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Master's Thesis

Developing Cost of Poor Quality calculations with emphasis on business impact

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ABSTRACT

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The main aim of this research was to develop cost of poor quality calculation model which will better reflect business impacts of lost productivity caused by IT incidents for the case company. This objective was pursued by reviewing literature and conducting a study in a Finnish multinational manufacturing company.

Broad analysis of the scientific literature allowed to identify main theories and models of Cost of Poor Quality and provided better base for development of measurements of business impacts of lost productivity. Empirical data was gathered with semi-structured interviews and internet based survey. In total, twelve interviews with experts and 39 survey results from business stakeholders were gathered.

Main results of empirical study helped to develop the measurement model of cost of poor quality and it was tied to incident priority matrix. Nevertheless, the model was created based on available data.

Main conclusions of the thesis were that cost of poor quality measurements could be even further improved if additional data points could be used. New model takes into consideration different cost regions and utilizes on this notion.

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To end with, I would like to thank my family, friends and especially my beautiful wife Chinara, her moral support and encouragement triggered my mind to generate the best possible results and this is why I dedicate this work to her.

Helsinki, Finland

May 2016 *Daniel Hollen*

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LIST OF ABBREVIATIONS

ABC – Activity Based Costing

CoPQ – Cost of Poor Qualtity

CoQ – Cost of Quality

CoC- Cost of Conformance

CoNC – Cost of Non-Conformance

ERP-Enterprise Resource Planning

IMP - Incident Management Process

IT-Information Technology

KPI-Key Performance Indicator

P-A-F – Prevention – Appraisal – Failure

PDM – Process Development Model

PQC – Poor Quality Cost

ROI - Return on Investment

R&D – Research and Development

SLA - Service Level Agreement

TQM – Total Quality Management

1. INTRODUCTION

Quality of products and services is important for numerous companies across the globe. The phenomenon of measuring cost of (poor) quality has been widely discussed in scientific literature. There is a good amount of case studies that portray the measurement process of Cost of Quality (CoQ) in the business process concept in service as well as in manufacturing industry; even though the CoQ concept give the impression to be more widely used in the manufacturing than in services industry.

The measurements of scarps, reworks and defects in a manufacturing industry are fairly easy tasks, due to the fact that manufacturing industry produce tangible products, whereas in services, these terms might not even be existent or difficult to measure. The aim of this research is to determine the Cost of Poor Quality (CoPQ) with emphasis on business impacts caused by IT in KONE Corporation. KONE Corporation is a manufacturing company, however this research is done for IT department and the goal is to find a way to measure CoPQ in IT, which is why the author will focus on service part of CoPQ.

1.1. Background

Since 1950´s, managers use quality as an important tool to sustain competitive advantage of company by frequently making decisions to reach the sufficient level of quality of products and services (Schiffauerova & Thomson, 2006; Khaled Omar and Murgan, 2014). Moreover, quality is a vital key strategy to thrive in the highly competitive and customer-driven market which demands high quality at low price. The process of making and measuring quality improvements is directly linked to necessity to improve an organization’s financial position (Yaacob Z, 2010).

However, in every company, in every department and in every project there is a strict budget which should not be exceeded. Thus, measuring Cost of Quality (CoQ) is a vital yet demanding undertaking. Consistent with prior researches and field literature, the CoQ methodology seems to be used significantly more in manufacturing companies rather than in service organizations.

Consistent with previous research (Tatikonda and Tatikonda 1996, Schiffauerova and Thomson 2006, Vaxevanidis and Petropoulos 2008, Wang et al. 2010, Yaacob 2010) while products and services have in common ceratin characteristics, quality of service is harder to define, since the customer is more engaged in the service life cycle. As, when cost of "good" quality is considered, it is quite easy to measure if a product achieves, or not, the set goals according to some set of requirements. In other hand, it is quite difficult to measure if service achieves, or not, the set goals according to customer's opinion. Customer's opinion is nevertheless highly dependent on variety of factors, such as: time, culture, previous experience, mood of the customer and many other factors.

1.2. The case company

The case company, founded in 1910, KONE Corporation is one of the world leaders in escalator and elevator industry. The objective of KONE Corporation is to provide best People Flow® experience through providing well developed solutions that allow people to move easily, comfortably and safely so, that they could enjoy life in modern urban environment. Company provide innovative and industry-leading escalators and elevators as well as state-of-the-art solutions for maintenance and modernization. For a past century, KONE Corporation is dedicated to understanding the customer needs in numerous segments. In 2015, KONE Corporation had annual net sales of EUR 8.6 billion and close to 50,000 employees across the globe (KONE Corporation, KONE in brief, 2016).

KONE IT is the IT department of KONE formerly known as Global Development (GD). KONE IT has over 500 employees and contractors across 28 countries, with main locations in Finland, Belgium, China, USA, India and Italy. KONE Corporation created a new Technology and Innovation unit (KTI) on January 1, 2016. KTI consists of former

Global Development (GD) and former KONE Technology and R&D (KTO) functions KONE IT Quality is part of KTI Development and Support.

KONE IT delivers IT services and related processes to help KONE people to perform at their best and ensure the continuity of KONE's business in all situations, by focusing on:

- Data Center service availability
- Network availability
- Desktop devices availability
- Application availability and performance
- Application maintenance and continuous improvement
- End-user support
- IT security

1.3. Research objectives, problem and questions

The main research objective is to outline an improved CoPQ calculationmethod for IT department which may be implemented as a managerial instrument at the quality management level, bearing in mind the business impacts caused by IT. While creating a calculation method for CoPQ. This research examines the several quality costing methods and reports of their suitability with the aim of providing an enhanced understanding on which Cost of Quality (CoQ) method case company should adapt in order to measure Cost of Poor Quality. Thus, thesis aims:

1. To study Cost of Poor Quality methods and link business impacts of such costs in order to improve CoPQ calculation.

2. To analyse the exact elements of CoQ settings, for instance adaptability and implementation, which may facilitate the creation of cost of poor quality calculations with emphasize on business impact.

In line with these aims, the subsequent research question should be indicated: ***"How the cost of poor quality calculations could be improved to better reflect business impact?"***

Correlation between cost of quality theories and development of measuring method is important aspect of this thesis this why the first sub-question, that should be considered, is:

1. *Which Cost of Poor Quality theory will better reflect trends in IT incident and business impact of the target company?*

Therefore, the second sub-question is:

2. *How Cost of Poor Quality could be better identified and improved?*

As a result of answering these sub-questions, the author will offer conclusion on particular situation in CoPQ calculation and which aspects of calculation should be improved.

1.4. Structure of the thesis

This work holds seven chapters and follows next structure: the first chapter is introduction, which is responsible for providing aims for the research, all essential background information and sets the research questions and objectives. Second chapter defines research and data collection methods. Third chapter offers overview of the academic literature from the field of Cost of Quality. Fourth chapter presents IT incident management process. Empirical study and analysis are presented at fifth chapter. Chapter six provides research results and findings. Deliberation of results, implications and provides conclusion are provided in the final chapter. Further down, at the Figure 1 the structure of the thesis is represented.

INPUT	CHAPTER	OUTPUT
Overall information about topic and thesis	Introduction	Objective of the research, research questions and structure
Methods of the research described	Research methodology	Stages of the research
Literature from the same field of study	Literature review	Essentials concepts and theories
IT incident management description	IT incident management process	Applications of IT incident management
Data collection from Survey and Interviews	Empirical study	Research result and findings
Findings and results	Discussion and conclusion	Answering the research questions and conclusions

Figure 1. Structure of the thesis

2. RESEARCH DESIGN AND METHODOLOGY

The methodology chapter starts by portraying the chosen research strategy and design, describes how the research was performed, further depicts the theoretical study and the empirical study and lastly reviews the quality of the research.

In order to create a better research, the author used a mix of both quantitative and qualitative research methods. According to Eskelinen and Garant (2012), mixed methods are widely accepted in research today. However, the qualitative method was given a preference as a main research method because it was found to be more suitable for this kind of research. Due to this fact, the quantitative part is relatively small. The qualitative part is done by interviewing key experts and stakeholders and then analyzing the results of interviews.

With the aim of finding an answer to the research questions, the author used primary and secondary data collection techniques. The main approach of data collecting was interviews with key IT employees that can be described as matter experts involved with IT quality.

In addition to interviews, a survey was sent to key business stakeholders, mainly change managers, in order to better incorporate business views. According to McDaniel & Gates (2001 p.98), qualitative research means that the research data is not subject to quantification or quantitative analysis. As stated by Saunders et al. (2009), in this kind of research survey can be used as one of the main research tool. This research tool permits both qualitative and quantitative data collection through the survey. Further, collected data can be used to define relationships between variables and produce possible models of relationships (Saunders et al. 2009), which is suitable for the aims of this particular study. According to Hague et al. (2004), research design can feature both qualitative and quantitative research methods for the reason that they can supplement each other.

The qualitative analysis is conducted with webropolsurveys.com own build in survey tool. Survey had both qualitative open questions and qualitative multiple choice questions. Structured and semi-structured survey questions were designed in order to gain valuable information from the target group on the research topic. Structured questions were used mainly to analyse data in quantitative way. Semi-structured and open questions were implemented to gain more in-depth answers about stakeholder's opinions and experiences on the research subject.

> "*Questionnaire surveys are a technique for gathering statistical information about the attributes, attitudes, or actions of a population by a structured set of questions'."* (Kitchin and Thrift 2009, p.46).

The secondary data collection is done by literature analysis. Literature examination offered the overview of main trends at Cost of Quality and Cost of Poor Quality with emphasis on business impact of both for the past years, including specification of the service.

2.1. Data collection

This research is grounded on the survey of 88 change managers as a business stakeholders and semi-structured interviews of key IT experts involved with studied issue. The survey for studying business impacts of poor quality of IT was sent to change managers and it was open from 3rd of March to 12th of March 2016. Current ways of calculating CoPQ as well as identification of important aspect were examined via semi-structured interviews with key stakeholders. The interviews were conducted prior the survey in between January and beginning of February of 2016 with key experts (12 interviews, 12h, and approximately 60 pages of transcribed pages) as strategic respondents. Respondents were selected for the interviews by using three criteria – ability to contribute new knowledge, past experience and knowledge of issue. The questionnaire was developed based on by Saunders et al. (2009) instructions and wide-ranging examination of academic papers in the field. The survey contains questions about various issues of CoPQ and business aspects, such as problems, costs of poor quality etc.

The sample for the quantitative analysis contained 88 change managers and business experts from different countries and regions. The list of regions included all regions where a change manager role exists. The selection of survey recipients was done based on the case company list of change managers. When planning sample for the data collection, only the change managers were taken into consideration, due to their extensive knowledge on the topic. Out of 88 change managers, 39 answered survey which gives response rate of 44.3%.

2.2. Research limitations

This research has few limitations. First the number of experts and other stakeholders who took part in this interviews as a part of research is limited to 12 experts, and, given the nature of research, only few employees had capabilities and expertise to answer research related questions. Second the sample consists of internal stakeholders, IT and business functions, but does not take into consideration all stakeholders (e.g. contractors). Third is lower than 50% response rate from the survey; out of 88 change managers, only 39 answered the survey which gives response rate of 44.3% - this is not an ideal response rate. Further researches may consider stated problem from a different point of view. For example, it is possible to examine business impact of CoPQ on other types of employees.

3. LITERATURE REVIEW

This chapter presents analysis of the academic literature related to the topic *Cost of Poor Quality (CoPQ)* and *Business Impact* and correlation between these two factors. Search for the applicable studies was completed through the several databases, including but not limiting to: EBSCO, Elsevier's Scopus and SpringerLink eJournals and eBooks. Quite many articles were accessed via Sci-Hub due to its easy use and accessibility. The search was done by applying following terms (but not limiting to): “Cost of Poor Quality”, “Business Impact”, “Cost of Quality”, “Business impact analysis”, “Quality calculation”. The specific context of CoPQ and Business impact will be considered more in the chapter Garvinfive.

The cost of quality is extensively described in scientific literature and there is several theories regarding this topic. It is necessary to take into account a number of dominant theories associated with cost of quality in order to provide sufficient theoretical background for this empirical study.

3.1. Quality costs

This study aims to deeper examine factors which affect the business impact of Cost of Poor Quality, however it is necessary to start from the basic concepts. There have been several attempts by researchers to provide suitable and inclusive explanation of the quality costs. Still, according to Machowski and Dale (1998), there is multiple definitions of quality costs and no general agreement on a single definition. However, the cost of quality can be described as a sum of conformance and non-conformance costs. Yet, as stated by David Garvin (1984 p.26), most of the definitions could be classified as it is shown in Figure 2 into five groups.

Transcendent:	Quality is something that is intuitively understood but nearly impossible to communicate, such as beauty or love.
Product-based:	Quality is found in the components and attributes of a product.
User-based:	If the customer is satisfied, the product has good quality.
Manufacturing-based:	If the product conforms to design specifications, it has good quality.
Value-based:	If the product is perceived as providing good value for the price, it has good quality.

Figure 2. Five approaches to defining Quality Garvin (1984 p.26)

3.2. Quality cost models

This study aims to improve the existing Cost of Poor Quality measurement model in an IT department. It is quite well known that Joseph M. Juran was the first researcher who started conversation about the Cost of Quality back in 1951, and since then many other studies have be conducted which offered other methods of measuring cost of quality (CoQ) (Banasik 2009, Ayati 2013). Nearly all researchers, such as Deming (1986), Juran (1993), Feigenbaum (1983), Crosby (1979), maintain that enhanced quality must decrease costs.

Plunkett and Dale (1988) performed an extensive research on the quality related costing models and they determined that, quite often cost reports based on general perception of quality related costs and not following typical P-A-F model. Plunkett and Dale's (1988) findings showed that the CoQ models can be improved by three points. In the first one, categorization of quality costs into prevention-appraisal-failure (PAF) is quite often not enough and depending on industry a possible alternative or even supplementary categorization is needed. The second point is that, definition of quality costs could be specified better, quite often problem is to isolate and identify those parts of the cost which change to the quality and report them separately. As a final point it is important to have the necessary mechanisms in place for collecting quality related costs and it also is necessary for senior management to have the fill to maintained collection and reporting process.

Several studies and literature reviews in CoQ models were conducted in past few decades, most of them focus on manufacturing rather than service industry. Almost all conclude that there is lack of single model which could be called the CoQ model. The CoQ models depend on different set of characteristics, business models and strategies. It is central to briefly describe the most commonly used Cost of Quality models and then subsequently select the Cost of Poor Quality model suitable for this case study. After all, Cost of Quality consists of two parts, Cost of (Good) Quality and Cost of Poor Qualtity Figure 4 (Feigenbaum, 1991).

3.2.1. Juran's model

Joseph M. Juran put forward a theoretical - graphical Cost of Quality (CoQ) model in his 1951 book: *Juran's Quality Control Handbook*. This model served as a foundation for other prospect CoQ models. Juran categorized in his model Cost of Quality into two parts: avoidable quality costs and unavoidable quality costs. Avoidable costs are the costs that would completely vanish when there is no defect in the system. Juran (1951) classified CoQ into basic manufacturing costs to meet the specification, quality control costs, avoidable costs and lastly, inspection costs. Figure 3 displays how Juran's (1951) optimum quality cost is achived. He acknowledged that: "*Increased conformance reduces the losses due to defects. However, the cost of the control is needed for greater conformance rises geometrically as perfection is approached. The optimum is always short of perfection*" (Juran, 1951, p .7).

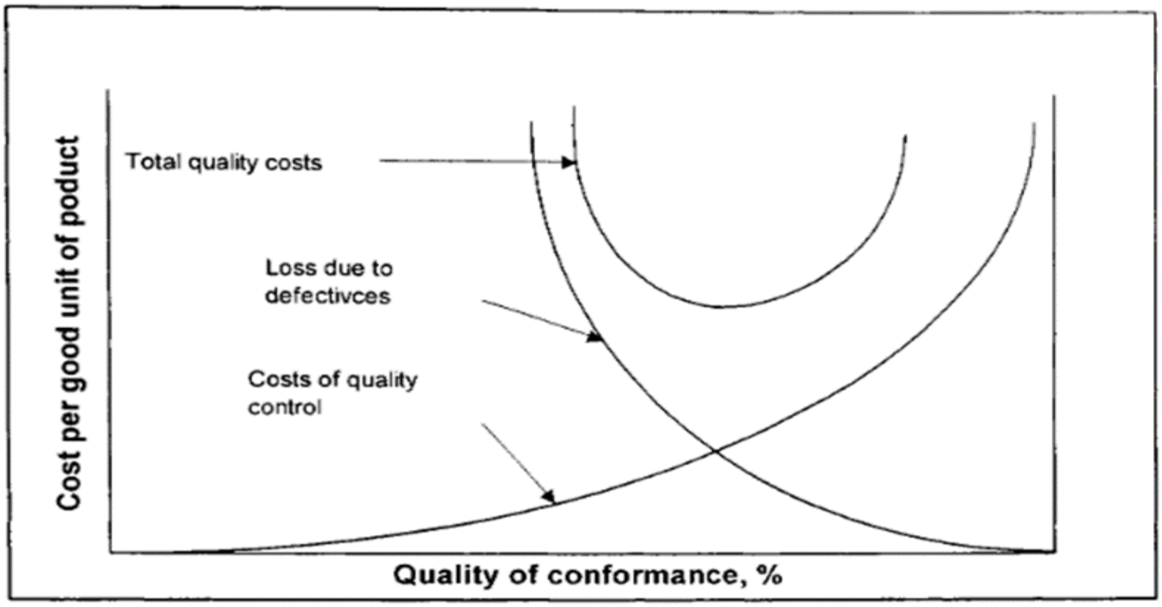


Figure 3. Model for Optimum Quality Costs, Juran (1951 p. 8)

Besides the above well-known model, Juran 1951 presented many important concepts about quality, such as quality reputation, the economics of quality, quality value and more. Schiffauerova and Thomson (2006) stated that the key goal of Juran's model is to find the level of quality which reduces the total quality cost per product. Based on this model, Juran (1951 p.9) referred as the value of quality; "*Value of quality is a composite of (1) value inherent in the design and (2) value inherent in the conformance to that design*". Deliberating more around the fact that is moral obligation to achieve best total quality, Juran (1951 p.34) indicated that there is an economic point for quality where a very high quality can be achieved for the least required quality cost. From this perspective, estimated advantage achieved from decrease of non - conformance costs ("the cost of poor quality") would be beneath the investment in conformance ("good" quality) actions with the intention of reaching higher quality level - "Gold in the mime" (Juran, 1951 p.34).

3.2.2. Prevention-Appraisal-Failure (P-A-F) Models

Armand V. Feigenbaum's (1991) categorization of the Cost of Quality (CoQ) (Figure 4), has two core modules; the cost of conformance (cost of "good" quality) and the cost of non-conformance (cost of poor quality).

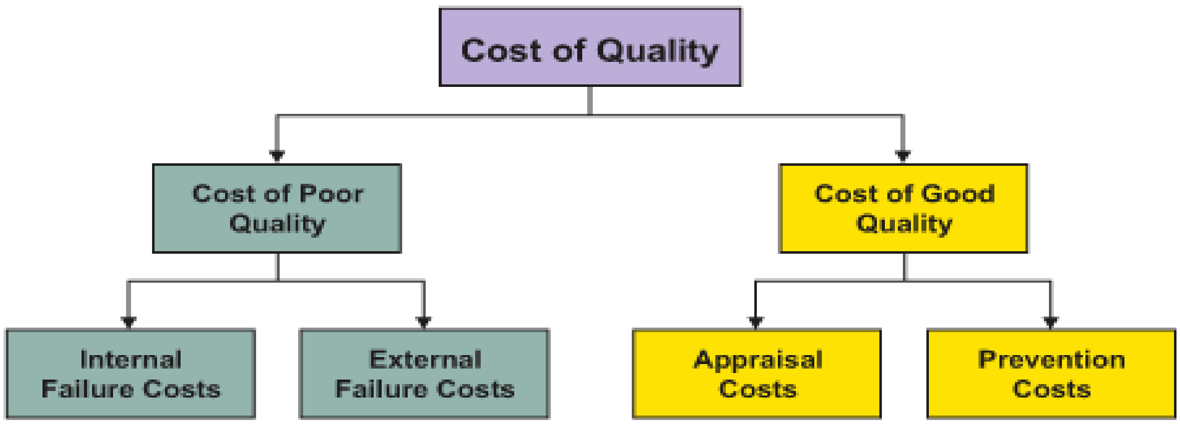


Figure 4. Cost of Quality. Feigenbaum (1991)

In addition to the cost of accomplishing the prerequisite level of quality is the investment made in the prevention of non-conformance (Cost of Poor Quality) to requirements, the cost of testing and appraisals to be comfortable the prerequisite quality levels have been accomplished must be added. In his work Feigenbaum's (1991) divided quality costs to prevention, appraisal and failure costs:

Prevention Costs: The costs related with all actions to investigate, prevent or reduce flaws and failures. These costs are linked to design, implementation, and maintenance of the quality management system and are intended to occur before actual operation.

Appraisal Costs: The cost of assessing, recording and auditing product and service to guarantee quality achieved.

Internal Failure: The costs arising from failure to achieve the quality specified of product or service before product or service is provided to the customer. These costs appear when the outcomes of fail to achieve design quality criteria and are revealed before they reached to the customer.

External Failure: Costs of non-conformance to the requirement when the product or service has been provided to the customer. These costs occur when products or services that failed to achieve design quality criteria are detected only after the customer attained it.

By investing to prevention and appraisal activities, failure cost will be reduced and continues investment in such activities will reduce appraisal costs in long run. In Figure 5, Feigenbaum Quality Cost Framework with software related examples is exhibited.

Cost Area		Description	Software Related Examples
Cost of control or conformance	Prevention costs	Defect avoidance	• Training • Process metrics • Formal inspections ala IEEE 1028-2008
	Appraisal costs	Defect detection	• Reviews • Inspections • Static analysis • Testing • Dynamic analysis
Cost of failure of control or non-conformance	Internal failure costs	Pre-release defect correction	• Requirements rework • Design rework • Code rework • Retesting
	External failure costs	Post-release defects	• Warranty costs • Recall costs • Penalties • Reputational loss • Renewal loss • Follow-on project delays

Figure 5. Feigenbaum Quality Cost Framework

3.2.3. Lesser's model

As stated by Castillo-Villar et al. (2012), Lesser's (1954) model is based on the P-A-F model and he was first scholar who used P-A-F classification for model. Lesser's (1954) classified the quality costs in manufacturing with the intention of categorizing quality costs and hidden quality costs and in order to justify investments in quality he proposed quality costs measurement as a tool. In his work, Lesser (1954 p.11) categorized quality costs to detectible quality costs and hidden quality costs. Hidden cost he defined as:

1. Extra cost due to poor quality planning
2. Production and shipping delays due to defective work
3. Lost business due to a poor quality reputation among customers
4. Inherent product design weakness

3.2.4. Crosby's Model

Philip B. Crosby Model dates back to 1979, according to Schiffauerova et al. (2006 p.1), Crosby's categorization is comparable with the P-A-F model; though, it classifies CoQ into conformance and non-conformance costs. Basically the price of conformance consist of all costs involved in making certain that things are done right at the first time and the price of non-conformance is the funds invested in fixing issue.

3.2.5. Harrington’s Poor Quality Cost (PQC) model

Harrington’s (1987) model is based on the P-A-F model. Harrington (1987, p.5) defines Poor-Quality Cost (PQC) as "all the cost incurred to help the employee do the job right every time and the cost of determining if the output is acceptable, plus any cost incurred by the company and the customer because the output did not meet specifications and/or customer expectations". According to Harrington (1987, p. 157) "Reducing the cost of poor quality will increase your overall profit more than doubling sales".

This model Poor Quality Cost aims at the analysis of cost of poor quality in office environment and not the cost of poor quality in manufacturing environment, as it usually presnted. Harrington (1987, 1999) argued that PQC would help managers to focus of issue of cost of quality even better than the traditional CoQ models. Harrington’s (1987 p.104) idea of model indicator for measuring quality and productivity simultaneously is to measure "*the sum of all inputs divided into the quantity of output that met customer expectations*”. Harrington classifies PQC into three types of costs: Controllable PQC, Resultant PQC, and Equipment PQC. Controllable PQC includes prevention cost and appraisal cost, while Resultant PQC consists of internal and external error costs. Equipment PQC is the total cost of investment in equipment and the space the equipment occupies. Figure 6 describes Harrington's (1987) explains how a maximized ROI can be reached fi-om the PQC curve. Harrington's (1987 p.31) stated that; "*An effective quality system should operate at the point on the curve labeled 'best interim operating point*".

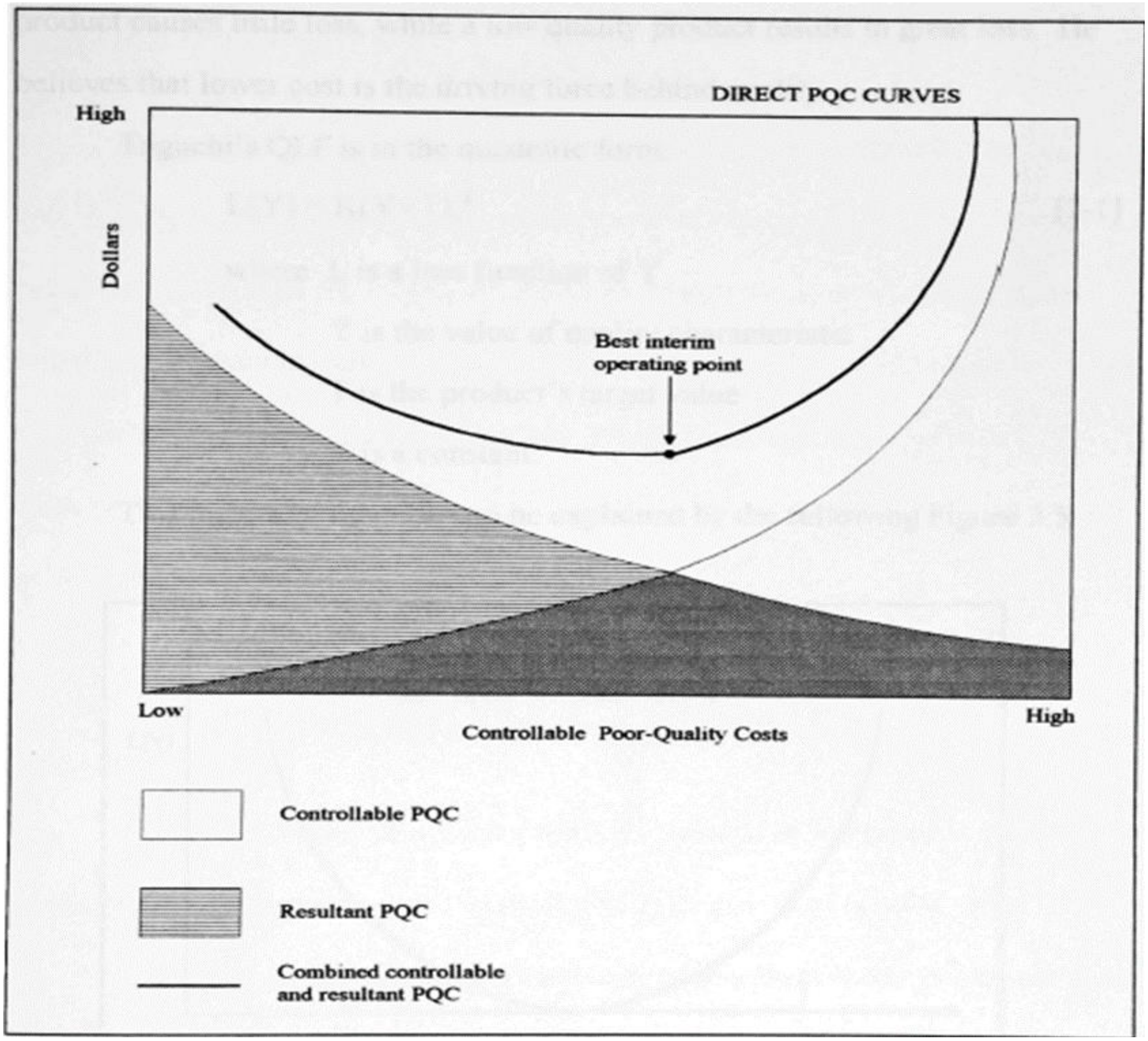


Figure 6. Effect of varying controllable PQC (Harrington 1987, p. 30)

3.2.6. Continuous improvement model

Freiesleben (2004 p.959) stated that; "*with the increasing success of Quality Techniques such as Six Sigma, which show that quality perfection is a desirable objective, the old quality-cost trade-off as propagated by the Cost of Quality Models has to be re-examined*". The first continuous improvement CoQ model was offered by Ittner (1996 p.114-116) proposing that thanks to the comprehensive quality programs and leaner inspection system, companies could achieve the point of reduce non-conformance with insignificant or zero expenses growth Figure 7. Thus, the optimum level will be below perfection. Also this model does not consider progress in technology and it makes it more feasible to find and cure the root of poor quality.

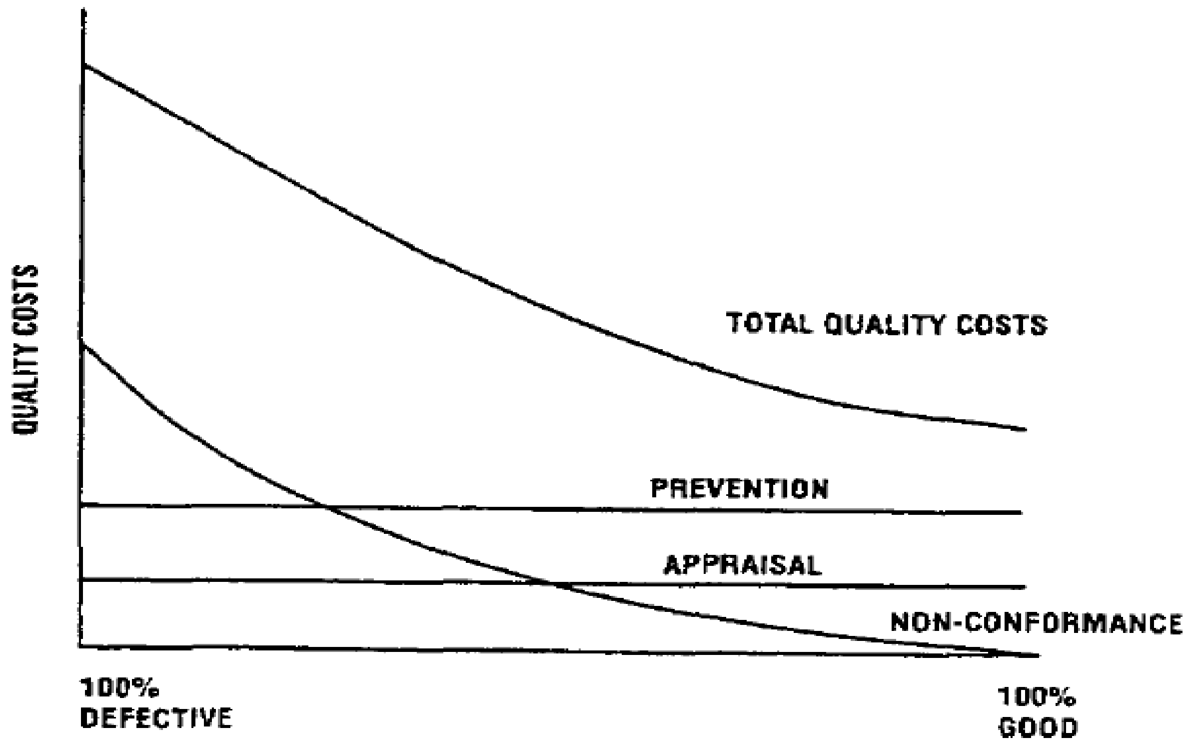


Figure 7. Ittner's (1996 p.115) continuous improvement CoQ model

Freiesleben (2004 p.968) stated that even though "*CoQ models alone can only establish a cost-minimal quality level, he confirmed that in the new CoQ model this cost-minimal quality level is equivalent to quality perfection*" (Figure 8). According to him in real live optimum quality level cannot be concluded from static CoQ models. As a result, Freiesleben (2004 p.964-966) offered a continuous improvement model with three fundamentals components for each phase of the quality program;

1. Technological advancement
2. Continues learning (based previous continuous improvement actions)

3. Uncovering the root cause of problem

Figure 8 portrays three phases of continues development model described directly above Freiesleben (2004 p.965) where the total cost curve reflect development of the costs per unit of good product over time. Freiesleben (2004) makes an assumption that failure cost curve is not affected by the continuous improvement process.

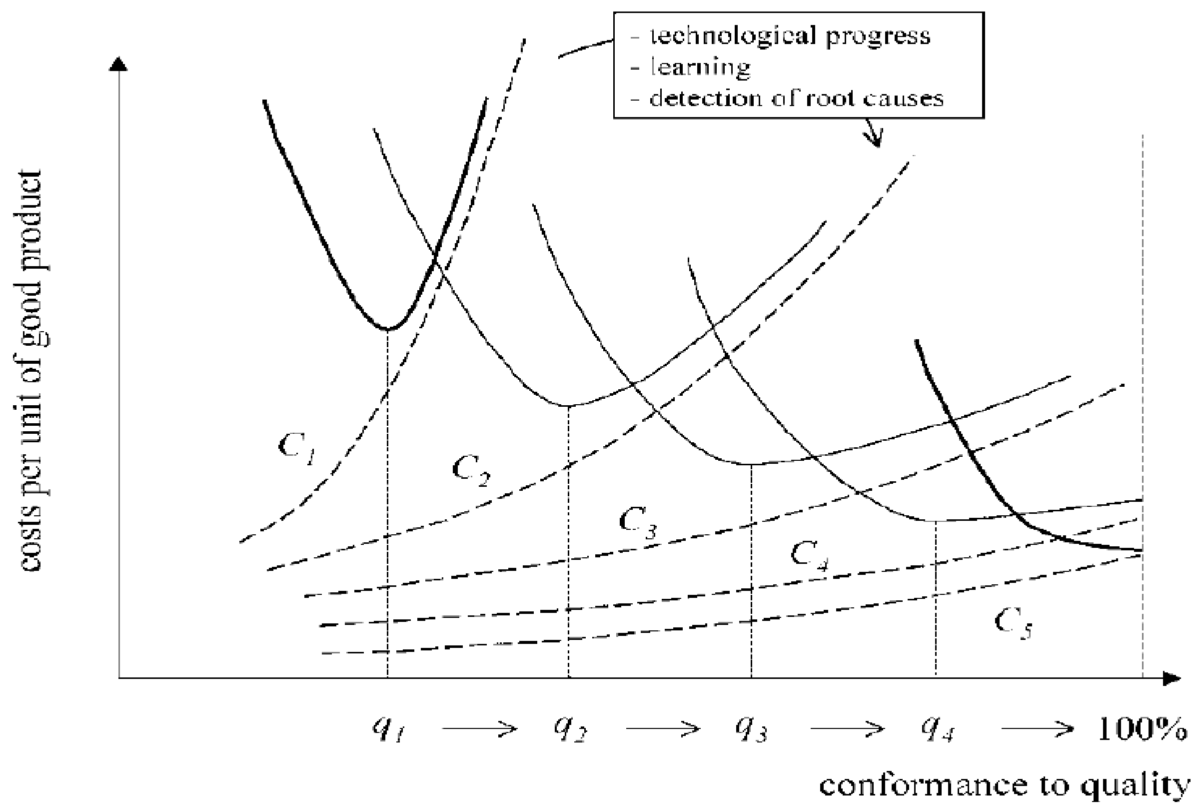


Figure 8. Three phases of continues development model, Freiesleben (2004 p.965)

3.2.7. Lawrence P. Carr's service model

Lawrence P. Carr (1992) presented the Cost of Quality (CoQ) model for the service service companies highlighting that classification of cost of quality in manufacturing and service is different and more challenging in services. Carr (1992 p.72) applied CoQ measurement in the marketing and sales division of U.S. Marketing group (USMG) of Xerox as a part of its operation management system and company received the Malcolm Baldrige Quality Award in 1989. The main alteration concerning Carr's model and the P-A-F model is the categorization of opportunity costs as a cost category. In his model developed for the U.S. Marketing Group, Carr categorized CoQ into conformance, non-conformance and lost opportunity costs and hese different costs are defined in Table 1.

Term	Definition	Example
Costs of Conformance	Necessary expenses associated with meeting customer requirements.	
• Prevention.	The costs to avoid failure.	Training, communications.
• Inspection / appraisal.	The costs to check work.	Incoming inspection, preinstalls, auditing.
Costs of Nonconformance	Unnecessary expenses associated with failure to meet customer requirements.	
• Failure to meet customer requirements.	The costs of redoing work, waste, remakes.	Aborted installs, machine replacement, incomplete surveys.
• Exceeding customer requirements.	The costs of unnecessary "extras."	Response time in excess of customer requirements, overly elaborate presentations.
Lost Opportunities	Profit not earned owing to lost customers and reduction in revenue because of non-conformance.	Cancellation owing to poor service.

Table 1. Xerox Cost of Quality Definitions (Banasik 2009 p.36)

3.2.8. Process cost model

Process cost model highpoints the significance of process cost measurement and ownership. In his work Douglas T. Ross (1977) proposed this model as a computer-aided integrated program to model, and to analyse costs for the manufacturing environment. Total costs of the conformance and non-conformance of a particular process represent process cost.

Vaxevanidis and Petropoulos (2008 p. 276) stated that “process cost model can be developed for any process within an organization, locating all the activities and parameters within the process to be observed by flowcharting the process”. According to Vaxevanidis and Petropoulos (2008 p. 276), diagrammed actions are exhibited as cost of conformance and cost of non-conformance (CoNC) in addition cost of quality is considered in each step of process. Ultimately, crucial issues for process development are acknowledged and enhanced. There is assumption that this idea could assist to spread the model of quality costing to whole enterprise and even service functions. Figure 10 refer to the structure of the model.

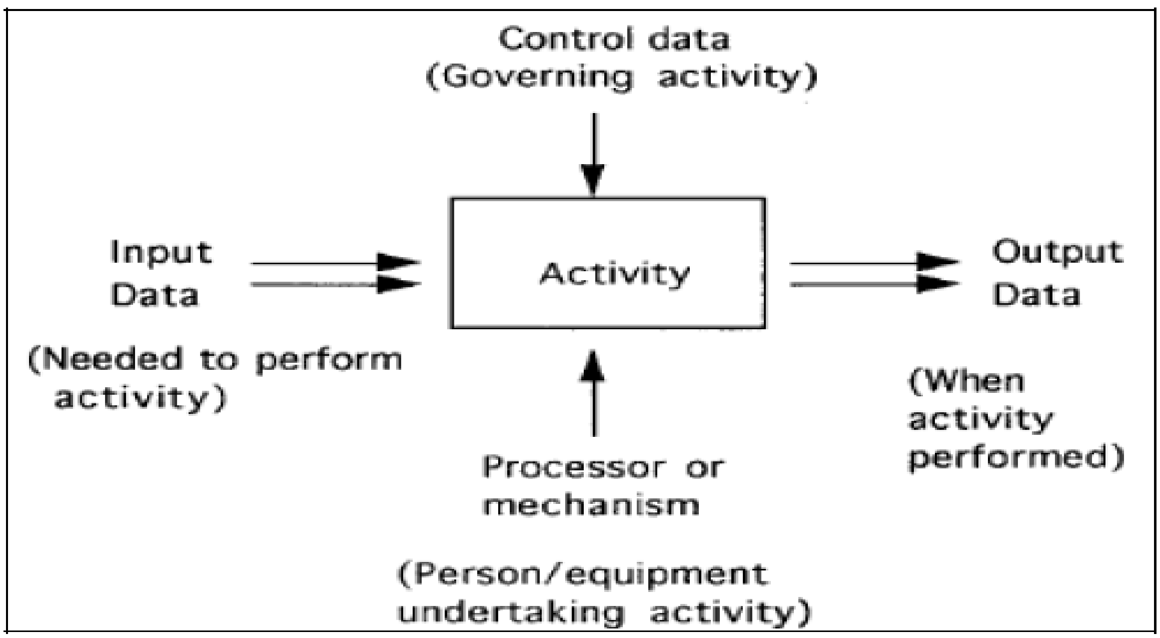


Figure 9. Configuration of the process cost model by Vaxevanidis and Petropoulos (2008 p.276)

The most favored method for quality costing within total quality management (TQM) is process cost model, because it acknowledges the significance of process cost ownership and measurement. In addition process cost model offers a more included method to quality than a P-A-F model. The causes of the quality problems call for more detailed analysis, such as Pareto charts (ASQC, 1987a). The process cost model follows a continuous improvement and can be applied to both service and manufacturing industries.

3.2.9. Opportunity or intangible cost models

According to Schiffauerova and Thomson (2006), both opportunity and intangible costs have been reviewed by several scholars and practitioners, documented cases of successful use of CoQ models and methods is given in Figure 10. Tatikonda and Tatikonda (1996) described in their work that they associate loss of customers due to bad quality of the products on the market with opportunity cost. Freiesleben (2004 p.14) offered several costs which are categorized as opportunity costs e.g. lost sales and reduction of revenue because on non-conformance. Schiffauerova and Thomson (2006 p.16) viewed opportunity costs as costs of losing profit as outcome of losing customers.

Company	*Industry*	*CoQ calculation*	*Base for CoQ calculation*	*Reported gains*	*Reference*
Westinghouse Semiconductor Division, USA		**CoQ = P+A+F (F includes opportunity costs)**		• overall productivity increased by 15% in 4 years • scrap reduced by 58% resulting in savings of over $2,4 million • material returned by customer reduced by 69% resulting in savings of over $600 000	Forys, 1986
Lebanon Steel Foundry, USA	steel casting	**CoQ = P+A+F (F includes Quality Image Loss)**	% of sales	• objective to reduce failure costs by 50%	Moyer and Gilmore, 1979
US Marketing Group of Xerox, USA	service business	**CoQ = P + A + IF + EF + ExR + OC**	% of sales revenue	• CoQ **reduced by $54 million** in first year.	Carr, 1992
Rank Xerox, UK	office equipment	**CoQ = P + A + IF + EF + ExR + OC**	% of total manufacturing cost	• CoQ reduced from **6% to 1%** in 5 years • defects rate reduced by over 75%	Huckett, 1985
Reprographic Manufacturing Operations Unit of Xerox, USA	office equipment	**CoQ = P + A + IF + EF + ExR + OC**	% of the standard cost of production	• CoQ reduced **by 50%**	Morse et al. 1987
pharmaceutical company	pharmaceutical	**CoQ = Operating Cost + CONC + Alternative Cost**		• CoQ reduced **by 11%**	Malchi and McGurk, 2001

Figure 10. Documented cases of successful use of CoQ models and methods Schiffauerova and Thomson (2006 p.12-13)

3.2.10.Juran's revised model

Due to influence of new technologies Juran updated his theory. Juran and Gryna (1993 p.25) thought that best product quality can be reached under limited prevention and appraisal cost, due notion that highly automated manufacturing and the improvements in inspection technologies help eliminating out the defective products under low appraisal cost, new model is shown in Figure 11. According to W. Edwards Deming (1995) "When selling products with poor quality is quite high and best quality point represent zero defect stage, therefore it is important for company to produce zero defects".

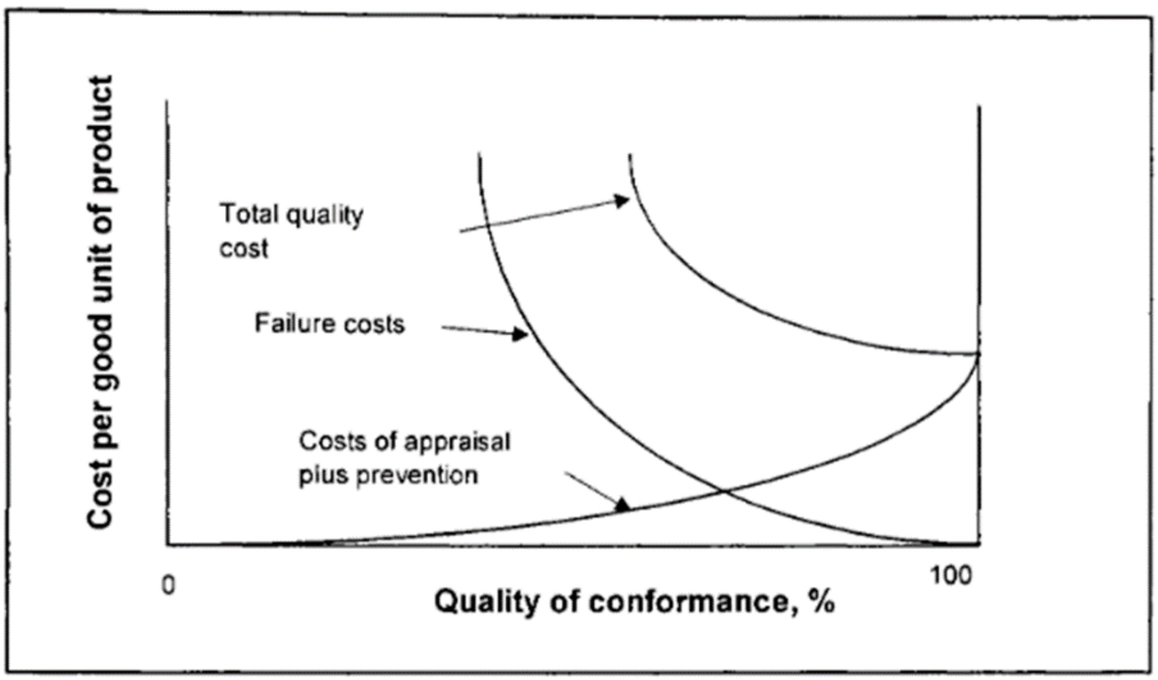


Figure 11. Revised Model of Optimum Quality Cost (Juran and Gryna, 1993, p. 25)

3.2.11.Deming's Model

In 1950, Deming (1986) presented a chain reaction concept related to quality and productivity. He taught this concept in every meeting with top management in Japan. This chain reaction is described in Figure 12. As Deming (1986 p. 168) stated that "Quality can be defined only in terms ofthe agent", he thought quality had different meanings to different levels of employees. Deming developed his model to stress his viewpoints that focusing on quality improvement could lead the productivity improvement.

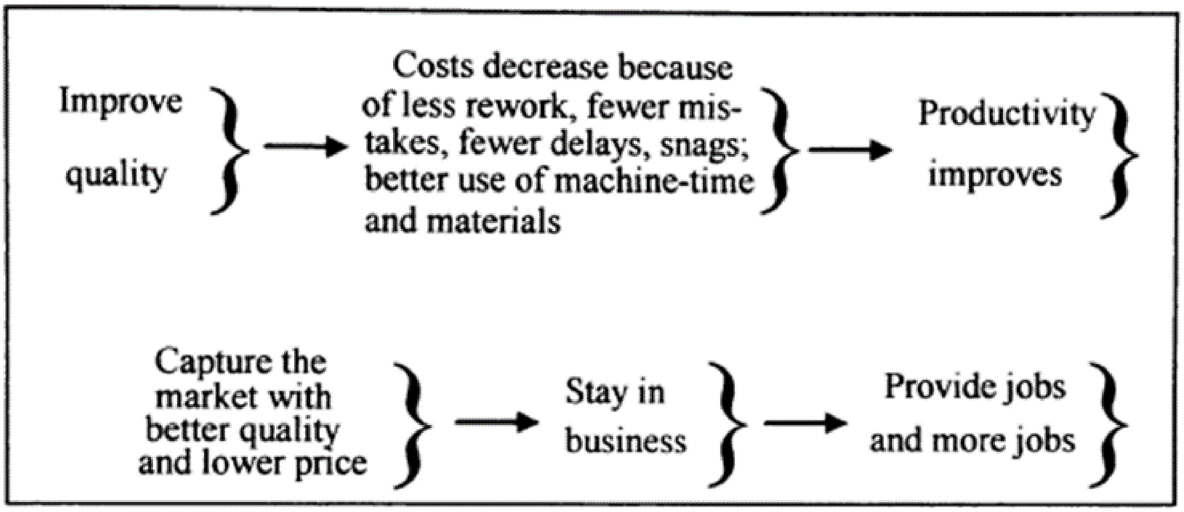


Figure 12. Chain Reaction Related to Quality and Productivity. (Deming 1986 p. 3)

3.2.12. Activity Based Costing (ABC) models

In his work Tsai (1998) suggested an integrated CoQ-Activity Based Costing model (ABC), where ABC and CoQ methods are joined in order to provide shared figures of financial and non-financial data for managing procedures. Activity Based Costing model is not a pure model of CoQ, it is a system recognizes the relationship between costs, activities and products, and through this relationship, it assigns indirect costs to products less arbitrarily than traditional methods. Activity Based Costing methods aim to eliminate non-value added activities with the aim of reduction of defects and waste.

3.3. Cost of quality in service

When searching for cost of quality model for service, the only renowned model what could be found is the Lawrence P. Carr Model (1992) relevant for sercive. Carr (1992, p 72.) applied CoQ measurement a part of operation management system in the marketing and sale division of Xerox (USMG). In his real implementation Carr (1992) demonstrated that CoQ in service is appropriate part of the model of service processes in addition to offering several advantages for Xerox (USMG). In addition, he presented a innovative group of cost known as “the cost of lost opportunity”. When comparing to the P-A-F model, the core divergent among the P-A-F model and Carr’s model is the labelling of lost opportunity costs as a part of own cost category.

Lawrence P. Carr’s service model (1992) classifies Cost of Quality in three categories:

1. Conformance costs (prevention and appraisal) e.g. cost of good quality
2. Non-conformance costs (providing bad good quality in advance and after delivery) e.g. cost of poor quality
3. The cost of lost opportunities e.g. both lost opportunities and cost of poor quality

Carr (1995 p.27) reported the later status of the COQ program in the USMG group of Xerox; there was a marvelous result, "Under this system, the four-year savings were experienced". He pointed out, "By and here to the key success factors that contributed to the initial results, Xerox overcame severe business pressures and organizational distractions that could have diluted any cost of quality effort" (Carr, 1995 p.26).

A case study by Campanella (1999) for the American Society for Quality (ASQ) is a one of the few works related to CoQ in service sector which can be found. This work mentioned in general terms to business cases of service enterprises that have applied cost of quality method and unfortunately this study just give a general overview and mention general results without any key details.

Within service industry most of the business cases of CoQ are in the software companies. Campanella (1999) gives a clear classification of these costs bearing in mind that even though the product in service industry is insubstantial and model of product life cycle is demonstrated as it can be observed in Table 2.

Cost Area		Description	Typical costs
Cost of control or conformance	Prevention cost	Defect avoidance; quality basis definition; project and process oriented interventions	Efforts to define quality and set quality goals, standards, and thresholds; quality trade-off analysis; definition of release criteria for acceptance testing and related quality standards; training; process metric creation and planning; formal inspection
	Appraisal costs	Defect detection; discovery of product non-conformance; finding the level of non-conformance	Quality control gating processes, contract or proposal reviews, quality audits, go-no go decisions, quality assurance of subcontractors, inspections, static/dynamic analysis, testing, walk-through, desk-checking
Cost of failure of control or non-conformance	Internal failure costs	Pre-release defect or anomaly correction prior to delivery to the customer	Recode, retest, re-review, re-document, requirements rework, design rework
	External failure costs	Post-release defect or anomaly correction and related costs after delivery to the customer	Warranty support, resolution of complaints, reimbursement damage paid to customer, domino effect to reputation or enterprise, added marketing to correct reputation problems, penalties.

Table 2. Costs of quality charecteristics for characteristics Campanella (1999)

3.4. Literature summary

As a conclusion, regardless of academic arguments about flaws of Juran's revised model and Prevention-Appraisal-Failure model, these two models are still dominating within practitioners who, despite all critic towards these models, find them most suitable. Similarly, CoQ and CoPQ can be calculated from two different viewpoints: one is putting production lifecycle as a long term business strategy (thus measuring product performance) and other is taking a short-tern business strategy viewpoint and calculation business process performance.

Even with their restrictions, the conventional quality cost models built on Prevention-Appraisal-Failure model cost groups are broadly recognized by the quality practitioners (Wang et al, 2010). According to Tye et al 2011, these models are restricted within the physical and directly quantifiable costs and are fail to deal with other cost areas for instance lost sales, loss of customer trust, loss due to low morale of employees etc. (Snieska et al. 2013). Many of the cost elements were not acknowledged, quantified or examined further in this approach (Jafari and Rodchua, 2014) and do not sufficiently evaluate the invisible or hidden quality related activities. Hidden costs are hidden profits and will provide a tremendous opportunity for improvement (Krishnan et al 2000, Krishnan 2006) on proper tracking and analysis.

As stated by Schiffauerova and Thomson (2006 p.1) cost of quality models in services industry exist to match the business requirements of the companies to turn into an "*effective systematic instrument in a quality management program*". For that reason, before trying to create some quality related business strategy in services industry, it is essential to recognize what kind of services business offers. There is a quite large variety of service companies, with different business requirements and this is why it is so difficult to create a single cost of quality model. For instance, while software companies are categorized under the service sector, they still use product life cycle model. Consequently, same model might not apply to all in a manufacturing or consulting company where the production of services follows an absolutely divergent pattern.

Customer satisfaction is a key measurement and cost of quality indicator in service, where manufacturing industry is keener to measure failure costs like imperfections or errors. According to Campanella (1999) this can be observed in large companies where low costs of quality could hide opportunities of improvement.

Karg et al. (2011) piloted a methodical literature review of research linked to software quality, examining 60 articles published between 1980 and 2009. As a conclusion they found out that roughly two-third of all examined articles did not present any case study or limited empirical results. This findings points out to inadequate data and that software cost of poor quality research could be improved. This is why Karg et al. (2011) recommends stronger collaboration amongst business and academia to make such information available.

4. IT INCIDENT MANAGEMENT PROCESS

This chapter describes KONE’s IT Incident Management process. It is a generic description of the roles, responsibilities and procedures required for effective common IT Incident Management process in KONE’s environment. Incident Management process is in a key role for determining business impacts of poor IT quality and how it can be measured.

Purpose of IT Incident Management process is to make sure that all IT related incidents are logged, categorized, prioritized and assigned to appropriate support group. Incidents are investigated, diagnosed and resolved in such manner that normal operation level is restored as fast as possible.

IT Incident Management process is utilized in all parts of KONE IT. This process covers any incident, external or internal, which impacts directly or indirectly on the service provided by KONE IT or by KONE IT service providers. In the end, incidents could have impact on KONE business and this why it is important to have IT incident management process. All incidents are recorded into the KONE IT Service Management Tool.

4.1. KONE IT Service Management

KONE IT service is a collection of capabilities offered to KONE businesses in order to ensure efficient business operations and innovations. KONE IT services are delivered through combination of business applications, people and processes that are used to enable the KONE IT mission. IT service support management include several key activities and from this research prospective important activities are managing and resolving incidents. KONE IT mission is to help KONE people to perform at their best.

4.2. Introduction to IT Incident Management

The main objective of the IT Incident Management process is to restore normal service operation as fast as possible and lessen the adversative impact on business operations, as a consequence guaranteeing that the highest possible levels of service quality and accessibility are sustained. “Normal service operation” is defined by KONE as service operation within Service Level Agreement (SLA) boundaries.

In addition IT incident management KPIs are recording total number of incidents, correct assignment rate to the appropriate resolver group first time, total number of major incidents (trend line), total SLA for incident resolution, financial impact of incident on business (CoPQ) and more.

Incident management provides ability to record and resolve incidents. Recording and resolving IT incidents in controlled way results in shorter disruption to the business and higher availability of the service.

The KONE definition of an *incident* is as defined in KONE IT Service Handbook: “*Any occurrence which is not part of the normal operation of a service and which causes, or may cause a disruption to, or a decrease in the quality of that service.”* For End users incident definition is: “*Something doesn’t work.*”

The KONE definition of *Incident management* is defined in KONE IT Service Handbook: “*The process accountable for managing the lifecycle of all incidents. The key objective of incident management is to return the IT service to normal state.*”

In the end is important to verify incident resolutions with end users when requested by 2nd level support team. Benefits of IT incident management include:

- Minimized time to restore normal service operation
- Reduced impact on business operations
- Higher level of service quality and availability
- Improved end user and stakeholder satisfaction

4.3. Process flow chart

The Process flow chart was taken from KONE QPR portal: Management and Support – Manage Company – Manage Processes and Solutions – Manage IT Solutions – Service Transition and Operations – Incident management and is described in Figure 13 below:

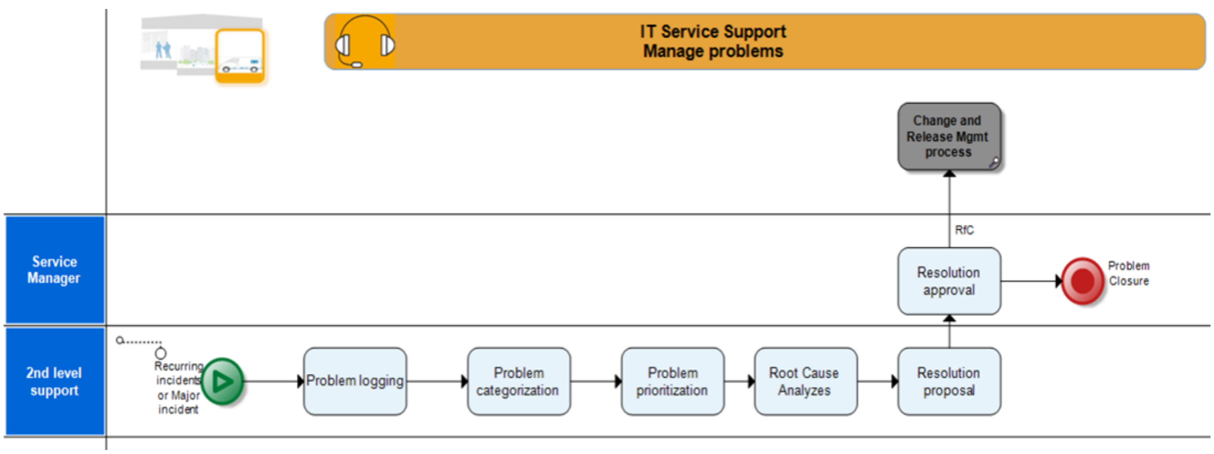


Figure 13. Process flow chart

Process starts when incident or major incident occur, first step is to contact GSD via one of the contact channels described earlier in this chapter. When GSD is contacted they firstly log the issue, it is necessary to capture as much vital information about incident as possible in this stage in order to solve issue fast and in quality. After incident is logged, it is categorized and the prioritized according to priority matrix (Table 6). Next step is to assign to a support team for resolution or try to solve it based on instructions in best guide. If future software related changes or updates required then necessary changes may be applied in next release and then follows change and release management process. More detailed activities will be described in next chapter: 4.6. Incident Management Process Activities.

4.4. Incident Management Process Activities

The process activities to be followed throughout the management of an incident are listed in the table below:

Activities	Description
Incident logging	• Log the basic details related to incident
Classification and initial support	• Categorize the incident • Match the Incident against the knowledge base of issues (Knowledge Base, KB) • Assign a priority • Assess its related configuration details • Provide initial support and resolve incident if possible • Close the incident ticket or direct it to the support group
Investigation and diagnosis	• Assessment of incident specifics • Gather and analyse the information and resolution • Use knowledge base (KB) if needed • Assign the Incident to appropriate support group if needed • Contact users if more info needed
Resolution and recovery	• Use a resolution or a workaround • Raise priority of a Service Request if needed (mainly GSD) • Raise a Request for Change if needed (mainly 2nd or 3rd level support teams)
Incident closure	• Confirm the resolution when required special confirmation

Activities	Description
	• Close the incident
Incident ownership, monitoring, tracking and communication	• These all are the activities that surround monitoring the incident, escalating it when needed, informing the user of the latest status, key accomplishments and next steps.

Table 3. Incident Management Process Activities

4.5. Roles and Responsibilities

In order to understand KONE IT Incident Management process it is important to examine process roles and responsibilities. This subchapter will examine vital KONE process roles and their responsibilities for this process.

End user – user of Business IT services or services provided by KONE.

Key User - A key user is a recognized expert of one or more KONE Way solutions in terms of process and tool understanding. This role exists at unit, area and global level. The key user is the primary support person for their dedicated solution. KONE Way solutions cover all aspects of the business.

Global Service Desk (GSD) – GSD is responsible for a single point of contact (1st level support) to the end users. Service Desk is the incident owner throughout its lifecycle. Service hours in English and Mandarin 24/7 and other languages 7:00 -17:00 local time.

Tasks of Global Service Desk are:

- Log incidents into the Service Management tool in English
- Provide initial support in defined languages

- Classify incidents
- Route incidents to support groups as appropriate
- Take care of the initial investigation and diagnosis when applicable
- Participate on major incident communication with major incident manager
- Act as the resolver for incidents that are not passed to the 2nd level support
- Ensure that actions to resolve incidents are captured and documented
- Inform all parties about progress of incidents
- Confirm resolution of identified incidents and close the incident ticket

Contact channels- GSD may be contacted using following channels:

- Call: always in high priority cases and when other channels are not available
- Email: lower priority issues and information sharing
- Chat: suitable for cases that will likely require clarification
- Portal: primary channel due to self service capabilities

The GSD response times are subject to the contact method.

Contact method	Target Response Time
Email	95% of emails are responded within 2 hours
Call	80% of GSD calls are answered within 30 seconds
Portal	Immediate
Chat	TBD

Table 4. GSD Response time

Support group - The support group is the 2nd and 3rd level support of assignment following the service desk. Support group can be an internal group or supplier's external group. Support group is responsible for resolving the incident in order to restore service in accordance with the Service Level Agreement (SLA).

Service Manager - The service manager is responsible for the effective implementation and reporting of the IT incident management process. Service manager is the 1st level of escalation for incidents.

Tasks for service manager are:

- Is accountable for all open incidents within their area
- Identify pro-actively incidents, which are at risk of being breached within set SLA's and take appropriate preventive measures
- Provide statistical information
- Act on statistical data to initiate problem management and continuous improvement actions
- Identify improvements to the incident management process with service management office
- Coordinate and manage the incident solving over the organization and support groups

Service Management Office (SMO) – is a cross-functional team accountable for service integration and operational efficiency. Goal of SMO is to create solid foundation for IT service management (ITSM), owns the ITSM processes and ensures process alignment.

Tasks for service management office are:

- Make certain that all IT teams follow the incident management process for every single incident
- Develop and maintain the Incident Management System

Major Incident Manager - Major incident manager is accountable for the coordination and management of major incidents, including:

- Maintain the major incident communication plan
- Facilitate the maintenance of the major incident recovery plan
- Facilitate system restoration calls
- Update progress of major incidents
- Coordinate and manage the major incident solving over the organization
- Participate in major incident reviews

4.6. Incident prioritization

Incident prioritization will determine on which priority order the incident is handled by support. Prioritization can be determined by bearing in mind equally the urgency of the incident and the level of business impact it is producing. Aspects that can add to incident impact levels are:

- The loss of service(s)
- The number of services affected
- The level of financial losses
- Impact to production lines in factories
- Influence on business reputation
- Regulatory or judicial breaches

- Infrastructure service level
- Solution criticality

4.6.1. Impact Definitions

Incident impact is defined by KONE standard definition is as follows in Table 4:

Impact	Definition
1 – Enterprise	Any problem that affects business wide productivity and/or call centers and/or factory sites
2 – Site/Dept	Any problem that affects a Site or Department and/or any problem that affects multiple users at KONE shared Service centers
3 – Multiple Users	Any problem that affects multiple users from different sites or departments
4 – User	Any problem that affects a single user

Table 5. Impact Definitions

4.6.2. Urgency Definitions

Urgency is defined as a measure of speed needed to resolve an incident. A high impact incident does not necessarily have an immediate urgency.

Urgency	Definition
1 – Critical	Any issue causing major business disruption or a system failure of any one Critical Service
2 – High	Any issue affecting the business operation and loss of one Service which makes the business performance or continued performance of any one system impossible

3 – Average	An individual hardware or software issue where no manual Workaround exists and which makes the performance or continue performance of any one or more system functions difficult and which the End User cannot circumvent or avoid on a temporary basis.
4 – Low	A non-critical issue where a Workaround exists and a documented Error or a limited condition that is not critical exists that the End User may circumvent.

Table 6. Urgency Definitions

4.6.3. Priority Matrix

Prioritization takes into concern mutually the urgency of the incident and the level of impact it is producing. Priority matrix is used to identify the priority of the incident. The Priority Matrix is shown in the following table:

Priority		**Impact**			
		1 – Enterprise	2 – Site/Dept	3 – Multiple Users	4 – User
Urgency	1 – Critical	1 – Critical	2 – High	3 – Average	3 – Average
	2 – High	2 – High	2 – High	3 – Average	3 – Average
	3 – Average	3 – Average	3 – Average	3 – Average	3 – Average
	4 – Low	4 – Low	4 – Low	4 – Low	4 – Low

Table 7. Priority Matrix

4.6.4. Priority and Resolution Time

These Service Level Agreement (SLA) targets are defined in the supplier's contract and there might be different targets with different suppliers. All services need to have a defined target response time, and target resolution time defined for each priority codes. Response time measures time between the tickets is created and until it is on status "Work in progress" (*). Example for reference:

Priority Code	Target Support team response time*	Target Resolution Time
P1 – Critical	15 minutes	4 hour (24x7)
P2 – High	15 minutes	8 hours (24x7)
P3 – Average	1 hour	16 hours (5x10 Mon-Fri)
P4– Low	1 hour	32 hours (5x10 Mon-Fri)

Table 8. Example of SLA targets

4.7. Status of incidents

Incidents must be followed during the course of their lifecycle to support appropriate handling and reporting on the status of incidents.

Incident Status	Description
New/ Open	• Ticket is created
Assigned / Accepted	• The ticket is assigned to a support group
Work in Progress	• When a support individual opens a ticket assigned to him/her or to the support group he/she belongs to, the status will be automatically moved from "Assigned" status to "Work in Progress" –status. The response timestamp is set. • This is a measure of the response SLA.

Awaiting User/ Pending customer	• This status is used when the support individual is waiting inputs from user. • Support individual asks information 3 times from customer. If a customer doesn´t answer, ticket will set as resolved.
Awaiting 3rd party / Pending vendor	• This status is used when the support individual is waiting inputs from supplier.
Resolved	• This status denotes that the issue is resolved and is awaiting End User confirmation. Ticket remains resolved status for 5 days, during which it can be re-opened, in case the issue recurs. • Once the Ticket moves to "Resolved", the Resolution Timestamp is set and this is a measure of the "Resolution SLA".
Closed	• This is the final state in the ticket lifecycle. The status change from "Resolved" to "Closed" happens automatically after 5 days in the Service Desk –system. • Once the status is changes to "Closed", the ticket cannot be re-opened again.

Table 9. Status of Incidents

4.8. Key performance indicator for incident management processes

According to KONE incident management processes the key performance indicator is a set of parameters that is used to support achievets of a process, service or activity. Key performance indicator KPI's are selected to ensure the efficiency, effectiveness and cost effectiveness. KPI's are reported for example daily, weekly or monthly.

KPI	Description
New incidents	Number of incidents raised within the period
Number of open incidents	Volume of open incidents within the period
Number of closed incidents	Volume of closed incidents within the period

KPI	Description
First call resolution	How many percent of incidents are resolved at first call
Incidents caused by changes	Number of incidents caused by applying a change
MTTR	Mean Time to Resolve incidents
Critical (P1/P2)	% Critical Incidents (Priority 1 and Priority 2) from all incidents
Open > 5 days	Backlog trend – long tail incidents
SLA target	How many percent of incidents are closed at SLA target
Reopened incidents	Number of reopened incidents
Reassigned incidents	Number of reassigned incidents > 3 times
Customer satisfaction survey	Customer satisfaction of all closed incidents

Table 10. KPI's for Incident Management Processes

5. EMPIRICAL STUDY

In this chapter results found during the course of research are presented in several categories based on theme related to specific issues. In the beginning author discuss current way of calculating CoPQ in KONE and then data collection and analysis. Then the author presents findings by presenting results of research by theme issues.

5.1. CoPQ at KONE

All KONE departments measure, collect and report statistics about cost of poor quality. Every month CoPQ measurements from all departments are gathered to one document and then results is sent to top management. Results are reviewed in the Quality and Environment Board and KONE Executive board. Currently KONE measures CoPQ by gathering information about Cost of Non-Conformance (CoNC) which includes three indicator areas: rework, project work and lost productivity from all departments. Below is more detailed description of these three areas in case of KONE IT:

Rework measures bug and defect fixing by applying next principal: Cost of one incident (support costs divided by number of incidents during 8 months) multiplied by incidents resolved in the month. In this case cost of one incident is preset as 580€.

Project work measures project delay. The project delays are measured by comparing original planned K5 date and planned budget to actual cost when K5 was given and how many man dates were used by actual K5. The K5 gate indicate permission to start roll-outs after a successful pilot.

Lost productivity measures incidents impacts on productivity. Where each priority is given a value to show the magnitude of the incident; priority 1 = 50000€, priority 2 = 5000€, priority 3

= 200€, priority 4 = 100€. These values are multiplied by the number of each priority incident tickets.

5.2. Data collection and analysis

As it was stated previously in Chapter 2, empirical findings of this work are based on the survey and semi-structured interviews. Firstly it is important to presents the both research methods and setting of how research was conducted. The profile of respondent and time frame of research is also presented.

Semi-Structured interviews

As stated by both Remenyi and Williams (1998) and Yin (2013), interviews are one of the most frequently used methods to collect data in a case study. In addition, in their book Bryman and Bell (2011) argue that when it comes to qualitative interviews, semi-structured interviews are most suitable with the benefit to be flexible and where the interview can adjust its focus to the most important issues if situation requires it. As stated by Strauss and Corbin (1990) qualitative techniques can be used to better apprehend any singularity regardless of extend of previous research on the topic.

In this work, author deliberates outcomes of this analysis as different “points of view” that exemplify how different stakeholder groups view business impact of poor quality. As suggested by Strauss and Corbin (1990) content analysis of the data collected (12 interviews, 12h, and approximately 60 pages of transcribed pages) was done as part of model creation process. A key contribution of this research is providing an empirical basis for better understanding and improving the concept of Cost of Poor Quality in case company.

The interview began with background information question where interviewees told they name, job description and experience of working years in KONE at the current position and similar positions. The list of job titles and dates of each interview is shown in Table 11 below. When it comes to educational background majority, 9 respondents, had some sort of technical or engineering degree and 3 of respondents had some sort of business degree.

Job title	Interview date
Senior Expert SAP Operations	19.02.2016
Service Manager	18.02.2016
Service Architect	16.02.2016
Process Development Manager, Quality	15.02.2016
Specialist	15.02.2016
Global Process Owner, Delivery	10.02.2016
Manager, End User Support	08.02.2016
Service Manager	08.02.2016
Service Manager and Planner	08.02.2016
Head of Computing	03.02.2016
Service Manager	03.02.2016
Expert	29.01.2016

Table 11. Background information from interview

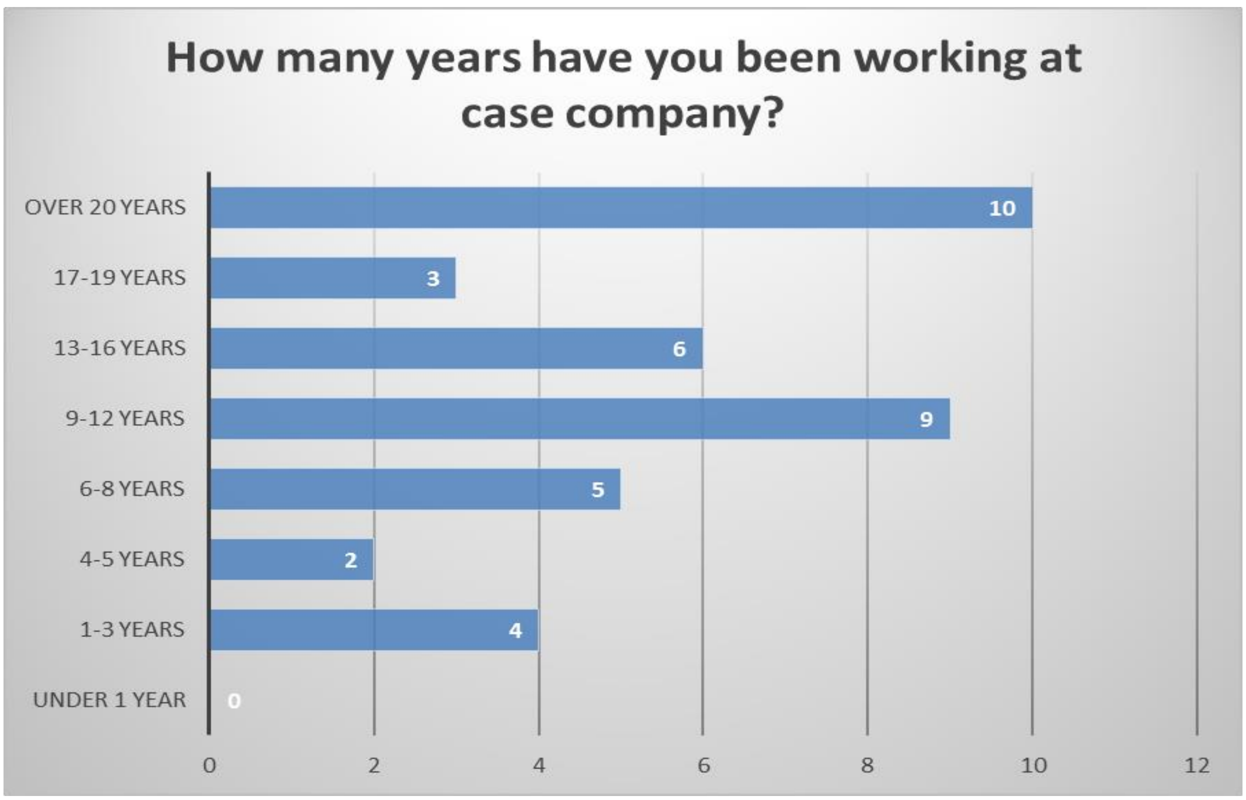
All except one of interviewees had worked for KONE more than 5 years, however not always in the same position. All interviewees can be considered as expert practitioners in their own respected field. Majority of participants had at least some sort of experience with IT related quality.

Survey

The survey was sent all in all to 88 participants, participants were chosen based on their possible contribution to research topic and knowledge of impacts on a business. Almost all participant are change managers working around the globe in different functions of case company. The aim of this survey was to understand better the business impacts of non-working IT to business and how familiar these concept is to change managers.

The survey was sent to change managers on the 3rd of March, 2016 and it was open until 12th of March, 2016. Two reminders were sent, first one on 7th of March and final one 10th of March 2016. Out of 88 change managers in the end 39 answered the survey, which give response rate of 44.3%. Participation in this survey was anonymous and survey consisted of 13 questions. Out of this 13 question first 3 where background information related quantifiable questions and other 10 where related to research topic.

Figure 14 reflects ratio of how many years employees worked in organization. Great majority of the employees have worked for company over 5 years at the same time, only 6 out of 39 worked for 5 or less years.



Collected data allowed examining of how many years employees worked as a change managers (Figure 15). The data in Figure 15 shows that out of total number of respondents (39), 31 had worked under 5 years in current position. All except one worked in same position under 10 years and only one employee had worked over 15 years in the same positon.

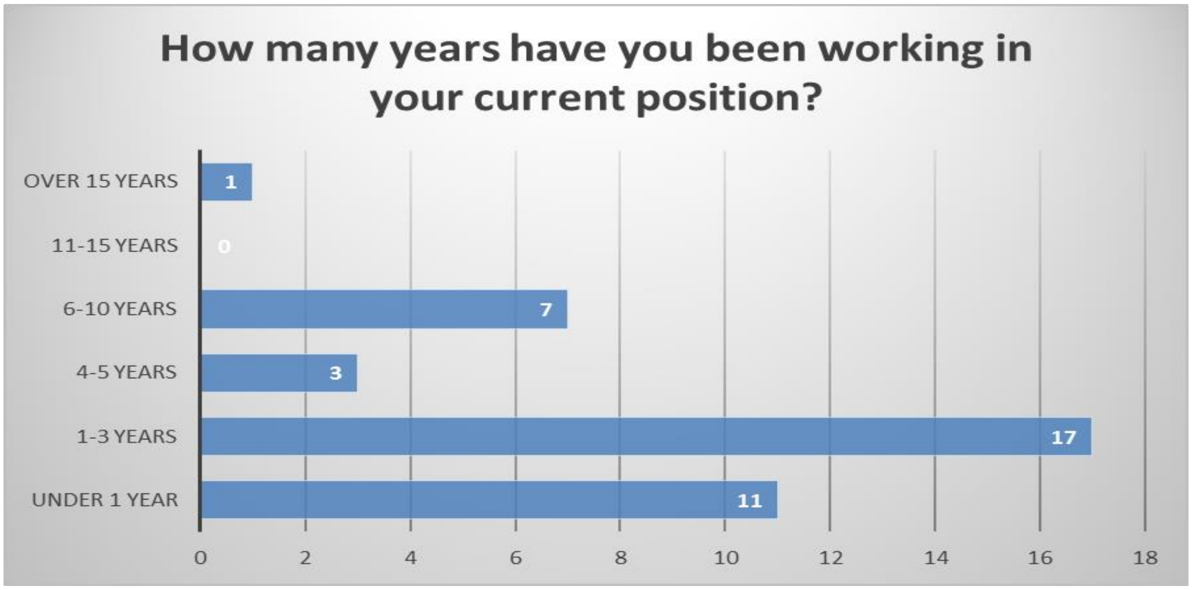


Figure 15. Years worked as Change Manager Position

The third background question revealed that only 11 out of 39 change managers had previous work experience in a similar position from outside of case company (Figure 16).

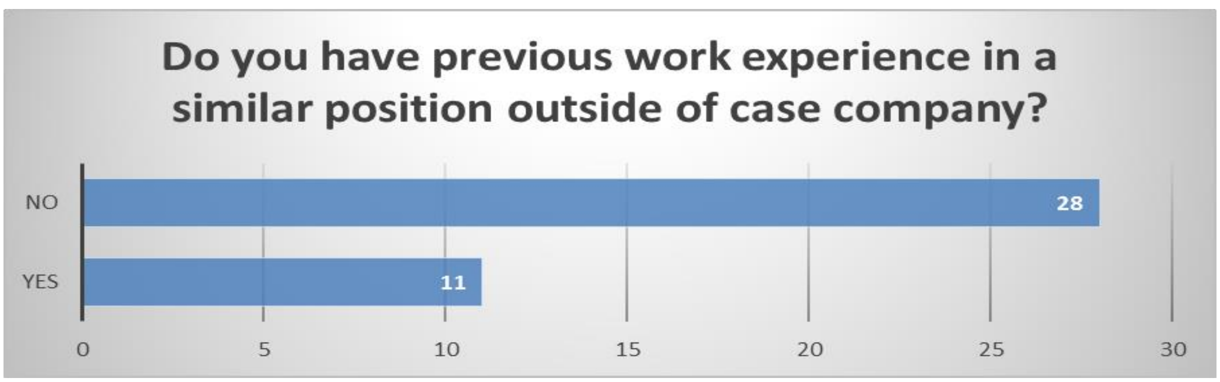


Figure 16. Previous work experience in a similar position

5.3. Business impacts of IT incidents

In the beginning it was important to establish the participants overall view on business impacts of IT incidents. It is essential to know how important and severe participants view the business impacts of IT incidents in order to properly asses the issue. Both survey and interview was constructed so that information about business impacts of incidents could be obtained both from IT experts and business function represented by Change managers.

When the answers from survey question about severity of business impacts of IT incidents presented in Table 12 closely examined it can be observed that there are four (4) different statements. In all four (4) statements participant could select their answer on scale from 1 to 5, where 1 represented very low business impact and 5 very high business impact. For this question the number of respondents was 39, meaning that all respondents answered this question.

	1 Very Low	**2 Low**	**3 Neutral**	**4 High**	**5 Very High**	**Total**	**Average**
A) Business impacts of IT incidents in general	0	3	7	25	4	39	3.77
B) Business impacts of major IT incidents	0	0	0	12	27	39	4.69
C) Business impacts of minor IT incidents	1	14	13	11	0	39	2.87
D) Business impacts of other, non-incident tickets/issues (e.g. Service requests)	1	11	14	13	0	39	3
Total	2	28	34	61	31	156	3.58

Table 12. Severity of business impacts of IT incidents

As it is evident from Table 12 it become apparent that in statement A) Business impact of IT incidents in general, participant gave average grade of 3.77/5.00 which fall closer to

“High” business impact. These clearly shows that business impact of IT incidents in general is view as significant by change managers. As well, according to all experts interviewed, overall business impact is quite significant, of course if always depends on type of incident, systems and application effected.

In the statement B) Business impact of major IT incidents, participant gave average grade of 4.69/5.00 which fall closer to “Very High” business impact. Noticeable, lowest grade given for this statement was 4 – “High”, this makes it clear that perception of major IT incidents throughout case organization is quite the same on this issue. This answer backed up initial hypothesis that major IT incidents has severe effects throughout the organization. In this case when author asked about “Major IT incidents” all participants knew what this term mean due to common companywide terminology. The interviewed experts where united in opinion that major incidents have major effect on overall business and operations.

In the statement C) Business impact of minor IT incidents, participant gave average grade of 2.87/5.00 which fall closer to “Medium” business impact. The term “minor IT incident” means such an IT incident were only one or few employees affected.

When it came to minor incidents even the interviewed experts where quite divided on this issue. Almost half stated that minor incidents in there nature poses minor threats and mainly has minor effects on overall operations. The other part of experts viewed minor incidents as a possible signals for upcoming major incident or simply by having large number of similar minor incidents same level of operations could be effected as by major incident.

In the statement D) Business impacts of other, non-incident tickets (e.g. service requests) participant gave average grade of 3.00/5.00 which fall directly to “Medium” business impact. In line with Campanella (1999) cost of quality have been usually highlighted the nonconformance costs and is this why CoPQ could include non-value adding operations such as dealing with service requests.

Evident that D) business impacts of other, non-incident tickets/issues grade 3.00/5.00 was according to finding slightly greater than C) Business impact of minor IT incidents which was 2.87/5.00. This result is a bit surprising, after all minor incidents could negatively affect few employee and service requests effects could be minimized much easier by better planning.

Interviewed experts acknowledged the facts that non–incident tickets e.g. service requests, indeed cause lost productivity and can have some negative factors, such as negative effects on work morale. The non-incidents tickets can’t really be included into “poor quality” definition. Non-incident tickets include different types of non-incident related requests, such as service requests. Service requests usually consist of requests for minor changes that represent lower risk such as request to change a password, request for information or jsut a request to install software to computer. This why non-incident tickets can be considered as a part of CoPQ and more as a part of cost of “good” quality.

5.4. How business impacts of IT impacts are measured?

When it came to interviewed experts, even they had different views on how and what to measure. All interviewed experts knew how the CoPQ is measured, at least in general level.

One of the survey questions asks if participants know how the assessment of priority levels for IT incidents is done in case company. All 39 participants answered this multiple choice survey question. Following Figure 17 illustrates that only 8 (20.5%) out of 39 participant know how the assessment of priority levels for IT incidents is done, this mean that 31 (79.5%) of participant don’t know this.

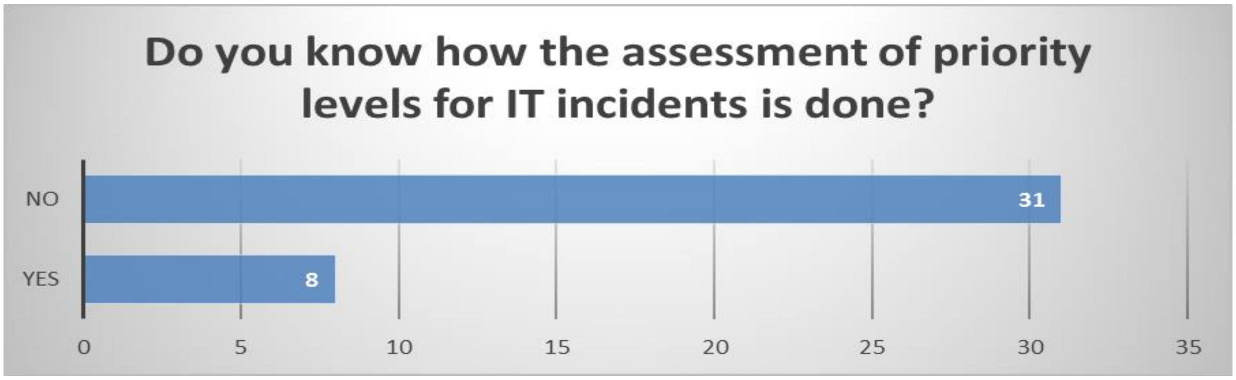


Figure 17. Priority levels for IT incidents

If participant answered yes to previous survey question they could tell in more detailes how assessment of priority levels is done. Totally 11 out of 39 participants answered this question, which is one more than 10 “Yes” answers for previous question. Typical answers by topic could be put in three different groups:

- Amount of users effected (+ criticality of the solution) (6)
- Based on impact level (3)
- Prioritizing incidents by: High, Medium, Low (2)

At the same time one respondent added: “How priorities are assigned and managed is not clear”. Those respondents who claimed that they knew answered in line with next quote: “Priority set by the users when creating the ticket.”

5.5. Impacts of lost productivity

In the survey the question related to impacts of lost productivity was asked in order to establish the change managers understanding of how lost productivity (CoPQ) and its business impact are measured in case company. This was first open-ended question in the survey. It allows the respondents to present their own arguments and better understand participants’ true knowledge of the issues. It must be noted that not all participants decided to reply all questions, Due to possibility to skip survey questions, some participants, chose to skip questions. In this question related to measuring impacts of lost productivity, only 29 out of 39 participants answered the open ended question.

When answers of 29 participants analysed they could be clustered into two groups. In first one, with total 17 (out of 29) participants had some idea on how CoPQ (lost productivity) is measured. However, second group, 12 (out of 29) participants had no idea or they didn't possess enough information, whether CoPQ is measured at case company today nor what the metrics are. When only looking at these numbers it was quite obvious that when 12 out of 29, which is 41.4% of all answers, these are incapable of answering this question, it could indicate that there are some communication issues when it comes to promoting reduction of lost productivity. If lost productivity (CoPQ) and its business impact would be better communicated the hypothesis is that issue could be better addressed.

When group one is closely examined who had some ideas how lost productivity is calculated we can see that participants had several different ideas how it is done. Majority 7 out of 17 proposed next way of calculating lost productivity for IT incidents:

Lost productivity = Lost Work (Hourly cost for calculating the impact) + Lost profit

Other similar examples for calculating the cost of lost productivity for IT incidents proposed by participants looked like this:

Lost productivity = Lost Work + Lost profit + Dissatisfaction costs

and

Lost productivity = Employee Hourly Rate * Employee Impacted * Number of Hours impacted

In addition to ideas for calculating lost productivity for incidents, one participants proposed idea on how lost productivity of non-incident IT tickets (e.g. service requests) could be calculated:

Lost productivity= Lost (working) time + Employee satisfaction + Employer brand

In second group even if participant didn't have enough information or was not sure on how lost productivity is exactly calculated, some still had some ideas. For example one participant answered as follows: "I have no information, whether this is measured today and if yes, what the metrics are. What is considered an IT incident? If it's an unplanned down-time of an IT system / a tool, it would probably be the number of hours employees can't do their work and the costs arising from it. Moreover you have to take into consideration the loss from invoices that can't be created or sent out to customers and a delay of incoming payments."

5.6. Reduction of business impact

Another survey question asked participants to help with ideas on how case company could reduce business impact of IT incidents. 30 out of 39 participants answered this open ended questions. Again comments could be clustered in several groups which can be observed in Table 17.

Comment type	Number of respondents
Quick fix, have clear procedure to have fast resolution	7
Improve processes	5
Workarounds	4
Improve communication, good communication (in advance if possible) is a key	4
Have back up plan	4
On-site support	3
Better testing	3

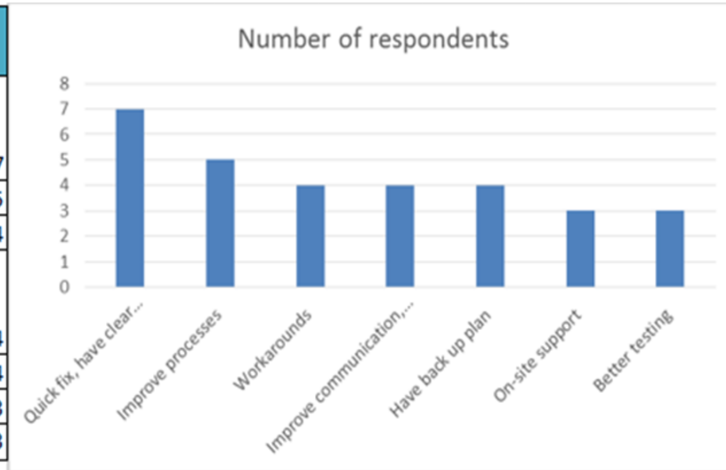


Figure 18. How business impacts of IT incidents could be reduced

Survey question number 7 ask for opinion from participants; if some quality related issues/problems more important than others. All 39 participants answered the multiple choice question. Figure 19 clearly shows that all except 3 participants think that there is different types of quality related issues and they all have to some extent different effects.

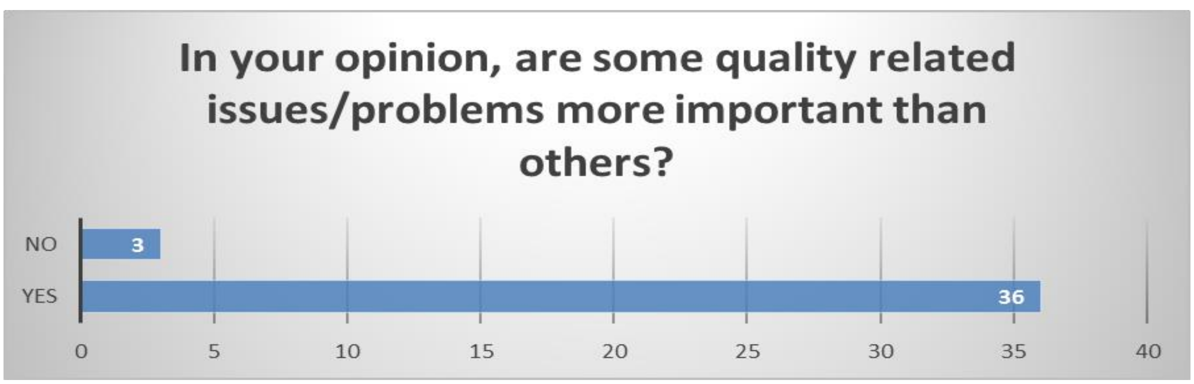


Figure 19. Importnace of diferent quality related issues

5.7. Priority levels of IT ncidents

Survey question number 10 ask if there is a possibility for a mistake in the assessment process. 35 out of 39 participants answered the multiple choice question. Majority of participants, 25 out of 35 (71.4 % of all participants) agreed that there is indeed a possibility for mistakes in the assessment process.

Figure 20. Possibility for a mistake in the assessment process

Survey question number 11 ask if participants to specify their answer if they answered "Yes" to the previous Question 10. In this question only 26 out of 39 participants answered the open ended question. Clustered by topics answers were split to following three aspects:

1. Misunderstandings or limited understanding of the issue (GSD, users or by someone else) (14 times mentioned)
2. Complexity of the issue + Human factor (13 times mentioned)
3. Mistrust of competence towards GSD (5 times mentioned)

5.8. Measuring and reporting CoPQ

Question number 12 asked participants to specify any other factors that should be considered when evaluating the business impacts of IT incidents in case company's IT department. All-in-all 20 out of 39 answered this question. When open ended question was analysed the next typical answers by topic were presented, in brackets is number of participants with similar view:

- Possible influence to customer relationship (4 times mentioned)

- Weekday and time of the month (3 times mentioned)
- Size of business impacted (3 times mentioned)
- Publicity of impacted business/ Loss of reputation (2 times mentioned)
- Cost of customer delay (2 times mentioned)
- User base (2 times mentioned)
- Backup plan (1 time mentioned)
- Clearer communication (1 time mentioned)

In addition two answers with no specific advice and a general feedback was provided by participants.

The last question (Question 13) asked if participant have any other comments, questions, or concerns. Only 10 participants out of 39 answered the last question. Over-all this question gathered constructive feedback such as: "*Our company relies so heavily on technology, we need to have dedicated people to manage and support our devices and processes that do so. Further, we need to not rush to implement new technology before the proper testing, and training can be implemented*." In addition some gave constructive feedback about current way. The comments included views as: "*IT is service for business, they should performance more proactively to help users*" and other participant stated "*I would like to see that issues are taken seriously and if they take place people responsible on applications take personal responsibility, find the root cause and communicate how in next time this is avoided.*"

5.9. Business impact of non-incident tickets

The business impact of non-incident tickets are out of cope of this research due to the fact that experts and change managers alike found them to be not a part of CoPQ. Even so, the non-incidents tickets could have significant impact on business, if key users are affected. This can be an interesting topic for further research.

5.10. Summary

The Figure 21 shows that Cost of Poor Quality is viewed by company as a costs of underutilization, rework, support and lost productivity. This research was however focusing mainly on lost productivity part of CoPQ.

Figure 21. Four categories of CoPQ

In order to achieve better results and decrease overall cost of poor quality KONE need to engage employees in process of understanding composition of CoPQ and how it effect on company, department and personal level. By helping employees realize the issue, company could empower them to do more to improve overall quality. One of the main finding was that business impacts of lost productivity and incidents are in general poorly communicated, especially to the business. Taken together, IT’s role is company such KONE is to support business. Communication is vital in order to engage business in improvement process.

6. DISCUSSION

The main objective of the study was to develop cost of poor quality calculation method which will better reflecting business impacts of IT incidents. The theoretical analysis of the literature helped to isolate key elements influencing Cost of Poor Quality and business impacts of it. These findings are presented in this chapter.

According to the findings, more precise measurements for cost of poor quality will provide more reliable data, which could portrait more accurate picture as well it may increase probability of getting more reliable information about overall trend of business impacts of CoPQ in IT.

6.1. CoPQ calculations

When it comes to CoPQ calculations, measuring the cost of poor quality is done for purpose of quantifying costs and following overall trend, but most importantly for taking corrective actions. In order to take control of actual costs it is important to set goals and then measure how well goal was achieved. The Figure 22 illustrates that blue bars represent actual cost of poor quality and green line represent target.

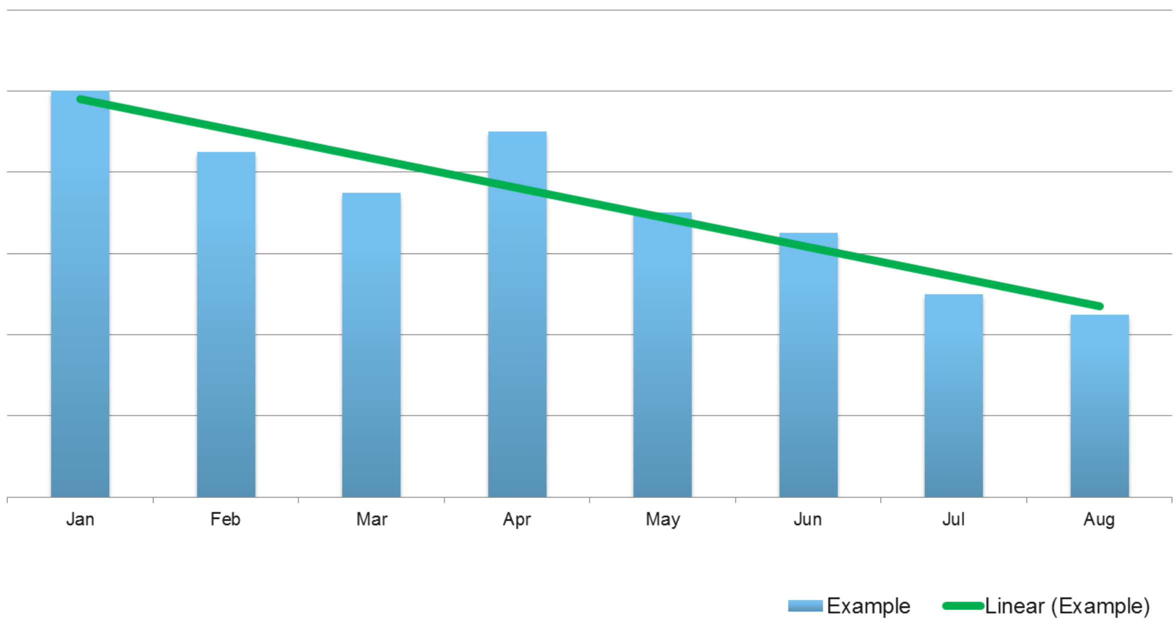


Figure 22. Example of trend and goal setting for CoPQ

6.2. Proposed model

Based on business impact analysis and several expert statements obtained in course of interviews, the proposed model of the total cost of poor quality of lost productivity is the sum of the prevention costs (P), appraisal costs (A), cost of lost opportunity (CO), and cost of labor (CL). After additional consideration based on research results and expert statements cost of labor was divided based on country of operation. Countries are clustered into two regions based on costs: low cost countries (LCC) and high cost countries (HCC). With this adjustment the proposed model is as follows:

CoPQ = P+A+CO+CL (LCC/HCC)

After model was proposed and accepted by the commissioner, the proposed model was used to calculate CoPQ of lost productivity caused by IT incidents. The following Table 13 shows the actual monetary values of each incident based of selected priority level and region. Then these values are multiplied by the number of each priority incident. Each priority is given a value to show the magnitude of the incident. This model utilize Priority Matrix presented in Table 6 as a tool for determine real cost of poor quality related to lost productivity. At the same time Priority Matrix (Table 6) perfectly illustrate severity of business impact of incidents, by combining impact level and urgency factors.

Priority Level	Region A	Region B
P1– Enterprise	50,000 €	50,000 €
P2– Site/Dept	5,000 €	5,000 €
P3– Multiple Users	200 €	100 €
P4 – User	100 €	50 €
Region A	High cost	100%
Region B	Low cost	50%

Table 13. Proposed model

As it can be seen in Table 13, the values for priority level 1 and 2 are not affected by regions, this is based on fact the priority 1 and 2 incidents effect multiple regions and this was are not bound to one region.

This model, which was based on existing model, was created because there was a need for simple and accurate model which could estimate magnitude of CoPQ of IT incidents on productivity. These model provide a good picture of overall trend and general cost of poor quality. Moreover this improved model can be easily used and minor incidents are more accurately calculated. In addition to this model one other model was proposed for future implementation and can be examined in next part.

6.3. Sugestion for future CoPQ calculation model

The previously proposed model is based on current capabilities and available data. In future when additional information points could be accessed via ERP (Enterprise Resource Planning) system, the real cost of major incidents could be calculated. At the moment there is ongoing KONE IT ERP project. IT ERP is an initiative, which aims to deliver a one-stop-shop solution to support KONE IT core processes including portfolio, project and resource management, IT service management as well as enabler processes such as finance, sourcing and quality management. The aim is to simplify and organize the way of working every day at KONE IT to serve KONE's business, resulting as increased efficiency throughout the company and higher IT services end user satisfaction.

For this calculations we need to know the cost of incident during office hours and costs of incident during out-of-office hours. Where cost of incident during office hours consists of down office hours multiplied by number of users effected multiplied by 50 € and multiplied by level of impact. Costs of incident during out-of-office hours is 10% of office hour costs, the 10% estimations comes of notion that during out-of-office hours there are still approximately 10% of employees, mainly maintenance workers, working and using IT. The price of 50 € is an estimated cost of lost productivity per hour of one employee.

Real Cost of Major incidents (P1 and P2) = Cost of Incident during office hours + Costs of Incident during out-of-office hours

Based on this general model, fallowing calculation model was proposed:

Real Cost = (((Down Office hours x Number of Users) x 50 €) x *A %) + 10% of Office hours costs x (((Down Office hours x Number of Users) x 50 €) x *A %)

***Where A% = Level of impact:**

- **A% = No impact = Loss of productivity is 0%**
- **A% = Limited = 30%**
- **A% = Performance issues = 60 %**
- **A% = Full outage = 100 %**

The impact level (A %) illustrates loss of productivity factor in four categories: No impact (0%), Limited impact (30%), Performance issues (60%) and Full outage (100%).

If these model is used, real cost of major incident could be calculated accurately, as it can be seen in next example:

Real Cost = (((5h x 1000 users) x 50 €) x 30%) + 0 (No Costs of Incident during out-of-office hours) = 75 000€

The minor incidents with priority level 3 and 4 will be calculated as in previously proposed model, see Table 14. The overall cost are calculated by adding overall costs of all incidents.

Priority Level	**Incident tickets**	
	Region A	**Region B**
P1	Real Cost	Real Cost
P2	Real Cost	Real Cost
P3	€ 200.00	€ 100.00
P4 and P5	€ 100.00	€ 50.00
Region A *	High cost = 100%	
Region B *	Low cost = 50%	

Table 14. Proposed future model

*List of countries included into Region A and B can be fiend in Appendixes D

6.4. Analysis

Results of the study produced concrete calculation model, model for future implementation and interesting way how incident management process can be used in order to determent business impacts of lost productivity. The originality of this study is revealed in the deliberation of cost of poor quality and business impact in KONE Corporation.

This research meant to answer one main question and two sub questions. As it turned out in the analysis of the literature, Cost of Poor Quality theories mainly focus on manufacturing industry and there is less information about service related cases. In consequence, the first research sub question was:

“Which Cost of Poor Quality theory will better reflect trends in IT incident and business impact of the target company?”

Literature review revealed several factors, including factors effecting cost of poor quality. Research findings showed significant influence of the traditional P-A-F model over all other theories. According to the scientific studies, e.g. Campanella (1999) it is essential to recognize development opportunities in services industry it look like to be more useful to measure customer satisfaction instead of assessing failure costs for instance errors or defects. As a result of empirical study, some factors related to quality showed significant influence in contrast with other factors. In order to deeper examine this issues, the second sub question of the study was:

"How Cost of Poor Quality could be better identified and improved?"

This question is answered in Chapter 6, where extensive deliberation on this topic is done. To sum-up, the identification and improvement suggestions are made based on empirical study and apply for case company.

The main question of the research was:

"How the cost of poor quality calculations could be improve in order to better reflect business impact?"

Research findings revealed positive influence of both measuring minor and major incindents in context of CoPQ in case company. Yet, examination of the academic literature revealed various distribution of theories. This may be explained by the nature of the issue, that traditionally cost of poor quality are associated with manufacturing and not service, which does not cover all directions of this particular IT department. After all KONE IT is not a service company itself but a department which function is to support business. "*The value of a good quality reputation is unbelievably high. To the sales force, a good quality reputation is a matchless tool for competition*" (Juran, 1951, p. 24).

Results of the study revealed most important issue of measuring CoPQ – is to show overall trend and provid capabilities for tracing the progress. Where major incidents obviously has major inpacts on overall business, minor incident should also be closely monitored and initiatives to prevent minor incidents from happening should also be considered in future. The proposed model, as well as a proposed model for future implementation both tackle the issues of main question and provide practical solution for it. At the same time, the most accurate model developed could not be implemented due to unavailability of data for such measurements at the moment.

7. CONCLUSIONS

Examination of the literature review revealed deficiency of data about business impact with Cost of Poor Qulaity. Therefore, literature analysis of the study create an additional dimension to the empirical study in regards about case company's CoPQ conduct and measuring IT incident activities. This research contributes to company's Cost of Poor Quality in IT incidents due to desire to improve quality of information reflecting IT Cost of Poor Quality. For company, predominantly in IT, with their particular business supportive functions and challenges in rapid incident management, it is important to recognize the value of factors, which may possibly considerably effect their incident measuremnets and cost of poor quality in general. By utilizing incident Priority Matrix and available data inputs calculation model was created.

In order to really tackle the issue of cost of poor quality and manage the cost besides the reporting the actual costs it is also important to communicate effects of the incidents in general in order to raise awareness of the issue. Major incidents and related costs to business are currently well understood.

However, when it comes to minor incidents same level of attention should be put into. The effect of single minor incident is indeed quite small, but amount of minor incident generate bigger cost than major incidents combined. In addition to that, series of minor incidents, as it was found during interviews with experts, may be indicators of bigger issue and even lead to major incident.

Because of set limitations, this study has emphasis on business impact of CoPQ. Future research possibly will deliver more exhaustive thought of the business impact of deliberated above factors on Cost of Poor Quality in case company. As an example, futher research in hiden cost related to cost of poor quality may be done. Mapping and indettification of the hiden costs will help to create set of action in order to reduce this costs.

REFERENCES

Ayati, E. (2013). Quantitative Cost of Quality Model in Manufacturing Supply Chain (Doctoral dissertation, Concordia University).

ASQC Quality Costs Committee; Jack Campanella, chairman. 1987b. Guide for Reducing Quality Costs. Milwaukee, Wisconsin: American Society for Quality Control. Second Edition. 79 p. ISBN 0 - 87389 - 029 – 9

Basak, P. C., & KG, V. (2015). Costs of quality: Exploratory analysis of hidden elements and prioritization using analytic hierarchy process. International Journal of Supply and Operations Management, 1(4), 489-506.

Banasik, M. B. S. B. A. (2009). A study of the costs of quality in a renewable resource environment (Doctoral dissertation, Texas Tech University).

Bryman, A., & Bell, E. (2015). Business research methods. Oxford University Press, USA.

Campanella, J. (1999, January). Principles of quality costs: Principles, implementation, and use. In ASQ World Conference on Quality and Improvement Proceedings (p.219, 507). American Society for Quality.

Carr, L. P. (1992). Applying cost of quality to a service business. Sloan Management Review, 33(4), 72.

Castillo-Villar, K. K., Smith, N. R., & Simonton, J. L. (2012). A model for supply chain design considering the cost of quality. Applied Mathematical Modelling, 36(12), 5920-5935.

Crosby P.B. (1979) Quality is Free, McGraw-Hill, New York, NY.

Deming, W. E. (1986). Out of the crisis, Massachusetts Institute of Technology. Center for advanced engineering study, Cambridge, MA, 510.

Deming, W. E. (1995). Out of the Crisis (Cambridge, MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study, 1986). Sharron Walker is an administrator at Queen Creek High School in Mesa, AZ. She has a doctorate in educational administration from the University of Arizona in Tucson. Walker is a member of ASQC. Excellent Circle, 373.

Eskelinen, J. & Garant, M. (2012). Information Retrieval among Undergraduate English Translation Students at the University of Helsinki.In: Arab World English Journal. 3, 1, p. 201-222 21 p.

Feigenbaum, A.V. (1956), “Total quality control”, Harvard Business Review, Vol. 34 No. 6, p. 93

Feigenbaum, Armand V. (1991), Total Quality Control (3 ed.), New York, New York: McGraw-Hill, p. 109, ISBN 978-0-07-112612-0.

Freiesleben, J. (2004). On the limited value of cost of quality models. Total Quality Management & Business Excellence, 15(7), 959-969.

Garvin, D. A., & Quality, W. D. P. (1984). Really Mean?. Sloan management review, 25.

Harrington, J.H. 1999. Performance improvement: a total poor - quality cost system. The TQM Magazine 11, 4, pp. 221 - 230.

Harrington, H. J. (1987). Poor-quality cost. New York, NY: M. Dekker.

Hague, P. N., Hague, N., & Morgan, C. A. (2004). Market research in practice: a guide to the basics. Kogan Page Publishers.

Ittner, C. D. (1996). Exploratory evidence on the behavior of quality costs. Operations research, 44(1), 114-130.

Juran, J. M, (1951) Juran's Quality Control Handbook, McGraw-Hill, N. York

Juran, J. M. J. M., & Gryna, F. M. (1993). Quality Planning and Analysis; from product development through use (No. 04; TS156, J8 1993.).

Jafari, A., & Rodchua, S. (2014). Survey research on quality costs and problems in the construction environment. Total Quality Management & Business Excellence, 25(3-4), 222-234.

Karg, L. M., Grottke, M., & Beckhaus, A. (2011). A systematic literature review of software quality cost research. Journal of Systems and Software, 84(3), 415-427.

KONE Incident Management Process Description 1.0 (2015-09-07), Intranet.

KONE IT Service Handbook, Intranet.

KONE Corporation, 2016. Financial Statements KONE 2015 http://www.kone.com/en/company/in-brief/

Khaled Omar, M., & Murgan, S. (2014). An improved model for the cost of quality. International Journal of Quality & Reliability Management, 31(4), 395-418.

Kitchin, R., & Thrift, N. (2009). International Encyclopedia of Human Geography: A 12-Volume Set. Elsevier.

Krishnan, M. S., Kriebel, C. H., Kekre, S., & Mukhopadhyay, T. (2000). An empirical analysis of productivity and quality in software products. Management science, 46(6), 745-759.

Krishnan, S.K. 2006. Increasing the visibility of hidden failure costs. Measuring Business Excellence 10, 4, pp. 77 – 101

Lesser, W. H. (1954). Cost of quality. Industrial Quality Control, 11(5), 11-14.

Machowski, F., & Dale, B. G. (1998). Quality costing: An examination of knowledge, attitudes, and perceptions. Quality Management Journal, 5(3).

McDaniel, C., & Gates, R. (2001). Marketing Research. Burr Ridge, IL.

Plunkett, J. J., & Dale, B. G. (1988). Quality-related costing: findings from an industry-based research study. Engineering Management International, 4(4), 247-257.

Remenyi, D., & Williams, B. (1998). Doing research in business and management: an introduction to process and method. Sage.

Ross, D. T. (1977). Structured analysis (SA): A language for communicating ideas. Software Engineering, IEEE Transactions on, (1), 16-34.

Saunders, M., Lewis, P. & Adrian, T. 2009. Research methods for business students. 5th ed. Pearson Education Limited. 614 p

Schiffauerova, A., & Thomson, V. (2006). Cost of quality: A survey of models and best practices. International Journal Of Quality and Relaiability Management http://www.mcgill. Ca/files/mmm/CoQ_Thomson_240ct03pdf, Erişim tarihi: 15.05.

Schiffauerova, A., & Thomson, V. (2006). A review of research on cost of quality models and best practices. International Journal of Quality & Reliability Management, 23(6), 647-669.

Schiffauerova, A., & Thomson, V. (2006). Managing cost of quality: insight into industry practice. The TQM Magazine, 18(5), 542-550.

Snieska, V., Daunoriene, A., & Zekeviciene, A. (2013). Hidden Costs in the Evaluation of Quality Failure Costs. Engineering Economics, 24(3), 176-186.

Strauss, A., & Corbin, J. (1990). Basics of qualitative research (Vol. 15). Newbury Park, CA: Sage.

Tatikonda, L. U., & Tatikonda, R. J. (1996). Measuring and reporting the cost of quality. Production and Inventory Management Journal, 37(2), 1.

Tye, L. H., Halim, H. A., & Ramayah, T. (2011). An Exploratory Study on Cost of Quality Implementation in Malaysia: The Case of Penang Manufacturing Firms. Total Quality Management & Business Excellence, 22(12), 1299-1315

Tsai, W. H. (1998). Quality cost measurement under activity-based costing. International Journal of Quality & Reliability Management, 15(7), 719-752.

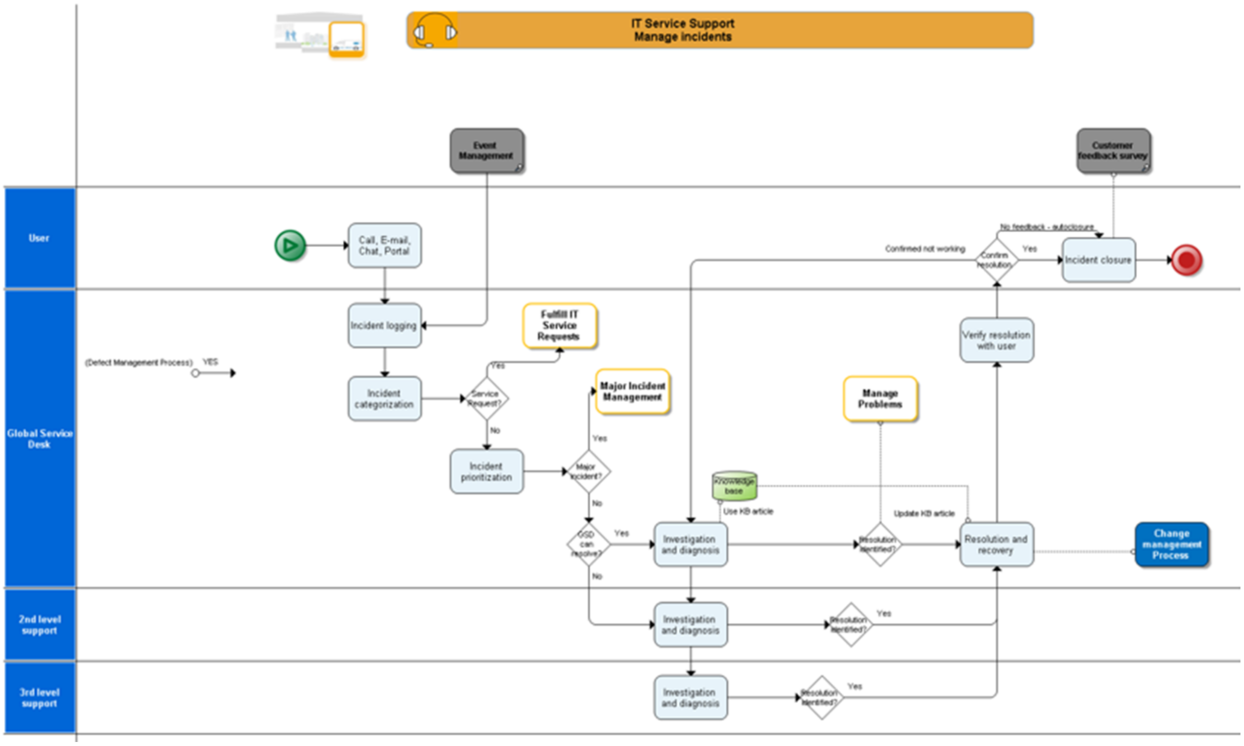
Vaxevanidis, N. M., & Petropoulos, G. (2008). A literature survey of cost of quality models. Journal of Engineering Annual of Engineering Huneduara.

Wang, M. T., Wang, S. S. C., Wang, S. W. C., & Wang, A. S. M. (2010, October). An Introduction of COQ Models and Their Applications. In Proceedings of the 2010 International Conference on Engineering, Project, and Production Management (Vol. 14).

Yaacob, Z. (2010). Quality management as an effective strategy of cost savings. African Journal of Business Management, 4(9), 1844.

Yin, R. K. (2013). Case study research: Design and methods. Sage publications. 181 p.

APPENDIX A: IT INCIDENT PROCESS



APPENDIX B: INTERVIEW QUESTIONS

Preliminary interview questions

Background

1. Background information (name, job description and experience of working years in KONE at the current position and similar positions)

Business impact of tickets

2. What do you think, what are the business impacts of incidents in general? What about other, non-incident tickets?
3. How do we measure business impact of incidents in KONE IT? How it is done in other departments (e.g. your department)? What business impact points are the most important to KONE?
4. How would you measure impacts of lost productivity yourself?
5. In your opinion, how we could reduce business impacts of incidents?
6. How providing solutions for incidents does differ from providing solutions for non-incident tickets (e.g. service requests)?
7. Are some quality related issues/problems more important than others?
8. How the assessment of priority levels for incidents is done? Is their possibility for mistakes in this assessment process, if yes, please tell them?
9. Do we insure quality of solution that suppliers provide across organization? How do we at KONE assess solutions? Suppliers? Between regions?

Cost of Poor Quality in KONE IT

10. Do you know how KONE IT/KONE is measuring and reporting CoPQ?
11. What would be benefits of reducing of costs of poor quality?
12. What kind of benefits reduction of cost of poor quality will produce for KONE IT? Your department? What about the individual employee?
13. Where can KONE IT employee currently obtain information on the reporting of poor quality?
14. How KONE IT does ensure that employees are realizing the possible benefits of the reduction of poor quality?
15. How can calculations of cost of poor quality be improved? How can it be improved? Any ideas what should be measured?

APPENDIX C: SURVEY QUESTIONS

Business Impact of Non-Working IT

This survey is created for KONE IT Quality and made as a part of a Master's Thesis. The aim of this study is to understand better the impacts of non-working IT to business. This survey is conducted by Master's Thesis worker Daniel Hollen. Participation in this survey is anonymous and information gathered will be used for KONE IT development purposes.

The survey should take around 5-10 minutes to complete and consist of 13 questions.

The data you provide herein is treated as confidential information and will be handled by personnel as such.

1. How many years have you been working at KONE?

◯ Under 1 year

◯ 1-3 years

◯ 4-5 years

◯ 6-8 years

◯ 9-12 years

◯ 13-16 years

◯ 17-19 years

◯ Over 20 years

2. How many years have you been working in your current position?

◯ Under 1 year

◯ 1-3 years

◯ 4-5 years

○ 6-10 years

○ 11-15 years

○ Over 15 years

3. Do you have previous work experience in a similar position outside of KONE?

○ Yes

○ No

Business Impacts of KONE IT Incidents

4. Overall, how severe do you think are the business impacts of IT incidents?

	1 Very Low	2 Low	3 Neutral	4 High	5 Very High
A) Business impacts of IT incidents in general	○	○	○	○	○
B) Business impacts of major IT incidents	○	○	○	○	○
C) Business impacts of minor IT incidents	○	○	○	○	○
D) Business impacts of other, non-incident tickets/issues (e.g. Service requests)	○	○	○	○	○

5. Do you have any ideas how impacts of lost productivity are measured?

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6. In your opinion, how we could reduce business impacts of incidents?

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7. In your opinion, are some quality related issues/problems more important than others?

○ Yes

○ No

Business Impact of Non-Working IT

8. Do you know how the assessment of priority levels for IT incidents is done?

○ Yes

○ No

9. If you answered "Yes" to Question 8, please specify in your own words how it is done?

10. Is there a possibility for mistakes in this assessment process?

○ Yes

○ No

11. If you answered "Yes" to Question 10, please specify

12. Specify any other factors that should be considered when evaluating the business impacts of IT incidents in KONE IT

13. Do you have any other comments, questions, or concerns?

APPENDIX D: List of countries included into Region A and Region B

Regions

Region	Country	Cost level
APM	Australia	High
CNE	Austria	High
APM	Bahrain	High
WSE	Belgium	High
ENA	Canada	High
WSE	Cyprus	High
CNE	Denmark	High
CNE	Finland	High
WSE	France	High
CNE	Germany	High
CNE	Great Britain	High
GCN	Hong Kong	High
CNE	Iceland	High
CNE	Ireland	High
WSE	Italy	High
WSE	Luxemburg	High
CNE	Netherlands	High
APM	New Zealand	High
CNE	Norway	High
APM	Oman	High
APM	Quatar	High
APM	Saudi Arabia	High
APM	Singapore	High
CNE	Sweden	High
CNE	Switzerland	High
GCN	Taiwan	High
APM	United Arab Emirates	High
ENA	USA	High

Low Cost Country Sourcing (LCCS)

Region	Country	Cost level
GCN	China	Low
CNE	Czech republic	Low
CNE	Estonia	Low
WSE	Greece	Low
CNE	Hungary	Low
APM	India	Low
APM	Indonesia	Low
WSE	Kenya	Low
CNE	Latvia	Low
CNE	Lithuania	Low
APM	Malayisa	Low
ENA	Mexico	Low
APM	Philippines	Low
CNE	Poland	Low
WSE	Portugal	Low
CNE	Russia	Low
CNE	Slovakia	Low
CNE	Slovenia	Low
WSE	South Africa	Low
WSE	Spain	Low
APM	Thailand	Low
WSE	Turkey	Low
CNE	Ukraine	Low
APM	Vietnam	Low

APPENDIX E: Generic CoQ models and cost categories (Schiffauerova and Thomson 2006)

Generic model	***Cost/activity categories***	***Publications developing or dealing with the model***
P-A-F models	prevention + appraisal + failure	Feigenbaum 1956, Purgslove and Dale 1995, Merino 1988, Fruin 1986, Thompson and Nakamura 1987, Denzer 1978, Chang et al. 1996, Sorquist 1997b, Plunkett and Dale 1988, Tatikonda and Tatikonda 1996
Crosby's model	conformance + non-conformance	Suminsky 1994, Denton and Kowalski 1988
Opportunity or intangible cost models	prevention + appraisal + failure + opportunity	Sandoval-Chavez and Beruvides 1998, Modarres and Ansari 1987
	conformance + non-conformance + opportunity	Carr 1992, Malchi and McGurk 2001
	tangibles + intangibles	Juran et al. 1975
Process cost models	conformance + non-conformance	Ross 1977, Marsh 1989, Goulden and Rawlins 1995, Crossfield and Dale1990
ABC models	value-added + non-value-added	Cooper, 1988, Cooper and Kaplan 1988, Tsai 1998, Jorgenson and Enkerlin 1992