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Quality Quandaries: Cost and Quality in Postal Service

Benjamin P. H. Kemper[1], Saskia Koning[2], Thom C. W. Luijben[2], Ronald J. M. M. Does[1]

[1]Institute for Business and Industrial Statistics (IBIS UvA), University of Amsterdam, The Netherlands
[2]TNT Post, The Hague, The Netherlands

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

INTRODUCTION

In 2011, the European Union (EU) started to liberalize the internal markets for postal service. The objective of the EU postal policy is to accomplish a single market for postal services and to ensure a high-quality universal postal service as part of the Lisbon Agenda. Over the last few years, The Netherlands has gradually opened up the postal sector to competition for both business and consumer products. In this period the mail volumes of letters are steadily decreasing due to Internet-related communication. Opposite this development the use of parcel services is growing fast. Due to the competition, the providers of postal services are encouraged to improve their quality of service and to reduce their costs; that is, to become more effective and efficient (see Juran [1989] and Kotler [1984]). As a result, providers are more or less forced to organize and to adopt improvement programs such as theory of constraints, business process redesign, lean thinking, and Six Sigma.

In this column we provide an example of the application of Lean Six Sigma to the postal service sector (see De Mast et al. [2006] for an introduction of Lean Six Sigma in the service industry). The specific case study is about the reduction of rework cost due to incorrectly routed post at the main postal service provider in The Netherlands. First, we provide a brief background for the case study. We then highlight the Lean Six Sigma tools used in the original project. The article ends with some conclusions.

BACKGROUND

TNT Post is the main provider of postal services in The Netherlands. The former state-owned provider is part of the public listed company TNT, which operates in the global transportation and distribution industry (approximate size of this global industry is 2,750 billion euros). In 2009 TNT Post's revenues were approximately 4.2 billion euros, and it handled about 1 billion single mail items and 3.5 billion bulk mail items.

For several years, these mail volumes are steadily decreasing, while most costs are not easily adjustable. At the same time, customers and business clients enjoy more providers, and choose a provider which offers the price and quality that match their demand. Fueled by these market dynamics, TNT Post started up a Lean Six Sigma program in 2007.

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With the assistance of an external consultancy firm, in this case the Institute for Business and Industrial Statistics of the University of Amsterdam, Lean Six Sigma trainings for Orange Belts (3-day training), Green Belts (8-day training), Black Belts (14-day training), and Champions (1-day training) were set up. During their training, Green and Black Belts lead an improvement project. The project follows the define, measure, analyze, improve, control (DMAIC) steps:

Define: Specify project objectives.
Measure: Define and validate the measurements.
Analyze: Analyze the problem and identify influence factors.
Improve: Establish effects of influence factors and define improvement actions.
Control: Implement improvements, assure quality, and close the project.

The training for Green and Black Belts consists of four or five modules, roughly following the DMAIC project phases. This case study considers a Black Belt project that started during one of the Black Belt trainings in 2008.

CASE STUDY

The study focuses on the reduction of operational costs in the process of handling and reworking incorrectly routed mail. The scope of the process is the stream of 37 million small mail items that are not processed right the first time. The financial target of the project is to reduce the corresponding costs by at least 10%, which is already a substantial amount of money. The project description is given in Figure 1.

The process contains two subprocesses: the splitting, and returning of incorrectly routed mail at one of the approximately 170 regional mail offices (in short, "handling"), and the reworking of this particular mail stream at one of the six sorting hubs in The Netherlands. The macro process description is given in Figure 2.

Project description:	Handle and rework incorrectly routed mail
Main benefit:	Reduce operational costs of rerouted mail
Additional benefits:	Reduce complexity, reduce throughput time, and a reduction in rerouted mail volumes
Expected financial savings:	600k Euros per year
Champion:	Mrs. Hendrickx

FIGURE 1 **Mail rerouting project summary.**

In more detail, mail items that could not be posted by the mail carrier are taken back to the regional office. There, the mail items are split based on ZIP code in a stream of delayed mail items that are reworked within the same regional office and a stream of incorrectly sorted mail items that are returned to the sorting hub in the office's area. The second mentioned stream is considered in this project.

The process of handling and reworking this stream is facing a high level of operational costs both in terms of employees' time and machine time. Part of the employees' time is spent at the regional offices to handle the stream of incorrectly sorted mail items. This handling process is far from standardized among regional offices and different types of mail items. The rework subprocess can be processed over sorting machines or by hand sorting. Note that the stream of incorrectly routed mail items is typically not easy to sort. It dramatically reduces machine efficiency (which is a local performance indicator). However, at the same time, hand sorting by employees is at least three times more costly than machine sorting (affecting organizational efficiency). This project strives to find the right balance between local and organizational efficiency.

There are two possible directions for the project. Because the process as a whole is considered as non-value-added, one would ideally want to improve the process by eliminating the incorrectly routed mail volumes. Another improvement could be to reduce the operational costs of the reroute process by means of a process redesign.

DMAIC STEP-BY-STEP: THE MAIL REROUTING PROJECT

Define

The define phase provides a project summary as in Figure 1. A clear overview of the project scope is provided with help of a supplier-input-process-output-client (SIPOC) analysis; see Rasmussen (2006). Figure 2 depicts the SIPOC used in the mail rerouting project.

The process under scope deals with the operational costs of the handling and reworking incorrectly sorted

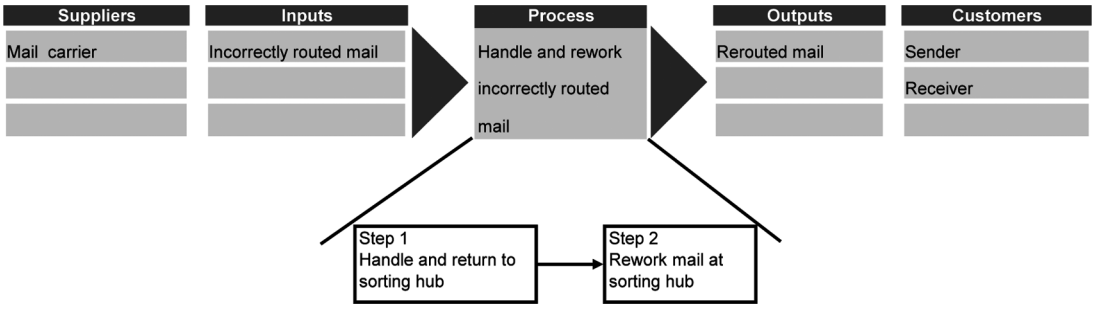

FIGURE 2 **Macro process description of the process handling and reworking incorrectly routed mail.**

mail; for example, a mail item that ended up in a mail bag of a mail carrier in a different region due to an incorrect machine code printed during one of the initial sorting rounds.

Furthermore, in the Define phase, the Black Belt provides project planning and also forms a project team consisting of employees with expert knowledge about the process.

Measure

The measure phase of the DMAIC methodology starts with a critical to quality (CTQ) flowdown (see De Koning and De Mast 2007). The idea behind the flowdown is to unravel high-level performance indicators (directly related to the project objective) into so-called CTQ parameters. The resulting breakdown helps to link the influence factors generated later in the project to the project objective defined by the champion. The project's CTQ flowdown is depicted in Figure 3.

For each CTQ we need an operational definition. An operational definition per CTQ includes the following:

The CTQ: Which process output component will be measured?

The measurement procedure: How is the CTQ measured?

The experimental unit: Per what is the CTQ measured?

Requirement: What is the desired or specified level of the CTQ?

The operational definition is a part of the measurement plan for each CTQ. Further, the measurement plan includes the following:

A schedule: When and for how long is the CTQ measured?

An operator or employee: Who is going to measure?

A database or spread sheet in which the data are recorded and analyzed.

The CTQs in this project are operationally defined in Figure 4.

During the measure phase the project leader has also measured some potential influence factors, such as type of mail item (there are three main types: moving service, sorting errors, incorrect address), size of the mail item, and intra (within a sorting hub's area) or inter (items with a destination outside a

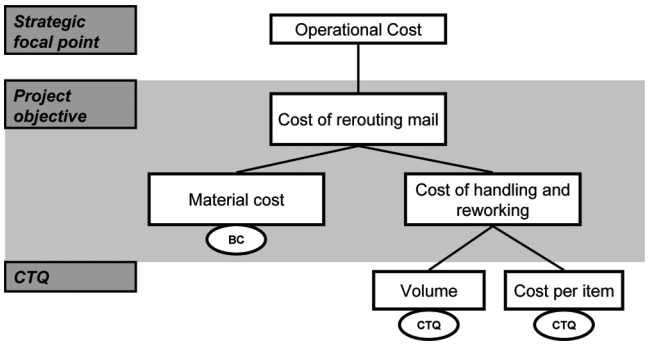

FIGURE 3 **The CTQ flowdown of the mail rerouting project.**

CTQ	Volume	Cost per item
Experimental unit	Per day	Per item
Measurement procedure	ERP system	Accountancy data
Requirement	As small as possible	As small as possible

FIGURE 4 **The operational definitions of the CTQs in the project.**

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sorting hub's area). For some of these influence factors, additional sampling has been done in two sorting hubs.

A widely applied and often discussed method to assess the precision of nominal measurements is the kappa method, or method of agreement. It assesses a measurement system's precision in terms of an index called kappa, which was proposed originally by Cohen (1960). Originating from the fields of medical statistics, psychometrics, and epidemiology, the method has recently gained in popularity in quality engineering and industrial statistics (cf. De Mast and Van Wieringen 2007). In this study it was important to classify the potential influence factors correctly. All kappa levels scored above 0.8 (the one below 0.8 was due to the fact that an operator had forgotten his pair of glasses), so the project leader and Master Black Belt approved the measurement procedures as defined in the measurement plan.

In total it took 4 weeks to collect the data. During this period the Black Belt also executed Gemba studies (see Womack and Jones 2003) to research the working methods used by mail carriers and operators in the different regional offices and in the two sorting hubs.

Analyze

To diagnose the current performance in the analyze phase, the Black Belt first analyzes the volumes of rerouted mail items with the use of descriptive statistics; see Table 1. Most rerouted mail (about 51%) is generated by incorrect addresses (IA), followed by sorting errors (SE) in the initial process (about 36%), and the rest (13%) is due to the moving service (MS) that facilitates mail rerouting for customers who recently moved to another address. As stated in the operational definitions, one should reduce these volumes in order to reach the project objective.

TABLE 1 Descriptive Statistics of the Rerouted Mail Volumes

Type rerouted mail	Yearly volume (millions)	Yearly volume (%)
Incorrect address (IA)	18.9	51
Sorting errors (SE)	13.3	36
Moving service (MS)	4.8	13
TOTAL	37	100

The Black Belt discusses these results with the project team members and experts in the process. The moving service stream of rerouted mail items is actually a product of TNT Post, so therefore it should not be regarded as part of this non-value-added process. Bear in mind that any operational cost reduction from this project could be beneficial for the margin of this product. Rerouted mail stream caused by customer behavior (IA) is a subject that belongs to the marketing and sales department. It was decided not to take any further action in this direction.

The direction to reach the project objective is to reduce the cost per item. The Black Belt studies the operational cost structure of both machine sorting and hand sorting. Of course, the costs of hand sorting were much higher than the costs of machine handling. Note that these costs exclude the handling cost of rerouted mail items at a regional office. For this subprocess, most findings came from the Gemba study.

During the Gemba study the project leader observed all kinds of complexities in the subprocess of handling rerouted mail items. We discuss here the three examples that are shown in Figure 5. The reroute stickers used in this process were not uniformly positioned. The positioning is a vital requirement to process the rerouted items over a sorting machine.

The stickers used for the moving service are usually taped over the address printed by the sender. However, the project team members observed that the bar code used differs from the code used for the IA or SE stream of rerouted mail. Furthermore, it was noticed that in some cases no sticker was used at all, especially in the IA stream. One observed ad hoc methods for handling rerouted mail; for example, that the ZIP code was crossed out in case of an incorrect address; see the bottom picture in Figure 5.

From these findings and based on the discussion with experts in the process, the Black Belt decides to focus on the CTQ "handling and rework cost per item" in the rest of project.

The analyze phase concludes with a list of the top six influence factors that are likely to have an influence on the project's CTQ cost per item. These six influence factors are selected from a long list of influence factors based on an evaluation of their expected

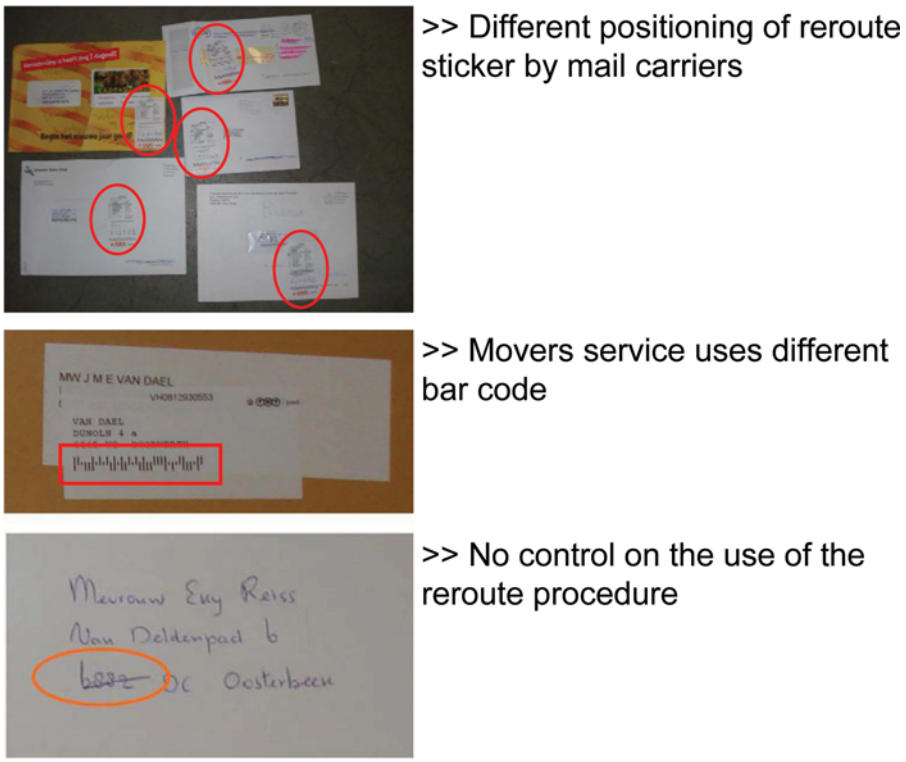

FIGURE 5 **Examples of results from Gemba study.**

effect and level of changeability. Note that all factors relate to the ability to rework rerouted mail over the machine, because that will reduce the cost per item substantially. Hence, the focus of the project was changed to process all rerouted mail items over the sorting machines.

The top six influence factors are listed as follows:

1. Reroute sticker: the current design does not cover using barcodes of the SE stream (36%) and there is no space for a house number.
2. Suboptimization machinery: MS stream often directly forwarded to hand sorting (13%).
3. Incomplete reroute sticker: about 7% is missing a ZIP code.
4. Unreadable reroute sticker: 6% cannot be read by machine software.
5. Incorrect positioning or no use of reroute sticker: lack of control on procedure.
6. Correctly indexed mail: could be directly returned in regular process

In the Improve phase the effect of each influence factors is investigated and improvement actions are defined.

Improve

The project leader and the project team started with the list of the six vital influence factors. The Black Belt conducted experiments to show that the improvement actions (relating to the design of the sticker, standard operating procedures [SOPs], and adjustments to the machine sorting process) were successful to solve the problems from the top six influence factors (IF). In Table 2 an overview is

TABLE 2 **Various Improvement Actions and their Estimated Effect on the CTQ**

Improvement action	Relates to IF	Type of mail	Estimated effect on cost (%)
1. New sticker + software update	1	IA, SE	30
2. Video coding	1, 2	IA, SE, MS	30
3. Software update 2	2, 4	IA, SE	15
4. SOP sticker use	1, 3, 4, 5, 6	IA, SE	6

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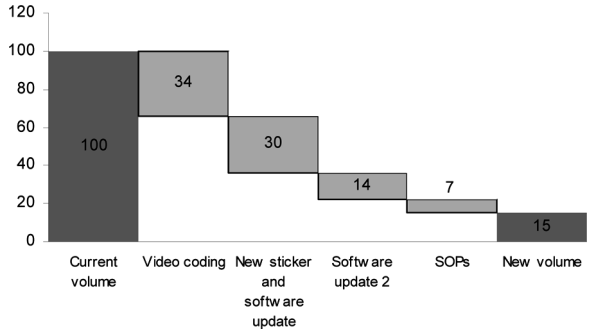

FIGURE 6 **Waterfall chart of the contributions (in percentages) of each improvement domain.**

given. Within the first experiment, each improvement action was tested separately to see whether it resulted in a significant improvement and to estimate its effect on the CTQ.

Next, a new reroute sticker was designed and implemented together with clear SOPs for both the use of the sticker and in particular the positioning of the sticker. The Black Belt tested these improvements in a pilot study. During the pilot study, part of the rerouted mail volume was rejected by the sorting machines due to incorrect use of stickers. Other issues that led to rejection, such as unclear handwriting, were related to the software in use. Based on these results the SOP was further improved and the software was updated once more. The project leader conducted a third and final test of the improved process on six different locations. With this study she proved that 85% of the rerouted mail volume could be processed over the sorting machines. Figure 6 depicts the final contributions of each improvement domain to the reduction in rerouted mail volumes processed by hand sorting.

Spin-offs for these improvements are a reduction in process times in the subprocess handling and a reduction in throughput time of rerouted mail. All of the improvements are to be fully implemented and controlled in the next phase of the project.

Control

In the final control phase of the DMAIC phases the process control is improved. The concrete deliverables in this phase are, among others, a control plan including out-of-control action plans, standard operating procedures, and a control pyramid that hierarchically summarizes the roles and responsibilities of the process control.

The control plan for the rerouting mail project includes two process indicators (see Figure 7); an indicator for correct sticker use that facilitates the machine sorting of rerouted mail (regarding the subprocess handling) and an indicator for the volumes of rerouted mail that are processed over the sorting machines (regarding the subprocess reworking). Each indicator refers to an out-of-control action plan (OCAP) when they are below their control limits (cf. Does et al. 1999). In Figure 7 the details for the specific targets and lower control limits for each indicator are given in the so-called control plan.

For each subprocess (handling and reworking rerouted mail) a control pyramid is defined that assigns the roles and responsibilities in the new process; see Juran (1989) for more details on the control pyramid. The project leader documented the new working procedures for operators and mail carriers and OCAPs for line managers.

Control plan for project Mail Rerouting

CONTROL PLAN

Process: Handling & reworking rerouted mail *Version:* 2.3

Process owner: Mrs. Hendrickx

Measurement	*Who*	*How*	*Where*	*When*	*Reporting*	*Norm / spec.*	*Lower control limit*	*Which OCAP*
Correct sticker use	Regional manager	Sampling with measurement form	Output stream of each team	Monthly	Senior dept. controller	95%	85%	OCAP HPB2
Machine processed rerouted mail	Senior dept. controller	System data	Input stream of sorting machines	Monthly	Manager Sorting hub	85%	80%	OCAP HPS2

FIGURE 7 **Control plan for the two process indicators that are implemented during the Control phase.**

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The project closure consists of an overview of the realized benefits, the benefits to be realized after fine-tuning the software even further, and a discharge form that is signed by the champion and a controller. The project's total realized benefits, based on a post-verification 6 weeks after the implementation of the improvement actions, were more than twice as high as originally stated in the project charter (cf. Figure 1).

CONCLUSION

Structured approaches, such as Lean Six Sigma, have shown to result in reduced operational costs, with improved quality as a spin-off. The approach helped to unravel the problem of high-level operational costs in the process of mail rerouting.

This study provides an application of Lean Six Sigma to postal service. Core principles of the Lean Six Sigma approach, such as problem structuring with the CTQ flowdown and deliberate analysis of the problem, helped the project a great deal to focus on the processing cost per item only. Though one would ideally eliminate all rerouted mail volumes, it turned out that one could take these volumes for granted and could focus on reducing the operational costs of the rerouting mail process.

Furthermore, the step-by-step approach helped to carefully investigate and test several improvement ideas and the various fine-tuning rounds, before it was decided to roll out the new process in all regional offices and sorting hubs.

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