Quality Engineering, 22:214–221, 2010
Copyright © Taylor & Francis Group, LLC
ISSN: 0898-2112 print/1532-4222 online
DOI: 10.1080/08982111003771854

Taylor & Francis
Taylor & Francis Group

Quality Quandaries: Improving the Invoicing Process of a Consulting Company

Tashi P. Erdmann[1], Manon de Groot[2], Ronald J. M. M. Does[1]

[1]Institute for Business and Industrial Statistics, University of Amsterdam, The Netherlands
[2]REAAL Insurances, Utrecht, The Netherlands

Downloaded By: [Universiteit van Amsterdam] At: 07:25 8 June 2010

INTRODUCTION

Although Lean Six Sigma originates from a manufacturing environment, over the past decennium the method has been used increasingly for improvement projects in the service industry (for an introduction see De Mast et al. 2006). Though projects in the manufacturing industry often involve experimenting and advanced statistical techniques, in services the most challenging part is in merely structuring and quantifying the problem. Once the problem is properly structured and made explicit, the solution is often quite straightforward and does not require advanced statistics. Therefore, the key to a successful project in services is to clearly define and quantify the problem. The first two phases of the define, measure, analyze, improve, control (DMAIC) roadmap used in Lean Six Sigma, the phases *define* and *measure*, focus on these important activities.

As an illustration, this article discusses an improvement project on the invoicing process in a large IT and business services company. The goal of the project was to reduce the throughput and processing time, such that the client would pay the invoice as soon as possible, and the company would reduce personnel costs. The yearly benefits of the project were targeted in advance to be at least €50,000 per year, as a result of increased interest earnings and reduced operational costs. For reasons of confidentiality and for illustrative purposes, some of the data and facts have been slightly modified.

DEFINE PHASE

The most important elements of the define phase of a Lean Six Sigma project are clearly defining the process that is to be improved, stating the project objectives and analyzing their potential benefits, and setting up the project organization and time planning.

In the project that is discussed here, the process that is improved is the process of invoicing consulting fees to clients. The supplier, input, process, output, and client (SIPOC) model of the process is shown in Figure 1.

Only the invoices regarding consultancy activities by the Financial Services division are within the scope of the project. At high level, the invoicing process is organized in the five following steps: First, the consultant fills in his or her time sheet. The consultant's division checks and

Edited by Ronald J. M. M. Does.

Address correspondence to Ronald J. M. M. Does, IBIS UvA, University of Amsterdam, Plantage Muidergracht 12, 1018 TV Amsterdam, The Netherlands. E-mail: r.j.m.m.does@uva.nl

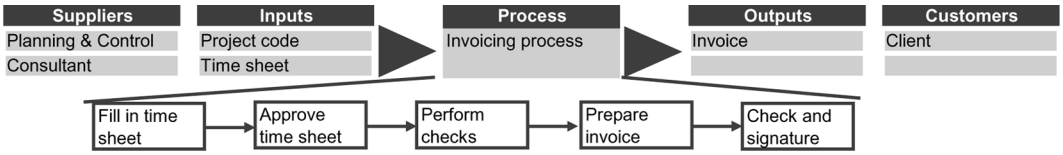

FIGURE 1 **The SIPOC of the invoicing process.**

approves the timesheet and then sends it to the Shared Service Center for processing. The Shared Service Center performs several checks and prepares the invoice. The invoice is then sent to the division for a check and signature and then finally sent to the client.

The project objectives consist of a reduction in the throughput time, the number of full-time equivalents (FTEs) involved, and the number of mistakes made in the invoicing process. The throughput time is especially important, because each day that the invoices are paid faster on average will lead to extra interest earnings of €17,000 per year, based on €183 million of total yearly revenues. An assumption made here is that extra throughput time causes the payment to be delayed with on average the same amount of time, which seems reasonable. Another important anticipated benefit of the project is expected to be achieved by reducing the processing time of time sheets and invoices by the employees of the Financial Services division and the Shared Service Center. At the beginning of the project, the total number of FTEs working on invoices is around eight: five at the Financial Services division and three at the Shared Service Center. A third project objective is a decrease in the number of mistakes. Receiving an incorrect invoice is clearly dissatisfying for clients. Additionally, mistakes in invoices lead to delayed payments and extra work for the consulting company. Currently, 11% of the invoices sent to clients are incorrect.

The project team consists of three consultants from the Financial Services division, one of whom is black belt (i.e., project leader). They report to a champion, who has given them the assignment to do the project. The project leader is coached by an external master black belt, an expert in the Lean Six Sigma methodology. The project is to be completed within 6 months, with planned reviews by the champion and master black belt at the end of each phase.

MEASURE

In the measure phase, the project objectives are operationalized as requirements on quantifiable and measurable quality characteristics. Then, a procedure is established to measure these characteristics, and this measurement procedure is validated. In Lean Six Sigma, these quality characteristics are often called *critical to quality* characteristics (CTQs).

The three CTQs in this project are processing time, waiting time, and the number of mistakes. Processing time and waiting time together add up to the total throughput time of the invoicing process and in this way influence the time to payment by the client and the service quality as perceived by the client. Processing time determines the number of employees necessary in this process, measured in FTEs. The number of mistakes influences both processing time and waiting time and is also a component of service quality. The way the CTQs relate to the project objectives and the strategic goals of the company can be schematically displayed in a so-called CTQ flowdown (cf. De Koning and De Mast 2007). The CTQ flowdown for this project is shown in Figure 2.

A common measurement plan used in Lean Six Sigma projects involving time measurements is to record processing times and waiting times for individual files as they make their way through the process. In this invoicing process, however, whole batches of files (time sheets and invoices) are processed together in so-called billing cycles of approximately 8 working days, which take place twice per month. Therefore, the black belt decided

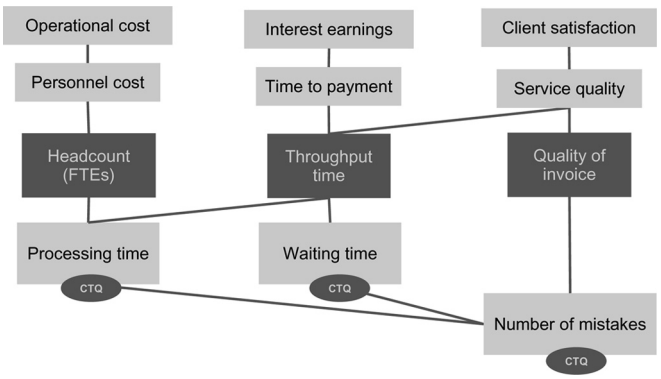

FIGURE 2 **The CTQ flowdown of the invoicing process.**

Downloaded By: [Universiteit van Amsterdam] At: 07:25 8 June 2010

to record the total processing times and waiting times for all files together, rather than those for the individual files separately.

The CTQs are measured for each process step. The CTQ *processing time* is defined as the time employees are occupied with activities in order to process all time sheets and invoices. The CTQ *waiting time* is the time in between steps when no time sheet or invoice is being processed, for each process step separately. For steps within the Financial Services division, the processing time and waiting time are measured per employee for a single billing cycle. For steps performed by the Shared Service Center the times are recorded per billing cycle, based on computer system reports of the last 3 months, covering six bimonthly billing cycles. The CTQ *number of mistakes* is a count of all mistakes found by employees or in the computer system reports during each process step. The requirement for all three CTQs is that they should be minimized.

There are several issues regarding the validity of the measurement procedure. A possible problem is the fact that the processing times and waiting times, as measured, do not cover part of the rework that is caused by mistakes. For example, additional processing and waiting times outside the billing period are not recorded. Another issue is that mistakes that are not immediately corrected when they are discovered are counted more than once, so the number of mistakes found in each process step does not add up to the actual total number of mistakes. Furthermore, a disadvantage of this measurement procedure is that the amount of variation in the total throughput time of the process cannot be determined, because times are not recorded for individual files but for batches of files. Although the measurement procedure has some drawbacks, it still gives a reasonably good insight into the nature of the problem.

ANALYZE

In the analyze phase the current performance of the CTQs is determined, based on the collected data. A thorough analysis leads to a diagnosis of the problem and a list of potential influence factors.

A useful tool for describing the process flow in detail and visualizing forms of waste in the process is the so-called value stream map (see Kemper et al. 2010; Womack and Jones 2003). In a value stream map for each process step the average processing time and average waiting time is given, and for each conditional routing the percentage following that routing is given. Different forms of waste in the process can be shown in the value stream map.

Two value stream maps for the invoicing process are shown in Figure 3.

The process is divided into two parts: the first part of the process takes place in the Financial Services division, and the second part takes place in the Shared Service Center. In the value stream map different layers are visible, representing the different actors that play a part in the process: the consultants, who fill in their time sheets; the secretaries and team managers, who each perform a check and make several corrections to the time sheets and invoices; the employee of Planning and Control, who creates project codes and performs a check; the employees of the Shared Service Center, who perform six consecutive checks of the time sheets and invoices, make several corrections, and create the invoices; the account managers who perform a check; and, finally, the clients. Different forms of waste are visualized using self-explanatory symbols. In Figure 3 there are symbols for transportation, redundant work and overprocessing, rework, complexity, and waiting time.

Based on the measurements and with help of the value stream map, the current performance can be assessed. The total *throughput time* of the invoicing process is currently 32 days on average and can be divided into three parts: the delivery of time sheets by the Financial Services division takes 1 day, the standard process that takes place twice per month at the Shared Service Center takes 8.5 days, and then further nonstandard corrections and issues that arise in the preparation for sending take 22.4 days on average, including rework after incorrect invoices are sent back by clients. It is clear that the last part, consisting of 22.4 days of rework and waiting, is the largest and should therefore be the focus of the project. Reducing the number of mistakes will probably greatly help in reducing this huge amount of rework. But also the first two parts of the throughput time, which together form the standard process, are full of inspections, rework, and waiting time. In the standard process, altogether nine separate checks are performed on the time sheets and invoices before the invoice reaches the client. Combining some of these inspections and redesigning the process will

Downloaded By: [Universiteit van Amsterdam] At: 07:25 8 June 2010

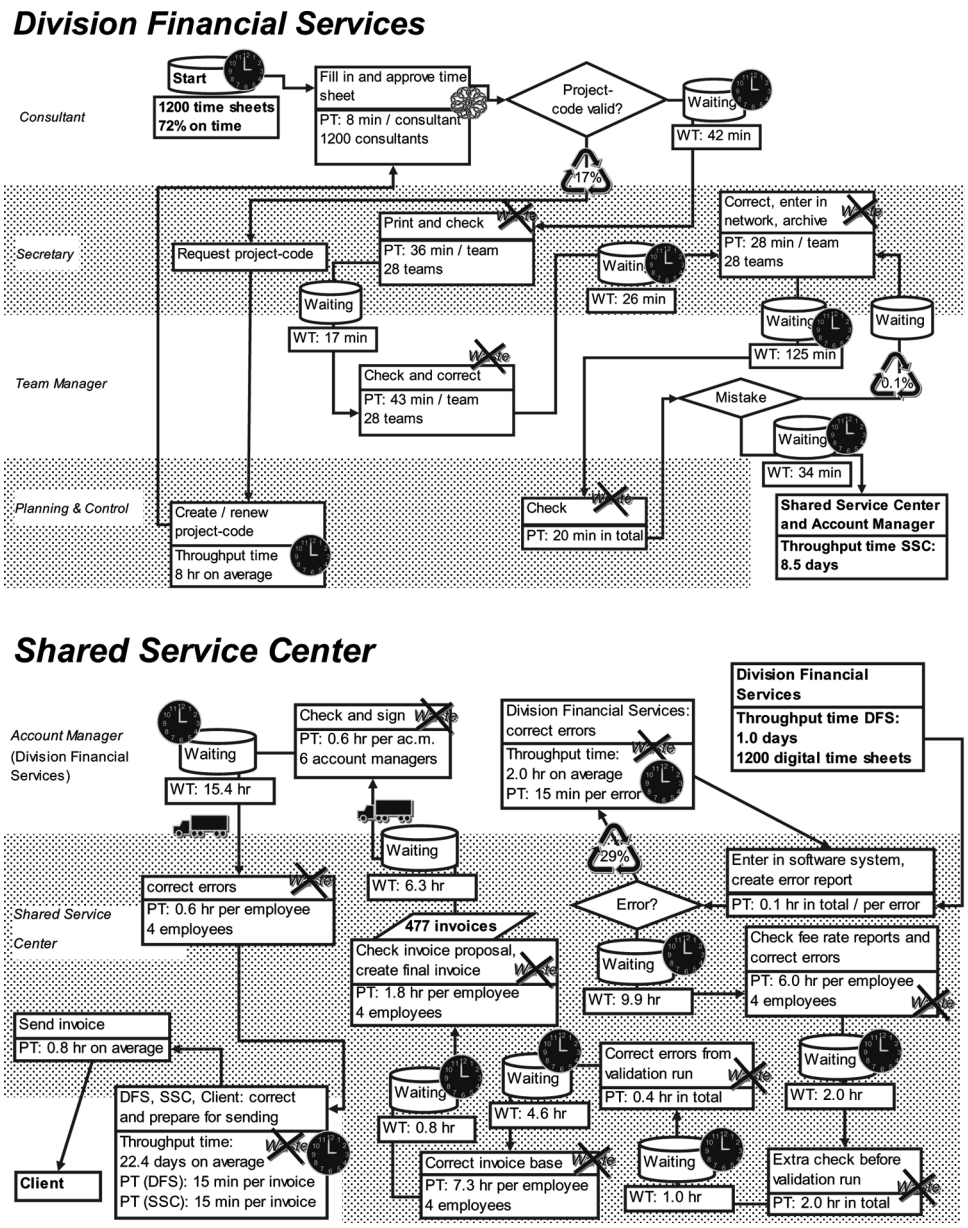

FIGURE 3 **Value stream maps of the two processes in the Financial Services division and Shared Service Center, respectively.**

probably reduce the throughput time with several days.

The total *processing time* of all time sheets and invoices in one billing cycle added together is currently 420 man-hours at the Financial Services division and 217 man-hours at the Shared Service Center. This implies that at the Financial Services division currently 5.3 FTEs are needed and at the Shared Service Center 2.8, considering that yearly there are 24 billing cycles and one FTE works 1,886 hours. An overview of the different components of processing time is given in Table 1.

Much of the processing time is caused by correction of mistakes, both during the standard process and after the standard process. After the computer system of the Shared Service Center creates an error report, the errors—on average 29% of the 1,200 time sheets have one error in the error report—have to be corrected by the Financial Services division, taking around 15 minutes per error. Then after the standard process, nonstandard corrections and issues that arise in the preparation for sending cost 30 minutes on average for each of the 477 invoices, 15 minutes for the Financial Services division and 15 minutes for the Shared Service Center. All those corrections are direct consequences of the large number of mistakes.

The total *number of mistakes* in all time sheets and invoices that were found during one billing period

Downloaded By: [Universiteit van Amsterdam] At: 07:25 8 June 2010

TABLE 1 Processing Times of the Process Steps

Process step	Total processing time in hours
Consultant	160.0
Print and check by secretary	16.8
Correction by secretary	13.1
Check and correction by team manager	20.1
Check by Planning and Control	0.3
Check by account manager	3.6
Corrections after error reports	87.0
Corrections after standard process	119.3
Total at division Financial Services	**420.1**
Enter in system	29.3
Check fee rate reports and correction	24.0
Extra check before TS03 and correction	2.0
Corrections after TS03	0.4
Corrections of invoice base	29.2
Check invoice proposals and correction, and create invoice	7.2
Correct errors in invoices	2.4
Prepare invoice and corrections after standard process	119.3
Send invoice	3.2
Total at Shared Service Center	**217.0**

Process steps written in *italics* are almost entirely (a) caused by mistakes or (b) considered redundant.

was 1,172. In this billing period altogether 477 invoices were sent, implying that the average number of mistakes per invoice was 2.5. Note that some mistakes may have been counted double, because they were not corrected the first time. The numbers of mistakes found in each inspection separately are given in Table 2.

One of the main objectives will be to reduce this large number of mistakes, because this will result in higher client satisfaction but also in a reduction in throughput time and processing time.

TABLE 2 Number of Mistakes per Process Step

Process step	Number of mistakes found
Check by team secretary	271
Check by team manager	130
Check by Planning and Control	1
Error report by software system	348
Fee rate reports	9
Extra check before validation run	238
Validation run	14
Check invoice proposals	31
Check by account manager	19
Client	116
Total	1,177

Based on this analysis the potential benefits of the project are recalculated as follows. The average number of mistakes is targeted to decrease with about 90% from 2.5 mistakes per invoice to 0.2 per invoice. We hope that with this improvement the number of incorrect invoices sent to clients will reduce proportionally from 11 to 1% of the invoices. This reduction in the number of mistakes combined with a more efficiently organized process will (hopefully) cause the total throughput time to decrease from 32 days to 10 days, leading to €374,000 extra interest earnings per year. This is based on a 90% reduction of the 22.4 days of rework because of the reduction in the number of mistakes and a 25% reduction of the 8.5 days of standard process because of a more efficiently organized process. The total processing time per billing period is targeted to decrease from 637 to 226 man-hours, such that the total number of FTEs will decrease from 8.1 to 2.9, saving €281,000 per year. This is based on a 90% reduction in processing time of the process steps that are written in italics in Table 1, because they are almost entirely caused by mistakes or considered redundant. Altogether the financial benefits of the projected are now targeted to be €655,000: much more than was expected in the define phase.

The last step of the analyze phase is the creation of a list of factors that influence the CTQs. In the invoicing process, the project manager defined five main influence factors, based on analysis of the measurement data, analysis of the process flow, and conversations with many of the employees working in the process. They are as follows:

1. clarity of operating procedures and responsibilities;
2. adequacy of information management;
3. correctness and timeliness of time sheets;
4. effectiveness of inspections and checks;
5. the adequacy of computer systems.

These five influence factors are thought to be the main causes of variability in the CTQs processing time, waiting time, and the number of mistakes. They will be further explained in the next section. These influence factors will be adjusted in order to optimize the process.

Downloaded By: [Universiteit van Amsterdam] At: 07:25 8 June 2010

IMPROVE

The purpose of the improve phase is to arrive at a number of improvement actions that together will cause the CTQs to satisfy their requirements. The improvement actions are based on the influence factors identified in the analyze phase. In the improve phase these influence factors are examined critically and are prioritized based on their effect on the CTQs and their changeability.

In the invoicing process, the effect of the five influence factors mentioned earlier is quite clear from the value stream maps in Figure 3 and from conversations with employees and does not need elaborate evidence in the form of experiments. The circumstantial evidence provided by all problems, disturbances, mistakes, and inefficiencies experienced by the people working in the process is convincing enough to design and implement improvement actions directly. In the following, the five influence factors will be further explained.

The *clarity of operating procedures and responsibilities* is an important influence factor. The different actors who play a part in the process currently do not have a clear picture of the process as a whole nor of their own tasks, authorities, and responsibilities. There is no central unit managing the process, and there are no standard operating procedures. Because of this, the predictability of the process is poor. Furthermore, the responsibilities are not well defined. Some employees perform activities for which they are not authorized. The number of different actors playing a part in the process is large, and this leads to a lot of communication between different actors, especially because it is unclear who is responsible for what. Too many different people are doing the same or similar tasks. Many agreements are violated and mistakes are made, because people do not know what the agreements are. Because of the absence of clear operating procedures, many tasks are not organized in an efficient way. For example, there are no separate procedures for different types of contracts, although it makes a large difference in average throughput time whether a contract is a fixed price or a time and material contract. Both types of contracts are treated as if they were the same, causing much rework and large delays after the standard process.

The *adequacy of information management* is a second influence factor. At the moment, the management and general accessibility of information is very poor. The information necessary is often unavailable for the persons involved. For example, when consultants are absent, secretaries sometimes have to fill in time sheets for the consultants based on e-mail correspondence, because the consultant's time registration is not readily available to them. As a consequence, many actions and decisions are taken based on incorrect or incomplete information, leading to mistakes. Many of the checks and inspections that are done during the process are impossible, or can only be done partially, because not all information that is needed is available to the person who performs the inspection. For example, information about the client contracts, which is one of the most important inputs for the process, is only available to account managers and is often not up to date, and therefore checks on completeness and correctness of the invoices cannot take place until the invoices are seen by the account managers in one of the last process steps. This is one of the reasons that so many different inspections are necessary. Another consequence is that a lot of additional communication has to take place between the different actors in the process.

A third important influence factor is the *correctness and timeliness of time sheets*. The input that the consultants deliver is of poor quality, full of mistakes, incomplete, and often late. For example, some consultants do not specify the number of kilometers they have driven, or they do not follow the rules for time registration specified in the contract of a specific client. This has to do with insufficient access to information, as explained in the previous paragraph, and with a lack of good instructions for the consultants. For most consultants it is not clear which requirements their time sheets have to meet. Consultants never become aware of their mistakes, because they are not informed of them. In addition, the discipline of the consultants is poor, because they do not face any consequences when their time sheets do not meet the requirements.

Influence factor number four is the *effectiveness of inspections and checks*. Many inspections take place in the current standard process. Altogether there are nine checks. Nevertheless, the invoices are still full of mistakes, despite all the checks. Inspections take place both manually and automatically. In the manual inspection mistakes are made because of missing

Downloaded By: [Universiteit van Amsterdam] At: 07:25 8 June 2010

information and because of the differences in the working methods of the actors in the process. In the automatic inspection mistakes are made, because of incomplete or incorrect input of parameters on which the software system bases its checks. Some of the nine checks seem redundant, because hardly any mistakes are found, such as the check by Planning and Control, the check of the fee rate reports, and the check by the account manager.

The last important influence factor is the *adequacy of computer systems*. At the moment there are many mistakes in the checks performed by the software system. This is because the data on which the configuration of the system is based are often incorrect and incomplete. The current software system used for the checks is more of an accounting system than an operational management system. It has insufficient possibilities in processing management information. The different systems used in the organization are not compatible with each other, such that it sometimes occurs that information that is changed in one system remains unchanged in another system. The interface of the software for hour registration is felt to miss some aspects, and it would be easy for the consultants if standard values were given for the different categories. Another software-related issue is that authorization by the account manager and team manager could be given with an Internet-based system. Signatures on paper by the team manager and by the account manager appear to be unnecessary and needlessly take time for printing and transportation of the physical documents.

Based on the five influence factors described above, the black belt has designed the following improvement actions:

1. Standard operating procedures will be written. These standard operating procedures and responsibilities will ensure that the process is manageable and will also contain feedback loops that define actions to be taken when mistakes are made. Responsibilities will be clearly defined. A central unit of three FTEs will be established within the Financial Services division and will serve as contact point for the Shared Service Center.
2. Information will be made available centrally. This central database should contain information regarding time allocation, consultant-specific agreements, contract administration, and project code administration and should be accessible to everyone and kept up to date. The central unit described above will manage this central database.
3. Instructions to consultants will be improved, and consultants will receive feedback when they have made a mistake. To improve discipline, the consultants will receive a reminder by text message before the start of each billing period, and the quality and timeliness of the time sheets will become part of the performance indicators used in the personal review of the consultants.
4. The central unit, which will have direct access to all the necessary information, will take over all inspections and checks formerly done by others. It will deliver correct invoices to the Shared Service Center, which will not have to do any inspections anymore. Several checks will be combined, and redundant checks will not be done anymore.
5. A software system for operational management will be implemented, which must be compatible with the other software systems used. Furthermore, the interface of the hour registration software will be designed in a way that makes it easy for the consultants to fill in their time sheets. In addition, Web-based authorization will replace signatures on physical documents.

CONTROL

The last phase of the DMAIC method of Lean Six Sigma is the control phase. In the control phase the process control is improved. This is done by documenting the improved process, creating a control plan, organizing continuous improvement, and defining roles and responsibilities. Then, finally, the benefits of the project are determined, and the black belt is discharged of the project.

In the new situation of the invoicing process, the central unit is set up with two employees who used to work at the Shared Service Center and one employee who used to be a secretary. The number of mistakes drops dramatically and in the first year after the implementation of the improvements, on average around 2% of the invoices sent to clients contain errors. Because of the reduction in the number of mistakes and the resulting efficiency improvement, altogether three secretaries are not necessary anymore and are given jobs at a different division, leading to personnel cost savings for the Financial

Downloaded By: [Universiteit van Amsterdam] At: 07:25 8 June 2010

Services division of around €153,000. The average total throughput time reduces from 32 to 10 days, which increases interest earnings by approximately €374,000.

CONCLUSION

The project about the invoicing process was a big success, with huge financial benefits to the consulting company. It shows how the DMAIC roadmap can help in structuring the problem. In the service industry, many processes have never been analyzed before and are full of potential improvements, the so-called low-hanging fruit. The define and measure phases of Lean Six Sigma give direction to the project. The solid structure and clear focus that result from the step-by-step approach help a great deal in solving problems. Once the black belt knows where to look, solutions are easily found.

REFERENCES

De Koning, H., De Mast, J. (2007). The CTQ flowdown as a conceptual model of project objectives. *Quality Management Journal*, 14(2): 19–28.

De Mast, J., Does, R. J. M. M., De Koning, H. (2006). *Lean Six Sigma for Service and Healthcare*. Alphen aan den Rijn, The Netherlands: Beaumont.

Kemper, B. P. H., De Mast, J., Mandjes, M. R. H. (2010). Modeling process flow using diagrams. *Quality and Reliability Engineering International*, 26(4):341–349.

Womack, J. P., Jones, D. T. (2003). *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. Florence, MA: Free Press.

Downloaded By: [Universiteit van Amsterdam] At: 07:25 8 June 2010