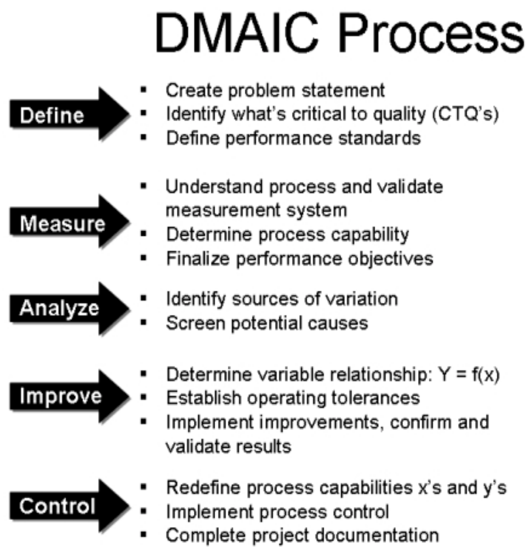

Figure 2: DMAIC Process

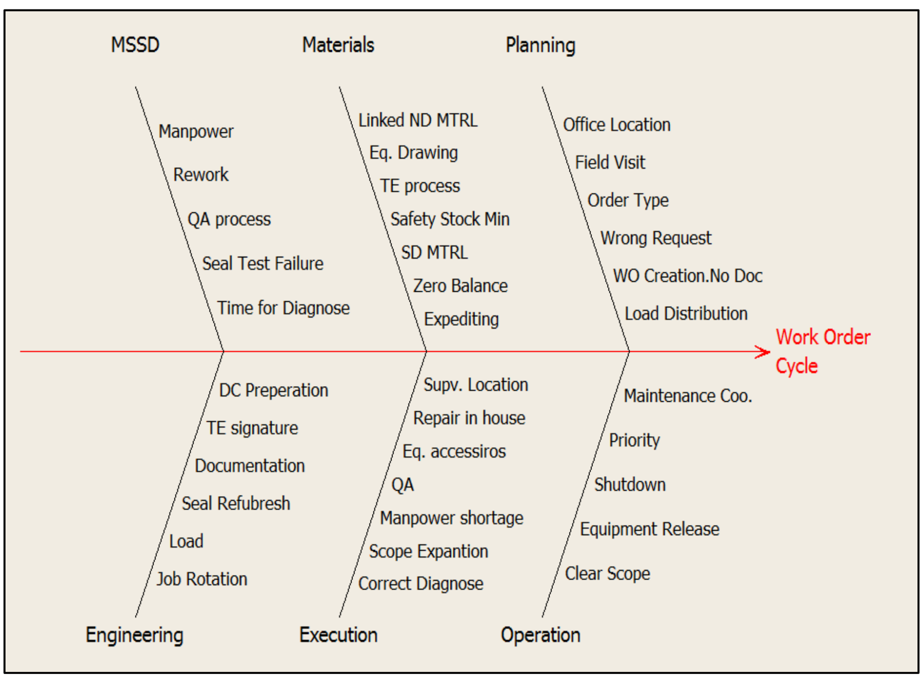

Figure 3: Brainstorming outcome

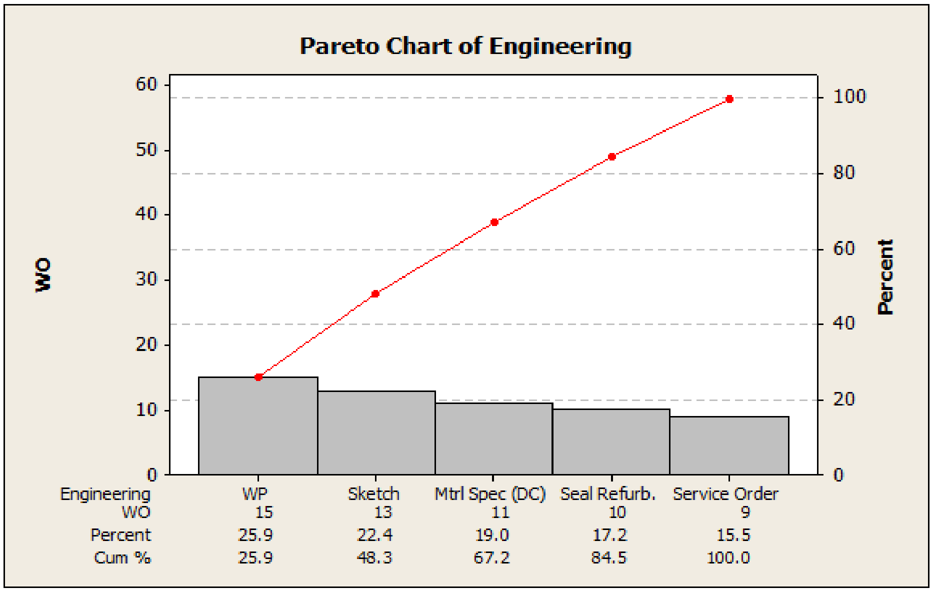

Figure 4: Work Order by Waiting Days

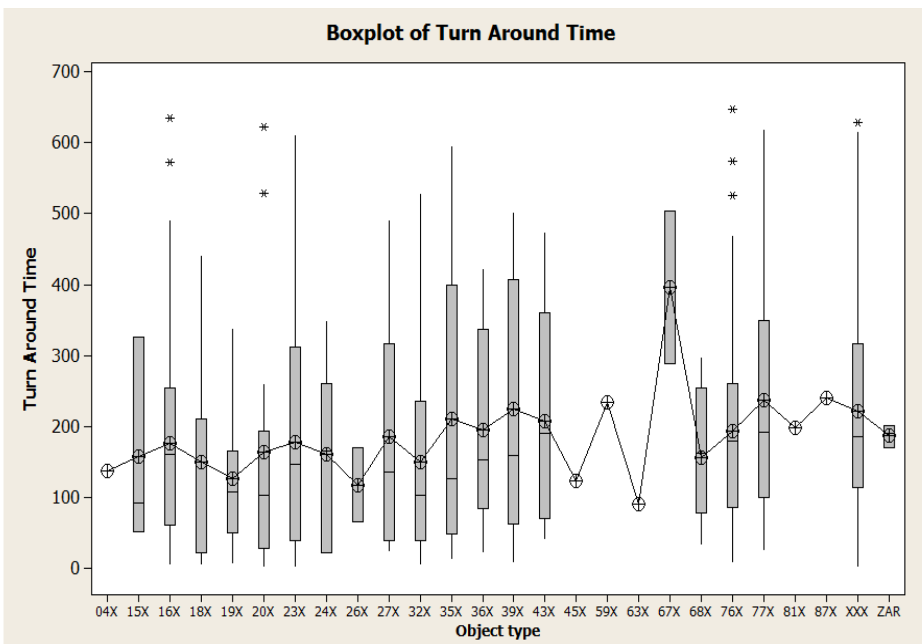

Figure 5: Turnaround time by Object type

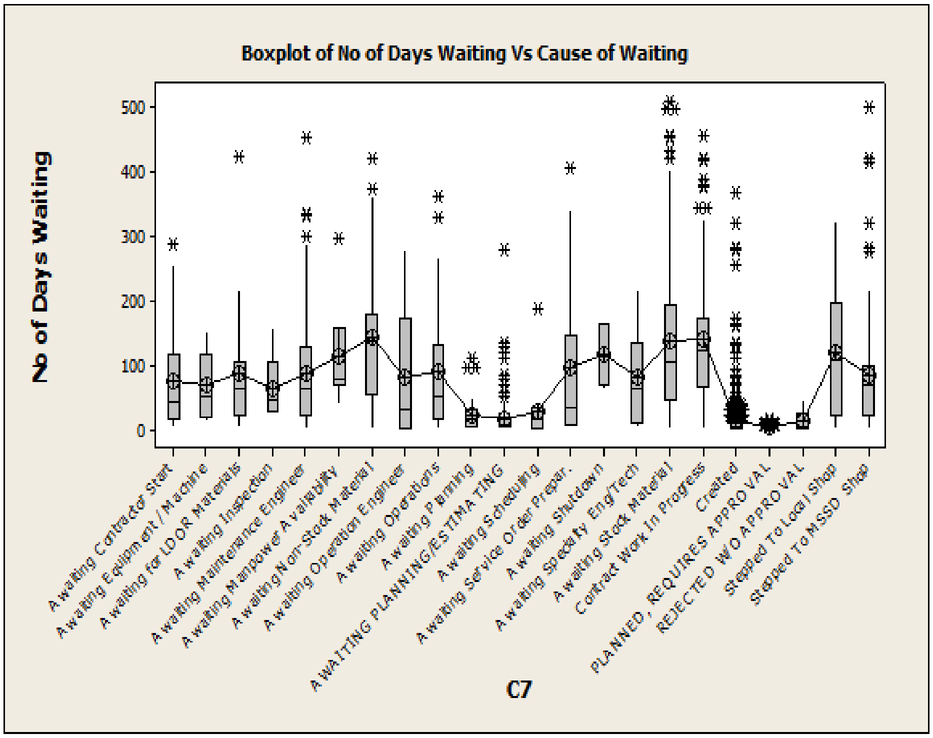

Figure 6: Number of days waiting by User

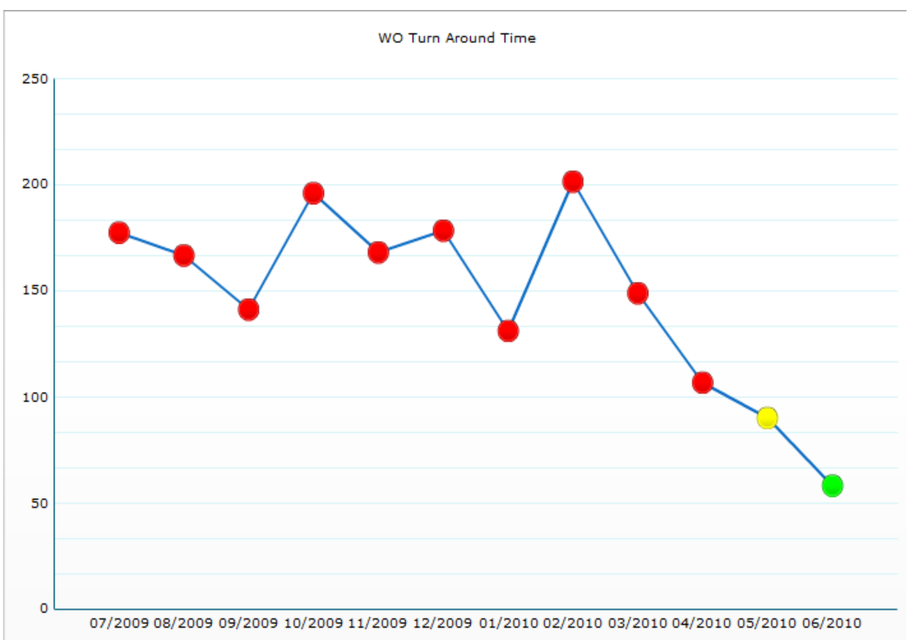

Figure 7: Improvement in Work Order Cycle time

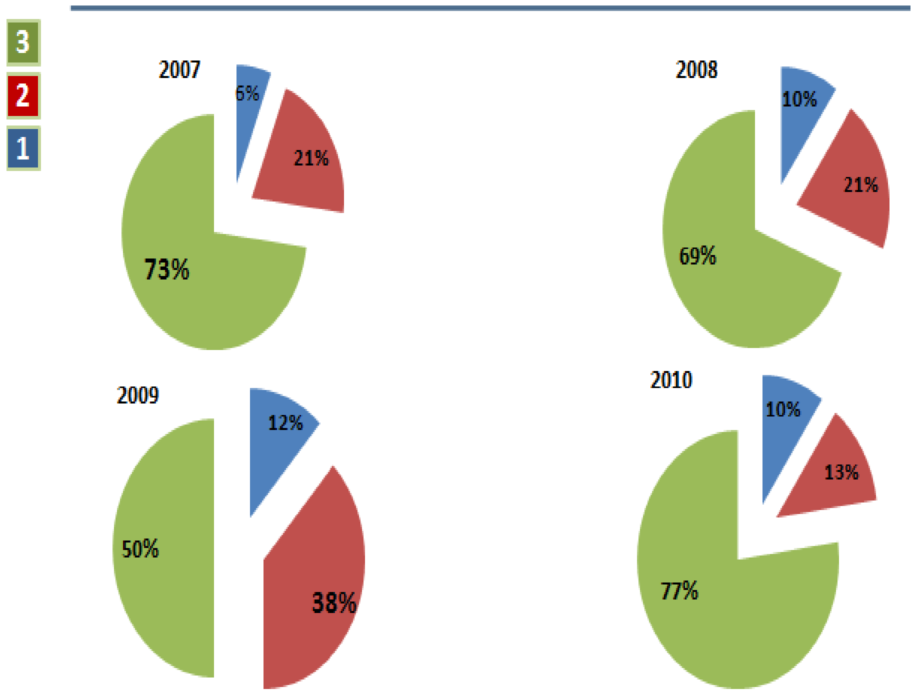

Figure 8: Improvements on Urgent Priority