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Tracking hidden quality costs in a manufacturing company: an action research

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Abstract

Purpose – The purpose of this paper is to present a report on the implementation of a quality cost program in a continuous-process manufacturing company, with particular emphasis on the unearthing of hidden quality costs, as well as gaining a closer understanding of the resistance against implementation.

Design/methodology/approach – Using an action research approach, the researchers participated – directly and indirectly – in the implementation of quality costing at the case company. The research process comprises iterative cycles of gathering data through documentary reviews, observations of company operations, discussions with operatives, analyzing data, undertaking actions and evaluating results. Following Sandoval-Chavez and Beruvides, the poor quality cost analysis includes an additional category to the conventional prevention-appraisal-failure model to reflect the cost of lost opportunities.

Findings – The study unearthed a significant portion of hidden quality costs which may be termed an "opportunity loss". The findings indicate that the company's total quality costs actually far exceed its current profit margin, and that the company could improve its competitive position if it focused on the elimination of these quality costs.

Research limitations/implications – This paper focuses on uncovering hidden quality costs. However, the measuring of quality costs only serves to identify opportunities for improvement. It is follow-up corrective actions that will lead to organizational effectiveness. The research findings support the contention that tracking of poor quality costs is an important step in the quality management process.

Originality/value – This paper presents a proactive way of tracking hidden quality costs.

Keywords Quality costs, Inventory costs, Opportunity costs, Production downtime

Paper type Research paper

Introduction

Quality cost is the sum total of expenses incurred to ensure the attainment of the desired quality level in products and services as well as the expenses incurred due to failure to meet the desired quality level. The second component of quality cost is also known as poor quality cost. Many managers are oblivious of a hidden factory in their companies that churns out poor quality costs day in and day out, mainly because traditional accounting systems fail to capture them. Quality costing is particularly relevant during times of economic meltdown, when cost reduction is on top of the agenda of every company's competitive strategy. With the current financial crisis, many companies, in order to stem the sharp drop in profits, are beginning to slash

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costs by downsizing their workforce, closing facilities and freezing new investments (Douglas, 2009; Young, 2009). However, cost cutting is a challenging exercise, and, if executed hastily, can adversely jeopardize firms' long-term sustainability (Warren, 2009). A more appropriate and prudent solution to reduce costs and improve efficiency in this dynamic environment is the implementation of quality improvement programs such as a quality costing system. Tracking and eliminating hidden poor quality costs may be a more superior cost reduction program than other seemingly obvious and expedient methods of retrenchment and cost cutting exercises.

This paper presents the results of a study of the identification and analysis of hidden poor quality costs in a continuous-process manufacturing company. It begins with a brief review of the quality costing literature in general and the opportunity cost model in particular. As a prelude, the background of the case company is presented. This is followed by a discussion of the data collection method. A report on the hidden poor quality costs and their implications is then presented. Finally, the paper concludes with a suggestion for future research.

Literature review

Definition of quality costs

The cost of quality refers to the total expenditure that an organization incurs for its overall quality. Campanella (1999, p.4) defined cost of quality as "the difference between the actual cost of a product or service and what the reduced cost would be if there were no possibility of sub-standard service, failure of products, or defects in their manufacture". It comprises two basic components:

(1) the cost of conformance; and

(2) the cost of non-conformance.

The former, consisting of the cost of prevention and the cost of appraisal, is also known as voluntary cost. The latter is referred to as involuntary cost, and is made up of internal and external failure costs.

According to Crosby (1979) quality means "conformance to requirements", and non-conformance refers to failure to do things right the first time. The popular prevention-appraisal-failure categorization is attributable to Feigenbaum (1991) who defined:

- prevention costs as the expenses of preventing defects and non-conformities from occurring;
- appraisal costs as the costs of evaluating product quality with the purpose of ensuring that quality products and services meet customer requirements; and
- failure costs as the costs incurred because of failure to meet customer requirements.

Failure cost is further classified into internal failure cost and external failure cost. Internal failure cost includes sub-standard products detected within the company prior to delivery to customers, scrap, re-work, and spoilage. External failure cost encompasses rejected goods, recall cost, warranty claims, concessions and customer complaints. It can be seen that both internal failure costs and external failure costs are engendered by the same causes, but are manifested in different forms. Subsequent

studies further expanded the list of external failure costs; for example, Dale and Plunkett (1999) included loss of sales due to poor quality in this category of quality costs. Quality cost behavior continues to receive wide coverage in the literature, especially on the relationships between the three main PAF categories, as well as their relationships with quality conformance level.

Quality cost behavior and quality level

The prevention-appraisal-failure categorization forms the basis of the widely used PAF model, which is also known as the optimal quality model. It is built on the premise that when additional resources are spent on prevention and appraisal activities, quality will improve, with a resulting decrease in failure costs (Campanella, 1999; Merino, 1990; Shah and Mandal, 1999). This implies a trade-off between conformance costs and non-conformance costs. According to Whitehall (1986, pp. 46-7), "investment in prevention activities will help to eliminate defects and improve the efficiency of appraisal activities". Quality experts generally share the view of that the most cost-effective category for quality spending is prevention (Gupta and Campbell, 1995). A study by Omachonu *et al.* (2004) indicates that there is an inverse relationship between costs of conformance and failure costs. The classic view of the quality cost behavior advocates the use of trade-offs as a guide for the allocation of resources to determine the optimal quality level (Burgess, 1996; Ittner, 1992). It suggests that as long as the increase in conformance costs is lower than the decrease in non-conformance costs, a company should continue its quality effort to prevent and detect non-conformance units until it reaches the optimal point. At this point, the total quality cost is the lowest. The quality level at this point is called the economic quality level (EQL). In simple terms, it implies the acceptance of a number of defects instead of total conformance (Foster, 1996; Gryna, 1988). This concept is generally known as "the economics of quality", and has attracted heavy criticisms from quality researchers. In a survey of the economics cost of quality models, Plunkett and Dale (1988) concluded that many of the models are inaccurate and cast serious doubt on the validity of the EQL concept. Visawan and Tannock (2004) and Burgess (1996) pointed out that the study of quality economics mainly focuses on the relationship between quality and costs, but overlooks the impact of quality on market share. Other researchers criticized the EQL concept on the grounds that it would lead to complacency and less commitment to quality. As an alternative, Crosby (1979) introduced the concept of zero defects as the quality performance standard. He called his zero defect methodology the absolute of management (Crosby, 1984). Basically, he emphasized conformance to requirements, which in essence is a goalpost concept. Crosby postulated that it is cost-beneficial to ensure total conformance within tolerance limits. As distinct from the EQL philosophy, the zero defect concept shifts the responsibility for product quality from the quality control department to the corporate department, which is vested with the responsibility of setting the tolerance limits. However, Campanella (1999) warned that under this goalpost approach, managers might arbitrarily make their decision on the tolerance level with the attitude of "that's good enough" and thus "operate with varying degrees of divergent views on quality" (Campanella, 1999, pp. 2-3). This may result in a failure to achieve an optimum role in the quality journey. Experts continue to debate whether management should aim for zero defects or make their quality decisions based on cost-benefit trade-offs (Burgess, 1996; Li and Rajagopalan, 1998). Li

and Rajagopalan (1998) noted that after spending substantial sums on quality improvement activities, US firms appear to be focusing on cost trade-offs again.

In yet another development, Taguchi extended the zero defect standard further with the introduction of the robust quality standard. While Crosby shifted the responsibility for quality from the quality control department to the corporate department, Taguchi moved the focus of quality control from in-line control of the manufacturing process to manufacturing design prior to the commencement of manufacturing. In other words, he shifted the focus from conformance quality to quality of design. He claimed that quality is a virtue of design (Taguchi and Clausing, 1990). The most important message that Taguchi tried to convey is that a loss is incurred when the product quality varies from the target value, and the greater the distance from the target value, the greater the quality loss. The emphasis is on robust design. Taguchi insisted that quality loss is always greater than what management perceives it to be. The main reason for this is that only the obvious poor quality costs are accounted for. Hidden quality losses, which could be many times higher than the plausible quality costs, are difficult to quantify and are thus obliterated. This argument lends further support to the iceberg hypothesis, which likens hidden quality costs to the larger part of iceberg, which is concealed below the waterline (Tannock and Saelem, 2007). Over time, a number of quality experts have attempted to advance and develop methods of tracking quality costs. Several authors have written on the evolution and categorization of quality costing models (e.g. Plunkett and Dale, 1988; Schiffauerova and Thomson, 2006; Williams *et al.*, 1999). The following section is a review of the various quality costing models.

Quality costing methods

Basically, the quality costing models may be classified into three generic groups:

(1) the quality cost model;

(2) the process cost model; and

(3) the activity-based costing (ABC) model.

The quality cost model classifies quality costs into prevention, appraisal and failure (internal and external) costs of products and services. The process cost model, on the other hand, concentrates on the quality costs of the processes. Under the process cost model, quality costs comprise the total process costs of conformance and non-conformance (Schiffauerova and Thomson, 2006). Goulden and Rawlins (1995, 1997) defined the cost of conformance as the intrinsic process costs incurred to ensure that products or services conform to the declared standards, and the cost of non-conformance as the process costs associated with failure. The third quality costing model is the incorporation of ABC procedures into the quality costing technique. Under the ABC method, costs are measured using a two-stage procedure. Firstly, resource costs are traced to activities using the resource drivers. Secondly, the activity costs are then assigned to products using the activity drivers (Garrison *et al.*, 2006). Resource drivers are factors used to approximate the consumption of resources by the activities, whereas activity drivers are the factors used to measure the consumption of activities by cost objects (Tsai, 1998).

Of these generic models, the quality cost model, also known as the PAF method, was the earliest model to be developed, and today it is still the most popular model

(Campanella, 1999; Dale and Plunkett, 1999). The PAF categorization has been commonly adopted by both practitioners and academicians (Sower and Quarles, 2003; Walsh and Antony, 2007). However, despite its popularity, the classic quality cost model has drawn various criticisms for its apparent drawbacks (Campanella, 1999; Tsai, 1998), many researchers are of the opinion that the classic model does not adequately evaluate all the quality-related activities, especially the invisible costs. According to Deming (2000, p. 121), "actually, the most important figures that one needs for management are unknown or unknowable, but successful management must nevertheless take account of them".

It has been suggested that the quality cost model needs to be modified to take into account of invisible quality costs. Kume (1985), for example, was critical of the inadequacy of the conventional quality cost model. Using examples from the Japanese electronics industry, Kume (1985) illustrated that the minimum quality cost does not necessarily mean the maximum profit, and that the minimum quality cost does not necessarily mean the minimum product cost. He further argued that the conventional quality cost model mainly deals with visible quality costs, but overlooks other strategically important hidden quality costs (e.g. quality of design and loss of sales) and product innovations. Yang (2008) noted that failure costs are either under-estimated or are never actually discovered.

Several researchers shared Kume's (1985) view on the inadequacy of the conventional quality cost model, and attempted to improve it by either incorporating additional categories or by re-classifying the cost elements. For example, Modarress and Ansari (1987) introduced two additional dimensions to the quality cost model:

(1) the cost of quality design; and

(2) the cost of inefficient utilization of resources.

Their study was undertaken in the context of just-in-time (JIT) and statistical quality control (SQC) programs. They argued that the cost of quality design forms a significant portion of the total quality costs, and that it could be reduced through the use of a SQC program. On the cost of inefficient utilization of resources, they cited several cost elements related to JIT – for example, costs relating to inventory, set-up time, lot size, and material handling. Nevertheless, Modarress and Ansari (1987) did not provide an empirical study to illustrate the benefit of their revised model.

Yang (2008), on the other hand, expanded the list of quality activities along the product life-cycle with the addition of two new categories:

(1) "extra resultant cost"; and

(2) "estimated hidden cost".

The former refers to extra costs incurred as a result of operational errors that can be traced and counted, whereas the latter includes many cost items that are difficult to analyze and quantify, such as lost sales.

Sandoval-Chavez and Beruvides (1998) developed a modified quality cost model with the inclusion of three opportunity loss components:

(1) under-utilization of installed capacity;

(2) inadequate material handling; and

(3) poor delivery service.

Their case study in a continuous-process industry reveals that opportunity factors account for 83.08 percent of the total revenue lost, and 56.33 percent of the total profit not earned. This is a clear indication of the importance of the opportunity loss components of the cost of quality.

Giakatis *et al.* (2001) analyzed the distinction between quality cost and quality loss and introduced the additional categories of prevention loss, appraisal loss, manufacturing loss and design loss. In essence, quality cost is similar to cost of conformance, while quality loss is akin to cost of non-conformance. However, it is more specific and refined – for example, prevention activities that fail to achieve their quality objective are separately classified as prevention losses. Under the traditional PAF, expenses incurred on both successful prevention activities and failed prevention activities are grouped together as prevention costs. By applying this improved model to a leading Japanese printing company, Giakatis *et al.* (2001) found that the hidden quality costs were more than three times the traditional quality costs.

While some researchers have introduced new categories to improve the conventional quality cost model, others have attempted to reclassify the prevention-appraisal-failure categorization. Dahlgaard *et al.* (1992) introduced a new method of measuring quality costs for the printing industry. They reclassified the quality cost elements into visible costs and invisible costs. They further suggested conducting an annual quality audit to evaluate the quality management system in order to identify hidden possibilities of failure.

Dahlgaard and Dahlgaard (2002) discussed the evolution of quality from inspection and defect reduction to the total quality management philosophy. They introduced a new classification of quality costs making a clearer distinction between visible and individual cost elements (Table I).

Harrington (1999) also touched on the evolution of the traditional quality cost system from a purely manufacturing defect-related cost reporting system to a new poor quality cost system that incorporates both the direct and indirect quality costs. Harrington's (1999) concept is in many ways similar to those proposed by Dahlgaard *et al.* (1992), and Dahlgaard and Dahlgaard (2002), except he used different terminologies to describe the invisible costs. Harrington (1999) separated the poor

	Internal costs	External costs	Total
Visible costs	1(a) Failure cost (scrap/ repairs costs, etc.) 1(b) Prevention cost 1(c) Appraisal cost	2. Failure cost (guarantee costs, complaints)	1 + 2
Invisible costs	3(a) Loss of efficiency due to poor quality/bad management 3(b) Prevention costs 3(c) Appraisal costs	4. Loss of goodwill due to poor quality/poor management	3 + 4
Total	1 + 3	2 + 4	1 + 2 + 3 + 4

Source: Dahlgaard and Dahlgaard (2002, p. 1079)

Table I.
Quality cost categorization

quality cost system into two major divisions. The first division is made up of the following direct poor quality costs:

- controllable poor quality cost (prevention and appraisal cost);
- resultant poor quality cost (internal and external error cost); and
- equipment poor quality cost.

The second division consists of the following indirect poor quality costs:

- customer-incurred poor quality cost;
- customer-dissatisfaction poor quality cost;
- loss-of-reputation poor quality cost; and
- lost opportunity poor quality cost.

In summary, the evolution of the quality cost model suggests a greater awareness of the impact of hidden quality costs on the effectiveness of company performance. Most researchers agree that the magnitude of the hidden quality costs is just too big to be ignored (e.g. Campanella, 1999; Krishnan, 2006; Wood, 2007), with some even claiming that they could be at least more than three times the size of the obvious quality costs (e.g. Giakatis *et al.*, 2001; Yang, 2008). Kim and Liao (1994) asserted that in some cases, hidden quality costs are the largest contributor of total quality costs and may be responsible for corporate failure. Despite their importance, the literature is still short of practical examples of how hidden quality costs can be identified. There is thus a need for more in-depth research into this hidden component of quality costs. The following sections provide an account of an investigation of hidden quality costs at a continuous-process manufacturing company.

Research methodology

Research objective

The main objective of this study was to investigate the practical aspects of implementing quality costing in a continuous-process manufacturing company with particular attention to the hidden component of poor quality costs.

Research design

In this study, quality costing is considered an administrative innovation, because it is an entirely new concept to the focal company. An innovation action research approach is deemed appropriate, because the action researcher would be "actively engaged in helping organizations to implement a new idea" (Kaplan, 1998, p. 90). According to McNiff (2002), action research is the developmental process of following through an idea, seeing how it goes, and continually checking whether it is in line with what it is expected to happen. Md. Shahbudin (2006) asserted that the essence of action research method is "its ability to study the change implementation program from its inception to its application by its users" (p. 72). Unlike a case study, an innovation action researcher does not just observe and document the existing phenomena. In innovation action research, the researcher acts as the change agent by helping client organizations to implement new solutions that improve existing practices. Implementing an innovation within an organization is a "process of gaining targeted employees' appropriate and committed use of an innovation" (Klein and Sorra, 1996, p. 1055).

Towards meeting the research objective, one of the authors took the role of a "participant-as-observer" who "participates fully with the group but it is made clear the observer is conducting research" (Atkinson and Shaffir, 1998, p. 57).

The decision to assume an overt/participant approach is justified on the grounds that none of the employees of the case company has any knowledge or previous experience in quality costing. They need the researcher's guidance on the technical aspects of quality costing. In this respect, neither a covert/participant approach where the researcher joins the organization under false pretenses to observe the behavior of the organization without disclosing his true intention nor an overt/non-participant approach where the researcher only observes and documents his observation is deemed appropriate in this typical setting. First, there is the ethical issue of concealing the researcher's true identity from the group if a covert/participant approach is adopted. Second, an overt/non-participant approach will definitely render the project a non-starter, since there is a complete lack of quality costing knowledge in the group.

The research process comprises data gathering, validating, analyzing, and evaluation through iterative cycles of observations, discussions, planning actions and taking actions. It is a participatory process that involves the contribution of ideas from everyone involved (Greenwood and Levin, 1998).

Data collection

Yin (1994) suggested that evidence for qualitative research may come from six sources:

(1) documents;
(2) archival records;
(3) interviews;
(4) direct observation;
(5) participant-observation; and
(6) physical artifacts.

For this project, data was primarily collected through interviews with management staff and informal discussions with operatives at the production lines. The interviews were open-ended in nature. This approach is in line with the action research approach described by Eriksson and Kovalainen (2008). They argue that open-ended questions usually produce more detailed responses, and that action research promotes mutual understanding and joint data gathering.

In line with the argument of Reason and Bradbury (2001, p. 1) that action research is "a participatory, democratic process concerned with developing practical knowledge in the pursuit of worthwhile human purposes, grounded in participatory worldview", the interviewees were also encouraged to give their opinions on what they perceived to be the quality problems and how they thought the problems could have been avoided or could be overcome. This approach was found to be useful in identifying hidden quality costs, and in eliciting a great deal of rich qualitative data from the frontline operatives.

Documentary records formed another important source of data collection. Documentary records were examined and analyzed. These include organizational records, production log books, key performance indicator (KPI) reports, accounting books, cost files and departmental records. The documentary evidence provided a better understanding of the decision process and validation of data collected from

interviews. The use of different sources of data permitted extensive triangulation in data analysis (Liu and Pan, 2007).

Background of the case company

The case company is engaged in the manufacture of artificial wooden planks using an admixture of agro-waste and other polymer materials through a continuous extrusion process. The company's product is used as a substitute for natural wood in an attempt to contribute towards the environmental protection campaign by using agro-waste and other recycled materials as its principal materials. The company's environmentally friendly product is expected to be a welcome substitute for natural wood because of its superior attributes such as longer durability and resistance to water and termites. Unfortunately, sales growth has been slower than anticipated, mainly because of price. In view of the company's high production costs, its product has been distributed at a price much higher than traditional wooden planks. Thus, the CEO of the case company, upon learning of the usefulness of quality costing, agreed to implement this new practice in the hope that it could help to point out the direction to take in reducing the company's costs to a level that would make it more competitive with conventional products.

Collection of quality costs

One of the authors of this paper was assigned to assist the quality costing implementation on site. The implementation exercise began with a briefing on the concept of quality costs to the management, and was followed by a discussion on the implementation program. The managers, while acknowledging that quality cost information might be useful, expressed the hope that the exercise could be carried without imposing too much workload on their workforce. It was pointed out that the company gained ISO 9001:2000 accreditation about two years ago and that they had been complying with the standard operating procedures. Apart from this, the company also has a KPI system to gauge its performances. The concern was to avoid over-management. It was agreed at the meeting that the initial step should be to perform an analysis of the quality costs of the production department based on existing records. Actual implementation would depend on the magnitude of quality costs found.

With this understanding, a task force consisting of a representative from each of the accounting, production and quality assurance departments as well as the researcher was formed. The main task was to analyze all production-related costs for the past six months and re-classify them into normal operating costs and quality-related costs. Table II gives a summary of the findings, showing the three categories of quality costs as a percentage of sales revenue, and as a percentage of the total quality cost (TQC). The data shows that failure costs constitute the largest TQC component. This is consistent with other published data (e.g. Bamford and Land, 2006; Dale and Plunkett, 1999; Dale and Wan, 2002).

Categories	Amount	Percentage of sales	Percentage of TQC
Prevention cost	38,557	0.95	16.8
Appraisal cost	40,014	0.98	17.5
Failure cost	150,412	3.71	65.7
Total	228,983	5.64	100.0

Table II. Quality cost as a percentage of sales revenue

At a glance, the total production-related quality costs amounted to only 5.64 percent of the sales revenue. This is at the lower end of the range of quality costs as reported in the literature. Crosby (1979), for example, estimated that companies spend between 15 and 20 percent of every sales dollar on re-working, scrapping, repeated service, inspections, tests, warranties, and other quality-related costs. On the other hand, Dale and Plunkett (1999) gave an estimate of 5-25 percent of turnover. A few managers thus questioned the need for quality costing, even though it was explained to them that the reported figure only represents quality costs that are captured by the accounting system, and that there could be other quality costs that are not recorded in the accounting system. The project could have been called off at this stage were it not for the intervention of the CEO, who insisted that further investigation be made to determine whether there were other hidden costs. The task force was requested to sift through all the non-financial records as well as to talk to operatives if needed. The CEO also wanted managers to assist in the collection of data.

The researcher discovered later that the main reason why the CEO was so persistent in wanting to continue with the quality costing project was due to the declining fortunes of the company. The global financial crisis has taken its toll on the company's sales, especially during the last quarter of 2008. Prior to this financial crisis, the company had been able to maintain its sales, albeit with smaller growth than anticipated. However, beginning in December, 2008 (i.e. one month after this quality costing project was initiated), sales had been in a tailspin. Two months into 2009, due to the worsening of the financial crisis, many factories in the region were beginning to lay off their employees and partially shut down their factory operations. For the case company, the threat of having to shut down appeared to be imminent because its customers were beginning to abandon the company's products for cheaper alternatives. Brainstorming sessions with the sales and marketing personnel reached the consensus that the only way to stem the declining trend was to bring the company's selling price down to a more competitive level. This would only be possible if the cost of production could be reduced, which explained the CEO's enthusiasm for this project. On the other hand, some of the managers were more pessimistic and skeptical about the efficacy of quality costing. The tendency was to avoid doing something that they perceived to have no effect. Apart from this lack of interest, the implementation also encountered some other resistance and barriers. Below is a discussion of these barriers, including some phrases and sentences used by the interviewees to reflect the richness of their replies and the context in which they were given.

- The existing accounting system was not designed to capture quality costs. This is consistent with similar findings by other researchers (e.g. Bamford and Land, 2006; Keogh *et al.*, 2003).
- There was a lack of understanding of the concept of quality cost, with many considering it to consist merely of the cost of maintaining the quality assurance department. Similar observations have also been reported by other researchers. For example, in a survey study conducted by Sower and Quarles (2003), it was found that lack of COQ knowledge was the primary reason for not tracking quality costs.
- Many of the staff deemed quality costing as an extra workload, while some thought it would incur more expenses to track quality costs instead of saving.

For example, one comment was: "spending costs to track another cost may further increase our operating expenses." The perception that tracking quality costs would incur cost instead of saving has not been found in the available literature.

- The production personnel were direct. They said "Uh, more paper work again!" and "Please, we have enough paper work" when they learned that tracking quality costs may involve filling in some forms to collect the data. This finding concurs with Pursglove and Dale (1996), who noted that one of the barriers to implementing a quality costing system is the problem of persuading production staff to log in details concerning non-conformance. In their study on two construction projects in the UK, Barber *et al.* (2000) encountered similar problems getting company personnel to fill in standard forms relating to quality costs. They complained that they were already filling too many forms relating to other efficiency initiatives.
- The marketing personnel were more diplomatic. They said: "Excellent! It is a good measure [. . .] but it is the job of the QA and the accounting people [. . .] we need to focus more on getting sales [. . .] ". Their message was the same – i.e. a dislike for extra workload, although it was expressed differently.
- The employees, especially those at the lower level, gave the implementation a lukewarm response. Tracking quality costs was perceived as extra paperwork that might not bring about any tangible benefits to them. Machowski and Dale (1998) reported similar findings. In their study on COQ system implementation in a manufacturing company, it was found that although their respondents seemed to be able to appreciate the concept of quality costs, they were more motivated by targets and bonuses.
- Although a quality cost briefing was held, the impression that the researchers got was that – perhaps with the exception of the accountant – the others were still not very convinced of the need to track quality costs.

Towards the end of February, 2009, the company actually shut down for three weeks until mid-March owing to the worsening of the economic downturn. A sense of pessimism was prevailing and what the employees looked forward to was more physical work rather than paperwork. This phenomenon inevitably exerted more pressure on the task force that had been assigned to identify areas where costs could be reduced to bring down the company's selling price.

The documentary analysis did pinpoint some abnormalities, and the researcher took it upon himself to seek clarification from people on the production line. It was found that generally they did not mind spending a few minutes (usually between 15 and 20 minutes) in informal conversation. During such conversations, they clarified questions raised by the researcher and sometimes even voiced their opinion. They tended to be more candid when engaging in informal conversations. It appears that people were more ready to talk than to fill in forms.

Analysis from past production records as well as informal conversations with the operatives helped to reveal substantial hidden costs, which are discussed below.

Under-utilization of installed capacity. The main production facilities consist of an agro-waste and scrap crushing section, located away from the main plant, which

comprises a complete extrusion line, and a trimming-cum-cutting section. The extrusion line is designed to run 24 hours a day, seven days a week. Originally, the workers were supposed to work on three shifts on a rotation basis with the proviso that none of the worker was required to work more than 48 hours per week. Below is the time schedule of the three shifts:

(1) *Shift 1*: 7.00 am to 3.00 pm;
(2) *Shift 2*: 3.00 pm to 11.00 pm; and
(3) *Shift 3*: 11.00 pm to 7.00 pm.

Nevertheless, owing to the low demand for the company's products, the factory had been operating on six-day week. This resulted in a loss of more than four working days per month.

The finished product of this company is a three-layer plank with two polymer outer layers and an inner layer of agro-waste bonded into a single profile. The extrusion process involves the melting of solid plastic resin in a heated chamber before being forced out through a die. It takes 140 minutes to warm up the heat chamber fully after a day off. Thus, this is another additional loss of 140 productive minutes, which incurred loss of energy, workers' time and other overheads. Further, the first lot produced during the restart process usually failed to meet specifications and had to be scrapped. All of the above were never quantified and taken into account. They represent a hidden cost to the company.

Set-up and change-over costs. The company produces a wide range of products that differ in size, thickness, and colors. The machine has to be reset whenever there is a change in product specifications. This may involve a change-over time of between 5 and 15 minutes. The first lot of all new products will also have to pass a tensile strength test before production can proceed. All tested products are not sellable and have to be scrapped. Again, the set-up and change-over costs were never quantified and captured in the accounts.

Double cutting process. During one of the many informal conversations with the production operatives, the researcher tumbled on another hidden cost in the cutting and trimming process. Under the normal production process, extruded sheets were trimmed to the standard sizes before sending to the warehouse. However, the introduction of the so-called "cut-to-size" grades meant the trimmed products had to be taken out of the warehouse and cut for the second time according to customer specifications. One of the normally very reserved production operatives remarked that actually the "cut-to-size" process could be done directly after extrusion. This would save the trimming process and reduce the amount of off-cuts. The researcher alerted the manager who readily agreed that considerable labor time could be saved by using the single cutting process for the "cut-to-size" grades. It was a very simple logic, but overlooked simply because they were used to automatically trim the products immediately after extrusion.

Machine down-time. An investigation discovered that there was significant machine downtime at the grinding-cum-crushing section. The cost of the downtime was never quantified. The function of this particular section is to crush and grind agro-waste, scraps, and off-cuts into small particles for feeding into the extruder. It is isolated from the rest of the operation areas because of the dust it generates. It was also an area that

escaped management's notice, partly because it was perceived to be a simple process, and partly because nobody liked to go into the dusty enclosure.

The grinding-cum-crushing section was manned by three operatives. One of them unintentionally disclosed to the researcher that if management were to spend some money to replace the old machines, which were not designed for heavy-duty usage and overheated easily, considerable machine downtime could be saved. In fact, they spent almost one-third of their time repairing the machines. When asked whether he had brought up this issue with the management, he answered that, "Nobody bothers about us here. And if they changed the old machine, one of us might even lose our job. So, why tell them?"

A subsequent enquiry discovered that the cost of changing the machine parts and overhauling the machines would amount to about 14 months' pay of one operative. The excess operative could be transferred to another department without having to retrench him. This is yet another clear evidence of hidden costs, which reveal the weaknesses in management practice and process design. Mid-level management was initially rather apprehensive over this kind of discovery, which they perceived as an exposure of their inefficiency, probably for fear of being reprimanded. Thus, they did not give wholehearted support to the quality cost investigation exercise. When asked for data, they would give all sorts of excuses to stall the provision of information, like "Too busy", "Too much work" or more politely "We will give the data later", or "Will try to do it next week", but "next week" had been repeated several times, apologetically of course.

However, with the repeated assurances of the CEO that "It is not to find fault with anybody. It is just to find ways to improve our efficiency", mid-level management were more forthcoming with information.

L/C discrepancy charges. An examination of the export and banking documents for the past 12 months revealed that approximately 61 percent of the shipments under export letters of credit (L/C) were subject to discrepancy charges of ranging from $US50 to $US100 per transaction – a condition imposed by the issuing banks. Whenever a set of shipping documents did not comply fully with the L/C terms and conditions, it would incur discrepancy charges and additional interest charges for late reimbursement by the issuing bank to the negotiating bank. This discrepancy charge had gone unnoticed because it was deducted directly from the export proceeds and had never been singled out – a kind of cover-up.

An analysis of the root cause indicates that most of the time, it was due to lack of coordination between the various departments, such as sales, warehousing, shipping and billing. To overcome this problem, a joint meeting between the personnel from the various departments was called. During the meeting, the nitty-gritty of the terms and conditions of documentary credits were fully explained and the participants willingly worked out a better communication system to avoid future mistakes, after being told of the magnitude of the discrepancy charges and extra interest charges paid for the past 12 months.

Inventory holding costs. Inventory holding costs are another item of hidden costs. No attempt had been made to capture this cost under the traditional accounting system. The record indicated an average turnover rate of three times sales, whereas according to the marketing department a turnover rate of two times sales would be adequate. With the economic downturn worsening, inventory of finished goods was building up

fast. A scrutiny of the breakdown of the inventory indicated an even grimmer picture. About 8 percent of the stock items were more than 12 months old. These are supposedly to be high-margin items, but per-order quantity is usually very much smaller than production lot size. This resulted in having to hold substantial amounts of this category of slow moving items. An analysis of product profitability indicated that they actually had a lower profit margin if the excess inventory holding cost was taken into consideration.

Lost sales and customer complaints. In order to track the quality loss due to lost sales, the task force vetted the debtor-ageing analysis for the last two years. It came to light that a number of customers had ceased to purchase from the company. Of this, the cessation of purchases from a Dubai importer some seven months ago raised particular concern. Firstly, this particular importer used to purchase substantial quantities from the company. Secondly, Dubai was perceived to be a growing market for the company's products in view of its booming construction industry.

An enquiry was thus directed to the export department. The researcher was told that it was due to dissatisfaction over some defective products found in the last shipment; however, they were unsure of further details since the manager who serviced this particular customer had already left the company. The task force then interviewed the warehouse supervisor to investigate the root cause of this problem. The warehouse supervisor was initially rather defensive. He disclosed that the Dubai customer's complaint was related to the shipment of some defective products and a pallet of products of the wrong thickness. He blamed the quality assurance people for the defective products, saying that all products that were sent to the finished goods warehouse had already passed quality inspection. On the shipment of wrong products, he claimed that it was happened at a time when there was a high volume of shipments and two of his assistants were on medical leave.

Using the average monthly sales to these lost customers, it was estimated that profit not earned due to lost sales amounted to 3.2 per cent of sales revenue. Customer complaints were estimated basing on time costs involved in attending to the complaints. This opportunity loss includes customer service executives' time costs and field work. The replacement of returned goods was not included under this category since it was already captured in the account and categorized as an external failure cost. The above represents the major areas of hidden quality costs uncovered. The next step is to determine the classification of these hidden quality costs.

Following Sandoval-Chavez and Beruvides (1998), the poor quality cost analysis includes "those elements in which the company potentially could have made more income and revenue if it could take full advantage of them". Under this approach, another category of quality costs called "opportunity lost in profit not earned" is incorporated in the traditional model. The revised model is now expressed as:

$$C_T = C_P + C_A + C_F + C_O,$$

where C_T is the total quality cost, C_P is the prevention cost, C_A is the appraisal cost, C_F is the failure cost, and C_O is the opportunity loss. C_O in this case includes under-utilization of installed capacity, extra set-up and change-over costs, double cutting costs, crushing machine downtime, L/C discrepancy charges, excess inventory holding costs, and lost sales and customer complaints.

Results

Based on the above discussion, the invisible opportunity costs are computed. Table III shows the quality cost elements as a percentage of sales revenue.

The result shows that quality costs captured in the traditional accounting system amount to 5.64 percent of the sales revenue, whereas the hidden quality cost amount to 8.78 percent of sales revenue, which is 1.6 times higher than the costs based on the conventional PAF model. Although this is less than the figure of three times higher, it still matches the findings of Giakatis *et al.* (2001). The total quality costs amount to 14.42 percent of the sales revenue. This lower than expected amount may be attributable to two reasons:

(1) the highly automatic production process (cf. Rapley *et al.*, 1999, wherein it was suggested that low quality costs were due to the relatively simple production process); and

(2) scrap in this particular case company may be recycled for use again.

Nevertheless, the hidden quality cost alone is already higher than the net profit margin of the case company. This matches Gryna's (1988) contention that the sum of poor quality costs has frequently been found to be larger than the company's profits. One interesting point of this finding is that most of the opportunity losses are avoidable with proper planning. For example, extra set-up and change-over time may be reduced through better production scheduling, while excess inventory holding costs may be reduced through the elimination of slow-moving items from future sales. Lastly, the opportunity loss in under-utilization of installed capacity may perhaps be improved by lowering the selling price to increase sales.

Discussion and implications

The paper has set out to study the implementation of quality costing in a continuous-process manufacturing company, paying particular attention to the uncovering of hidden quality costs and trying to gain insight into resistance against the implementation. The study supports the view that most quality costs are hidden and

Categories	Visible COQ	Invisible COQ	Total COQ	Percentage of sales revenue
Prevention	38,557		38,557	0.95
Appraisal	40,014		40,014	0.98
Failure	150,412	8,262	158,674	3.91
Opportunity loss				
Under-utilization		79,200	79,200	1.95
Extra set-up cost		13,800	13,800	0.34
Double cutting		95,550	95,550	2.35
Down time		9,625	9,625	0.24
Excess inventory		16,122	16,122	0.40
L/C discrepancy charges		3,850	3,850	0.09
Lost sales and complaints		130,050	130,050	3.20
Total	228,983	356,459	585,442	14.42
Percentage of sales revenue	5.64	8.78	14.42	

Table III. Quality costs as a percentage of sales revenue (six months)

are larger than the size of easily measured costs (Wood, 2007). The analysis shows that hidden quality costs could be avoided. The uncovering of which helped to improve quality awareness within the company, because everyone becomes aware of what non-conformance can cost the company (Salm, 1991). Nevertheless, the implementation of quality costing is not without barriers. Firstly, there is a lack of understanding on the quality cost concept. Secondly, the existing accounting and information systems do not support the collection of quality data. Lastly, there is a tendency to hide the truth. As argued by Munro (2003, p. 49), "management generally has little understanding of or willingness to be truthful about what is going wrong". During the course of the research, it was noted that apart from the general dislike for filling forms to report non-conformance, the feeling of anxiety that the uncovering of hidden quality costs would reveal operational inefficiency and ineffectiveness was clearly discernible, especially among the mid level managerial staff. As a result, some did try to find ways and means to resist the tracking of hidden quality costs. The unwillingness to uncover the hidden poor quality costs may be explained by the "learning anxiety" phenomenon. Schein (2006, p. 2) asserted that "learning anxiety" is "the feeling that if we allow ourselves to enter a learning or change process, if we admit to ourselves and others that something is wrong or imperfect, we will lose our effectiveness, our self-esteem and maybe even our identity". One way to overcome this learning anxiety, as suggested by Bamford and Land (2006), is to ensure that the people involved are able to discuss openly without fear of chastisement. Another possible solution is to introduce a scheme of quality-focused incentives to encourage uncovering and eliminating hidden quality costs.

On the distribution of quality costs, Table II indicates that failure cost forms the largest portion of the total quality costs (TQC) at 65.7 percent, with appraisal cost ranks second at 17.5 percent of TQC, and prevention cost ranking lowest at 16.8 percent of TQC. This finding indicates that the company has treated prevention activities with a low priority, which may explain the company's high failure costs. According to the wisdom of the PAF philosophy, the company can reduce its total quality costs by investing in prevention activities. For example, a case study by Visawan and Tannock (2004) shows that increased spending on appraisal and prevention caused a rapid reduction in total quality costs. However, since the data reported represents only a one-time measurement of quality costs, it is insufficient to derive any inference on the cost relationship without a comparison of the quality cost trend. This study mainly focuses on the tracking of hidden quality costs and the barriers of quality cost tracking. The study of quality cost relationship is the subject of another paper, which examines the change in quality cost distribution after corrective measures have been taken.

On the hidden quality cost elements, the high proportion of hidden quality costs as shown in Table III were mainly caused by lack of training (e.g. L/C discrepancy costs), improper production scheduling (e.g. high set-up and change-over costs), lack of employee involvement (e.g. double cutting cost), and inefficient marketing management (e.g. lost sales and high inventory costs). These findings indicate that many of the improvements do not involve sophisticated processes, but were actually suggested by frontline operatives. The key words appear to be "employee involvement". As argued by Deming (1986), employees should be encouraged to make suggestions and take a relatively high degree of responsibility for overall performance.

In summary, it needs to be emphasized that the tracking of hidden quality costs by itself does not improve a company's profitability directly. However, it does influence the attitude towards quality costs, and show the direction for remedial actions. The actual improvement will be the follow-up measures. As argued by Bland *et al.* (1998), quality costing is a tool, but quality improvement is still a management responsibility.

Conclusion

Even though the COQ concept and practices have been covered widely in the literature, there is still a paucity of research-based literature that addresses the practicalities of identifying hidden quality costs. This paper provides an insight into how hidden quality costs may be identified, and also suggests ways to improve organizational efficiency – for example the provision of training in handling international banking documents, improvements in production scheduling, and encouraging more employee involvement. The examples given may be of practical value to managers. In line with the main focus of this paper, the discussion is limited to hidden costs. Other visible costs are not emphasized.

Using the model developed by Sandoval-Chavez and Beruvides (1998), an additional category of opportunity loss is added to the conventional PAF categories. The result indicates a significant amount of both visible and invisible quality costs, which, when combined, far exceed the case company's net profit. More hidden quality costs can be expected with further investigation, for example the quality costs of employee motivation (or the lack of it), which is a new area of quality cost that has never been explored previously. Human resource management experts have long identified motivation as an important factor that influences work performance. They have attempted to appraise this aspect of work performance using situational factors (or system factors), but no attempt has ever been made to assess the quality cost of motivation. This may be an interesting area for future research.

The implication of this study is that a traditional accounting system is inadequate to meet the need of tracking quality costs. In order to track the hidden quality costs, it is necessary to move beyond the data produced by the traditional accounting system (Ittner, 1992). Furthermore, uncovering of hidden quality costs only serves to highlight the potential for improvement. It is the follow-up actions that eliminate quality costs and lead to organizational effectiveness. Further studies are therefore needed to find out how the case company makes use of the quality cost information to formulate a survival strategy at this time of economic downturn, and a growth strategy for its future expansion.

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