POOR QUALITY COSTS IN LARGE CONSTRUCTION COMPANIES: WHAT CAN BE LEARNED FROM OTHER INDUSTRIES?

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Abstract: Poor quality costs are often defined as the costs that would disappear if a company's products and activity processes would be complete. A way to show why improvements in quality need to be done and how much poor quality can affect a company financially is to measure poor quality costs. The purpose of this study is to find out what large construction companies can learn from other industries concerning why, what and how to systematically measure poor quality costs. Experts in four companies in the manufacturing, logistic and research industry are interviewed. Skanska Sweden is used a reference organisation. The main conclusions are that this kind of systems is a necessary tool for reducing costs of poor quality in a systematic way, the system should focus on visible costs such as costs for scrap and rework, and that the culture within the organisation must allow open discussions about poor quality.
Keywords: Poor Quality Costs; Continuous Improvement; Cost Reduction; Benchmarking

1 Introduction

There is a widespread acceptance that quality is an important strategic competence and a key competitive issue that cannot be ignored by any organisation (Eldridge et al, 2006). There is reported in a number of studies that costs of poor quality may be in the size of 25-30% of the organisation's turnover (e.g. Sörqvist, 1998). Despite this awareness it seems as surprisingly few organisations systematically measure costs of poor quality in order to decide actions to reduce them. One reason is that the costs of poor quality often are underestimated in real situations (e.g. Sörqvist, 1998; Josephson and Saukkoriipi, 2005). Another reason is that most studies of costs of poor quality within construction (see e.g. Burati et al, 1992; Josephson and Hammarlund, 1999; Nylén, 1999; Barber et al, 2000) are limited to defects, deviations or rework. Suggested systems for measuring costs of poor quality (see e.g. Davis, 1987; Holland, 2000; Hall and Tomkins, 2001; Love and Irani, 2002) are also limited to costs for deviations, defects and rework. Based on a literature review Eldridge et al (2006) says that it appears that organisations do not collect quality costs because of five difficulties. First, lack of understanding and/or awareness of the concept and principles of quality costing among the management team. Second, the company culture. Third, an acute lack of information and data. Fourth, the confusion between the levels of the organisational hierarchy over the terms used in quality costing. Fifth, inefficiency of the accounting information system, which prevents firms from providing quality cost data.

The traditional manufacturing industry has for several years developed improvements in production to make the quality better and the production more efficient. The construction industry is often perceived to be slower in their development of the production processes. A common explanation – or excuse - is that construction is more based on producing unique products and more geographically spread business. When it comes to collecting data about poor quality it seems as organisations within construction have less experience than organisations in other industries.

This paper evaluates the concept of poor quality costs, including the obvious costs to correct defects in the production process and also costs for activities that customer needs to pay for, but not gives value back. The main purpose of the paper is to find out what large construction companies can learn from other companies considering measuring poor quality costs. The discussion starts from Skanska Sweden, which is one of the major construction companies in Sweden. Studies of four companies from other industries are used for benchmarking.

2 Poor quality costs

In the 1950's Juran introduced the term Quality Costs referring to costs related to quality. But it is not quality that is resource demanding, instead it is lack of quality that costs. Of that reason it is often argued that Poor Quality Costs (PQC) is a more adequate term to use.

Traditionally, PQC involved the costs of deviation from customer requirements. Although customer requirements do not include requirements that are unspoken, implicit or unaware. Therefore you receive the costs of "not doing things right" instead of "doing the right things". Juran broadened the definition to *"the costs that would disappear if a company's products and activity processes would be complete"*. The negative aspect of this definition is that it can be considered too broad. It includes all kinds of costs because of poor quality in all the company's activities. Also, the focus is on costs that appear because of lack of quality but for a successful quality work it is important to realize that it is not cost minimization that should be the focus but profit maximization.

Sörqvist (1998) states that by measuring poor quality costs, the company can identify where the problem areas lie. A common mistake for companies is that they are only aware of the traditional poor quality costs, i.e. "the top of the iceberg" (Figure 1). These are usually visible in the already existing economy system; examples are costs from rejects, rework and guarantees. But the hidden costs are just as important, it is costs that directly affects the company's economy but is not shown in the existing system. Other hidden costs can be losses of income due to delivering incorrect products, customer's costs due to bad quality, i.e. breakdowns in production functional defects or market effects. Finally, socio-economic costs involve costs for i.e. harm done to the environment due to poor quality which leads to low profitability. This can lead to high unemployment and furthermore generates low tax revenues for the state.

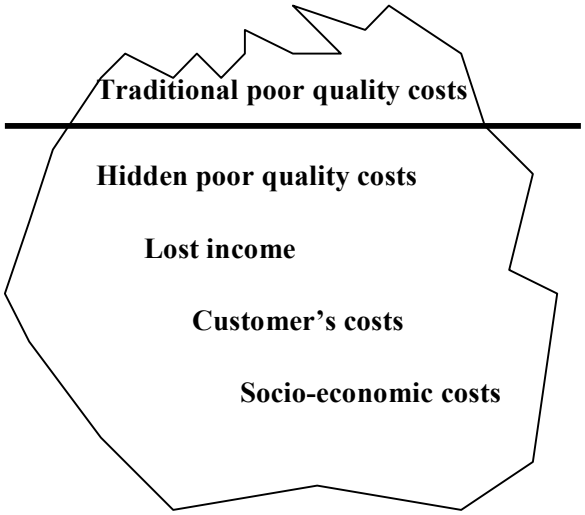

Figure 1 The iceberg of poor quality costs (From Sörqvist, 1998).

Feigenbaum (1956) points out four main categories in quality costs. Prevention costs are the costs associated with planning and controlling the quality assurance programme and system. Appraisal costs are the costs for the activities to verify the quality achieved compared to the desired level of the quality for a satisfied costumer and quality standards. Internal failure costs are defined as losses caused by deviations from the desired quality level discovered before delivery to an external customer. External failure costs are losses discovered after the delivery. The idea of this categorization is to show the meaning of preventive measures. If a company's economy regarding PQC is similar to this, then the management ought to encourage more preventive methods. The right bar in Figure 2, which is bigger regarding preventive costs, has got a lower total cost because of the money spent on preventive measures. The interviewed experts in this study agree that prevention is the key to improving quality and profitability.

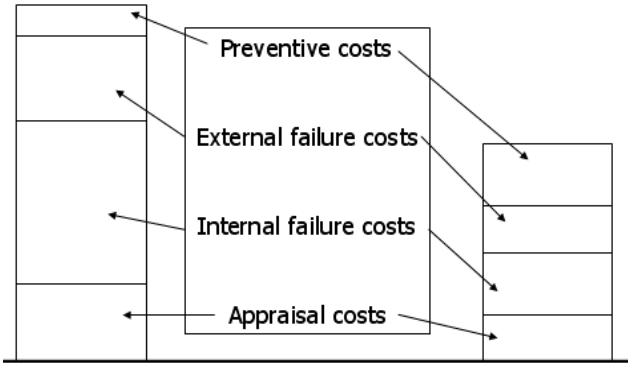

Figure 2 Categorization of quality costs shows the measure of preventive costs

The measuring of PQC can be accomplished in two ways; by temporary surveys or by systematic measurement systems (Sörqvist, 1998). For a survey, a few co-workers are singled out to collect information at single occasions. This procedure is fast and simple. A system for continuously measure PQC demands all co-workers to continuously report data. This approach is of course time consuming and demands motivated co-workers.

3 Method

3.1 Data collection and data analysis

This study is focused on what large construction companies can learn from other industrial companies concerning measurement of poor quality costs. At an early stage of the working process a meeting with a development manager at Skanska Sweden, a major construction company, was carried out to get their views of the construction business in general and the organisation, structure, culture and working system in Skanska in specific. The reason with this meeting was to learn what the company currently is measuring, but also to better understand the needs and the possibilities to develop systems for measuring poor quality costs.

The major part of the study is based on interviews with specialists on poor quality costs within four Swedish companies; Saab Ericsson Space, SKF, Volvo Car Corporation and Volvo Logistics. These four companies were recommended by the former managing director at the Swedish Institute for Quality. Each interview was at least one hour at the company and was followed up by a few questions by telephone or by electronic mail. The approach was to give the interviewer the opportunity to guide the interview towards what he/she thought was vital in measuring poor quality costs. I between open ended questions about how, what and why the company was measuring poor quality costs were asked. It was especially important to cover how the data collected and analysed was used in improvement activities.

The information gathered in the four companies was evaluated. Then, a group discussion was organised in Skanska Sweden in order to fins out what the company could learn from the four companies' ways of collect data and use the data in their improvement work.

3.2 The reference organisation – Skanska Sweden

Skanska Sweden is a part of Skanska. Its mission is to develop, build and service the physical environment where people live, work and travel. The business comprises more than 150 local units, is almost exclusively project based and geographically spread all over Sweden. These characteristics, in the form of project-oriented business and a large regionally spread organisation are not in any way unique for Skanska, but rather quite common for most large construction companies (Samuelsson, 2003).

At present Skanska Sweden keeps track of the number of projects that has no defects at the hand over. Of the defects that occur during the construction project the more considerable ones originate in a report and will

later be discussed at the final meeting. Minor deviations are rectified right away without any further evaluation. On the subject of production of hired contractors Skanska Sweden have a system for measuring the hired contractors work performance. Skanska gather information about their suppliers in a data system called Oracle. The suppliers are evaluated upon issues such as; quality, technique, time, cooperation, economy and work environment.

Skanska Sweden experiences two major difficulties in how to handle the output of a measurement system. The first difficulty concerns how to inform all employees in such a large company. Skanska Sweden has 12,000 employees. If deviations only are discussed during final project meetings the information will only follow the persons attending the meetings. Once a project is finished, the members of the project haste on to another project. There is lack of both time and effort to concentrate on earlier mistakes. The second difficulty concerns the utilization of the gathered information. It all comes down to that the information is used in the right way. There is no way to investigate or report problems if the information later on only is thrown away.

4 Four companies

The four non-construction companies studied are founded in Sweden, international active and stock listed. Their scope of business, turnover, number of employees and current measurements is summarised in Table 1.

Table 1 The reference organisation and the four companies.

Company	Scope of business	Number of employees	Turnover (SEK)	Current measurements
Skanska Sweden (ref. org.)	Construction-related services and project development	12,000	22 billion	Deviations and number of defects at hand over.
Saab Ericsson Space	Specialize in digital and microwave electronics and antennas to satellite manufacturers.	500	673 million	Production processes: faults, consequence costs and good will and bad will.
SKF	Supplier of products, customer solutions and service in the rolling bearing and seals business.	39,000	50 billion	Five strategic parameters where the organisation strives to reach the outcome of zero
Volvo Car Corporation	Volvo Car Corporation develops and manufactures cars and is a part of the Ford group.	27,000	Not available	Prevention costs, failure costs and costs from quality controls.
Volvo Logistics	Handles and develops business logistics system for the automotive and transport industries.	800	8 billion	Time precision, used volume per transport, personal injuries.

4.1 SAAB Ericsson Space

SAAB Ericsson Space finds working with poor quality costs very important since the economic improvement directly turns to profit on the balance sheet. They have an open deviation system which their customers have access to and can find recent information about deviations at any time. This open system is common in their industry and results in better understanding for the customers.

They only focus on production processes and measures four levels; faults, costs for the consequences, costs for good will and costs for bad will. They categorize deviations as major, minor or observations, where major and minor deviations are accessible for their customers.

Their system for measuring poor quality costs is called QueBase, Quality Under Evaluation Data Base. It is user friendly and the employees can easily print out statistics. The employees have understood the importance and value of working with poor quality costs. Therefore it is a matter of course to report deviations.

The quality manager at Saab Ericsson Space describes a special company culture where it is natural to report deviations, the employees are not afraid to commit to their own mistakes. An example of this is an incident when two co-workers just finished inspecting a new mainframe that Saab Ericsson Space had invested a lot of money and effort to. An accident led to a choice for one of the co-workers. The co-worker could either report the accident or not mentioning anything. The employee decided to report immediately to the boss, who was very grateful for that decision. To not punish employees for their mistakes encourages the openness and honesty in the company.

4.2 SKF

The SKF Group is active on a global market with a number of strong competitors and with a constant demand of developing and increasing their products, processes and added values. Poor quality costs are measured in the manufacturing processes as scrap, losses and rework. These data are set in proportion to the total amount of costs on order to get more concrete information. A statement from the quality manager during the interview made it clear how the SKF Group look at poor quality cost and how far they are in the quality process. "Poor quality cost is not a common used concept within the organisation". In clear this means that the organisation has worked with quality improvement since the 1980's and the development of it is far gone. The quality manager also made it clear that SKF's main purpose is to retain their customers and keep them satisfied before increasing their revenue.

Their poor quality measuring is concentrated on external and internal factors with the difference that the measuring unit is not in money. Instead they have developed system called "4Z + BZ" which consist of five strategic parameters where all five represent fields where the organisation strives to reach the outcome of zero. The quality parameters of this system are zero accidents (none injuries on personal), zero defects (none defective delivered gods), zero broken promises and zero none profitable divisions.
SKF use a data base to control and evaluate the strategic fields. The data base is designed as an intranet and is used and available by and for all division worldwide.

An example is the measuring of *zero defects* where the SKF Group supervise the numbers of complaints from customers. They have about 550 factors and receive approximately 600-700 complaints in total per year. The SKF Group keep track of all factories regarding reported defects from customers. This is a form of competition among the divisions which they believe generates increased quality.

4.3 Volvo Car Corporation

Volvo Car Corporations' definition of poor quality costs is investments that do not give value back to the customers. The poor quality costs process is mainly used by the management and is not spread in the entire organisation, although this has varied through the years depending on the managements´ attitude. Volvo Car Corporation does not work active with finding processes with poor quality, instead they motivate managers to inform the employees of the consequences of poor quality costs. The reason of not using costs of poor quality is that the management of Volvo Car Corporation thinks it is enough to have a detailed financially report to see where improvements need to be done. Extra measurements are in that point of view just a waste of time and money according to them.

Preventive costs measured by Volvo Cars Corporation are from virtual modelling and FMAA Fail Modern Affect Analysis. Virtual modelling is used for examine new models before production and FMAA to see how coincidences can affect for example material.

Measurements concerning external costs are resources spent on warranties and failure to retain and acquire customers because of bad reputations. Costs from warranties are based on information from dealer report. Every part that needs to be exchanged has a fixed price both with material and cost of time to change the parts. Failure measurements through bad reputation are made from estimations.

Staff at the bottom line does quality measurement trough test drives of cars. With that sort of measurement deviations are discovered with help from a Pareto analysis in a few hours, and corrections can be made at once. The Volvo Cars Corporation also measures costs from repair and scrap as well as employees´ overtime.

4.4 VOLVO Logistics

Volvo Logistics has decided to create a new system to measure and monitor poor quality costs (although at Volvo they use the term non conformance costs) due to the problems with the current system. The main problems with the current system are the complexity of using it and the large number of factors which are measured.

The main subjects when measuring poor quality costs is delivery precision from their suppliers as well as delivery precision to the recipients. Transporters have a buffer zone on +/- 15 minutes to deliver gods on agreed time. Precision is measured by time and then transferred into cost. Other areas of interest to measure for Volvo Logistics are used volume in comparison with maximum volume per transport and environmental impact and incidents.

According to the quality manger at Volvo Logistics a vital tool to use is the personal business plan. The purpose of a personal business plan is that every level in the organisation creates their own adapted business plan from the original vision established by the Volvo management. This will create an increased feeling of participation for all employees from the highest level of management to the bottom line workers. Additional to this it is important to create tangible goals that are easy to reach. Volvo Logistics uses management attention to motivate the staff to use the system and show what sort of effects the bottom line workers has on the process.

Furthermore, Volvo Logistics talks about the issue of the various interests in reporting and the different competence in computer knowledge. This is why the system should be simple. Another factor to achieve high frequency of reporting is to use anonymous reporting. A single person should never publicly be responsible for a deviation in the manufacturing process. Hopefully this will minimize the number of unreported incidents.

5 Discussion

The interviews revealed what could be described as necessary fundamentals for measuring poor quality costs. Such ground rules is a simple system for reporting information of the results, feedback and an open and honest company culture were considered to be fundamentals in order to get gratifying measurements. An open and honest company culture has been a key factor for Saab Ericsson Space during their work with poor quality costs. With this they have created a feeling of communion which helps to motivate their employees to improve their work. It is essential to find these kinds of critical success factors for the construction sector. Not be ashamed of ones mistakes is important in order to improve procedures for the company. One challenge for Skanska Sweden is to alter this mindset within their company since organisations in the construction industry are not used to admit their mistakes openly and learn from them. Using already acquired knowledge for continuous improvement and thereby reducing costs should be evident for every company executive.

Neither Skanska Sweden nor other companies in the construction sector have measured poor quality costs to any noticeable extent before. Exceptions are a few single measurements organised as temporary projects. Since there is a lot of money to save, the effort to reduce PQC should be obvious. When establishing the company's current poor quality costs one ought to realize that the money lost on poor quality is just a waste of money.

For a large company like Skanska Sweden it should be natural to work close with your suppliers and also make high demands, especially when about 80 percent of Skanska's work is outsourced. Therefore Skanska

should take a closer look at their suppliers and sub-contractors when measuring PQC and evaluate their suppliers and sub-contractors efforts and performance.

A simple way to start measuring PQC is to concentrate on scrap, losses and rework in the projects. Sörqvist (1998) define these parameters as traditional PQC. They are often visible, which means that they are fairly easy to measure and report for the *construction site manager* and also easy to accept as poor quality.

Vital differences between the manufacturing industry and the construction industry are the access to computers, computer knowledge and urge to report. Employees at the interviewed companies have no choice but to report deviations, but still the management have convinced their staff of the importance of reporting and therefore created a commitment. This is the kind of morale that must be implemented at Skanska's organisation. The feeling of communion and the insight of the problem among employees At Saab Ericsson Space all workers have access to a computer and they have computer skills since they work with this on an everyday basis, whereas workers at a construction site does not necessarily have the same computer skills and can not as easily access a computer.

For Skanska or other large construction companies it is of importance to make small progress in the quality process. Compared with for example SKF and Saab Ericsson Space, who has worked with poor quality costs for more or less 20 years, Skanska must realize that it will take a lot of time and effort to be able to compare itself with these organisations. Since the organisation has not worked with PQC that much before, they need to have patience when introducing a new system to handle PQC. This is a process which will, and has to take time. To compare with Volvo Logistics, they have planned two months for installing their new system to handle poor quality costs, but they are planning on two years until it is fully used by all their employees.

6 Conclusions

The study have shown that new possibilities arise when introducing a system for measuring PQC and the investment can save a lot of money in the end. PQC is a good tool to use for identifying losses, but there are a lot of pitfalls along the way when introducing a measuring system.

Factors to be considered for large construction organisations when introducing a system for systematically measuring PQC:

- The companies should include their sub-contractors' and other suppliers' processes in the system, since most work are done by these groups. Relevant parameters related to PQC are time, performance and attitude.
- The companies should focus on obvious parameters such as scrap, losses and rework, since many companies experience difficulties with the terminology and definitions of what is poor quality and not.
- Strong management attention and involving the bottom line workers in evaluating parameters is essential. With a general participation throughout the organisation it is easier to implement a system. Continuously giving feedback to the bottom line workers on the progress will generate in a desire to report failures and poor quality.
- The computer knowledge and urge to report among the construction site workers is low. By using a simple system with only a few parameters to measure, and use notebooks etcetera for reporting, the easiness will increase the site workers use of the system.
- The major difficulty is however to change the attitude and morale considering poor quality throughout the organisation. There must be an open and honest culture where failures should be seen as opportunities to improve quality. This way of thinking seems to be rare within the construction sector today and only a drastic incitement, time or strong management attention will change it.

This paper reports initial findings from a pre-study. This study will be followed by a major study, which includes reference organisations in real estate, design and construction and a number of non-construction companies with existing systems for measuring PQC.

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