Available online at www.sciencedirect.com
ScienceDirect
Int. J. Production Economics 105 (2007) 560–579
international journal of production economics
www.elsevier.com/locate/ijpe

Total Quality Environmental Management and Total Cost Assessment: An exploratory study

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Received 1 March 2005; accepted 1 April 2006
Available online 28 July 2006

Abstract

This study addresses one of the major perceived barriers to Total Quality Environmental Management (TQEM): Total Cost Assessment (TCA). Managers have difficulty assessing the impact of TQEM programs because of the lack of appropriate measures. In order for TQEM investments to be given serious consideration, a process is required for measuring, monitoring and evaluating TQEM by appropriately including all the environmental costs and savings for each investment option. After reviewing the background of TQEM and frameworks for capturing environmental costs, an opportunity emerges for research involving the use of TQEM and TCA. This research presented in this study develops a framework for identifying and formulating a set of cost measures associated with TQEM investments. The framework serves as a basis for comparing environmental cost measures used among several large US companies. Two major outputs yielded by this research are: (1) a catalog of the various cost measures and procedures used to implement and carryout a TQEM–TCA and (2) the TQEM–TCA framework itself. The catalog and framework will be important for later empirical assessment and modeling of TQEM.

Keywords: Total Quality Management; Total Quality Environmental Management; Environmental cost accounting; Total Cost Assessment; Qualitative methods

1. Introduction

As firms strive to improve their bottom-line, many find that traditional pollution prevention techniques are no longer cost effective. In fact, many manufacturers have found that minimizing or avoiding waste generating activities altogether is a much more cost effective solution than traditional "end-of-pipe" strategies. Replacing these traditional strategies is a new proactive approach known as Total Quality Environmental Management (TQEM) (Bhat, 1998). TQEM has collectively been defined as an economically driven, system-wide and integrated approach to the reduction and elimination of all waste streams associated with the design, manufacture, use and/or disposal of products and materials (Willig, 1994; Bhat, 1998; Curkovic and Landeros, 2000; Handfield et al., 1997; Melnyk et al., 2001). The TQEM concept, based on the theories of Deming, Juran, and Crosby to name a few, combines the principals of Total Quality

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0925-5273/$ - see front matter
doi:10.1016/j.ijpe.2006.04.021

Management (TQM) with the goals of environmental management. This gradual evolution of quality to include aspects of the environment has been anticipated by several other authors such as Mizuno (1988), Willig (1994), May and Flannery (1995), Sarkis and Rasheed (1995), Epstein (1996 a, b), Curkovic et al. (2000), and Gerhard (2002).

Fundamental to TQEM is the recognition that pollution, irrespective of its type and form, is waste. Strategies such as just-in-time (JIT), TQM, and time-based competition (TBC), have defined waste as any activity or product which consumes resources or creates costs without generating any form of offsetting stream of value (Porter, 1991; Porter and Van der Linde, 1995a, b). By minimizing waste, a firm can reduce disposal costs and permit requirements, avoid environmental fines, boost profits, discover new business opportunities, rejuvenate employee morale, and protect and improve the state of the environment (Hanna et al., 2000). It would be expected that more managers be interested in the development and use of TQEM-based systems. However, according to some, for most firms, TQEM has not achieved the same degree of acceptance as have JIT, TQM, and TBC (Angell and Klassen, 1999; Epstein, 1996a, b; Makower, 1993, 1994).

One of the most important problems associated with the development and implementation of TQEM systems is that managers have difficulty assessing the impact of TQEM investments because of the lack of appropriate measures. In order for TQEM programs to be given serious consideration, a process is required for evaluating TQEM by appropriately including environmental costs and savings for each investment option (Sarkis and Rasheed, 1995; Epstein, 1996a, b). Unfortunately, many projects that pursue pollution prevention and support TQEM are quickly overlooked in traditional capital budgeting processes based on research from Greer and Van Loben Sels (1997). A fundamental goal of TQEM is to get companies to recognize environmental costs and incorporate them into the capital budgeting process so that better decisions can be made. By incorporating Total Cost Assessment (TCA) into each project, environmental proposals can successfully compete with non-environmental alternatives for valuable capital resources within the company.

The purpose of this study is to develop a conceptual framework for managers to identify and assess the relative costs associated with environmental business practices. The objective from the onset was to identify and capture all relevant costs (qualitative and quantitative) using existing cost measures, but evaluating these measures using a newer and more effective approach. The proposed approach is the TQEM–TCA framework.

The paper is composed of several sections. To start, the background of TQEM and TCA and other relevant accounting methods are used to identify a gap in the literature and establish a need for the research presented. Following the review of the literature, a cost framework is presented, and the research methodology is discussed. The paper will then discuss the results from field visits, implementation issues, and implications for future research.

2. Total Quality Environmental Management

The results of the literature review show that the move to adoption of environmental business practices and TQEM has been viewed from a perspective heavily influenced by either normative or legal considerations by Friedman (1992), Klassen (2000a, b), and Curkovic (2003), with some evidence that TQEM can be motivated by the potential for competitive advantage and improved public relations by Khanna and Anton (2002). Epstein (1996a, b) found that for most companies, compliance is seen as an adequate position to assume. With compliance, the firm does only what is necessary to meet the letter of the law. It is a reactive position that means environmental problems are corrected once they have been created. Many have claimed this is relatively ineffective because it does not attack the causal factors, merely the symptoms (Carpenter, 1991; Alm, 1992; Allenby, 1993; Gupta and Sharma, 1996; Klassen and Whybark, 1999a, b). It is also a potentially dangerous position given the retroactive and dynamic nature of many laws. That is, what may be in compliance today may be considered out-of-compliance tomorrow. As a result, the firm may find itself always spending to bring itself into compliance with regulations that are continuously becoming more stringent.

The challenge of determining whether it is better for the firm to simply emphasize compliance or whether the firm wants to become recognized as an industrial leader in the development and application of TQEM based systems describes the first of many obstacles and paradoxes surrounding the TQEM literature. In large part, the failure of management to become more environmentally responsible is really a reflection of its inability to address and resolve these paradoxes and problems. The following are some of the most important paradoxes and problems associated with the development and implementation of TQEM systems:

- Hunt and Auster (1990), Epstein (1996a, b), and Hanna et al. (2000) claim top management must be willing to accept and champion corporate-wide developments if TQEM is to become widespread. However, when dealing with TQEM, some research has shown there is a strong bias in favor of ignorance at the highest levels of the firm by Makower (1993, 1994), and ReVelle (2000).
- Findings from Palmer et al. (1995) and Hanna et al. (2000) show that in the short run, implementing TQEM often causes costs to rise. However, there is a real concern as to whether customers are willing to pay the added costs associated with having something that is environmentally friendly (Rosewicz, 1990; Willig, 1994; Hanna and Newman, 1995).
- It has been argued by Klassen and McLaughlin (1993), Klassen (1993), Klassen and Whybark (1994), Willig (1994), Geffen and Rothenberg (2000) and Sroufe (2003) that being environmentally responsible ultimately makes a company more efficient and more competitive. However, there are many reported cases of environmentally responsible investments which have resulted in negative returns by Makower (1993, 1994), Walley and Whitehead (1994) and Klassen and Angell (1998).
- Alm (1992) Fiskel (1993, 1996) Angell and Klassen (1999), Melnyk et al. (2001) and Ahmed (2001) support the notion that ideally, the most appropriate place for considering TQEM issues is in the design phase since the amount of waste generated is a direct consequence of decisions made during design. However, Van Weenen and Eeckles (1989), Allenby (1993) Graedel and Allenby (1995) and Sroufe et al. (2000) claim there is a lack of appropriate measures and tools for capturing the environmental impact of designs.
- There is evidence by Vastag et al. (1996), Bhat (1998), Takeuchi et al. (1999), Curkovic et al. (2000), and Revelle (2000) that managers need frameworks or guidelines which they can use to better understand what TQEM is and its components. However, a great deal of the information surrounding TQEM is either legally based or derived from anecdotal stories and case studies as pointed out by Willig (1994) and Curkovic (2003).
- Finally, and the focus of this study, managers have difficulty assessing the impact of TQEM programs because of the lack of appropriate measures. In order for TQEM to be given serious consideration by a firm, it has been suggested by Sarkis and Rasheed (1995), Epstein (1996a, b), Klassen and McLaughlin (1996), and Bhat (1998) that a process is required for evaluating TQEM by appropriately including environmental costs and savings for each investment option. However, there appears to be a lack of easy-to-use measures.

At present, several conceptual frameworks for identifying the various costs associated with waste and pollution have been proposed. These include Allenby (1993), Huang and Hunkeler (1995/1996), Bhat (1998), and Bengt's (2005) work on *Life-Cycle Assessment* (LCA), GEMI (1992, 1993), Willig (1994), and the work by White et al. (1993) involving *environmental cost accounting* (ECA), Popoff and Buzzelli (1993), Makower (1994), Savage and White (1995), and Epstein (1996a, b) work on *full cost accounting* (FCA), and Epstein (1996a, b), Kennedy (1994), White et al. (1995), and Kennedy's (1998) work on TCA. Of these approaches, LCA has been recognized as extremely information intensive, difficult to implement, somewhat subjective and difficult to defend. With LCA, you must be prepared to show your methodology and open it up to peer review, or public scrutiny. If you are not ready for that scrutiny, then you are not ready for LCA. Examples of this can be found in issues brought up by Makower (1993, 1994), or Epstein (1996a, b) involving the clamshell controversy at McDonalds and with the insights gained from scrutinizing LCA predictions for disposable products. Presently, LCA has very limited use in industry.

The other frameworks such as ECA, FCA, and TCA are derived from the same premise that accounting systems need to incorporate environmental information. There is also a limited use of these accounting approaches in industry. Their common call for the inclusion of environmental costs is an overlooked opportunity for managers to use this information to make decisions concerning the allocation of scarce resources toward environmental project needs. Thus, the application of these techniques presents a gap in the literature and an opportunity for researchers to explore the use of these frameworks in the field. This research need not create new tools and measures to capture environmental information; instead existing measures can be used.

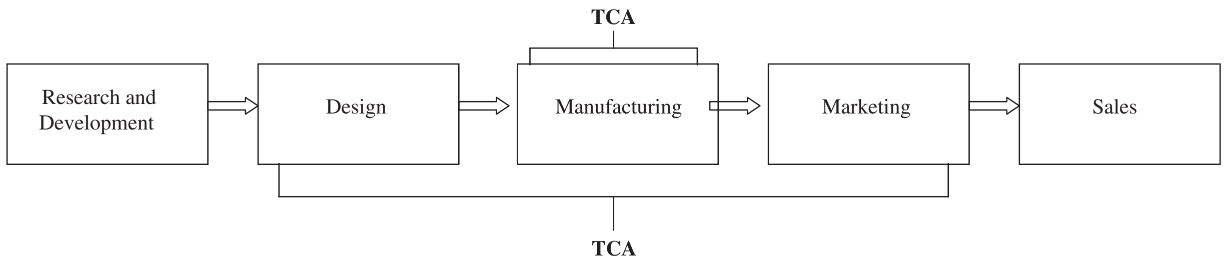
3. Total Cost Assessment

White and Savage (1995) claim environmental accounting can be defined as a general term for the identification, compilation, analysis, and reporting of environmental information within the firm. Its applications extend across a variety of business decisions such as the identification of TQEM investments and the financial analysis of such investments. In general, environmental accounting includes both materials accounting and ECA. Materials accounting information provides the foundation for decision-making. However, an understanding of how materials and energy impact a process is essential for identifying potential improvements. ECA information translates the business impact of environmental issues into quantifiable measures that can be used in a cost/benefit analysis. ECA provides businesses with the information they need to improve their environmental performance while reducing costs.

According to Popoff and Buzzelli (1993), White et al. (1993), or Savage and White (1995) one application of ECA is FCA, which includes environmental costs that accrue to identifiable third parties or to society as a whole. Examples would include global warming from carbon dioxide emissions, the depletion of rain forests, or damage from acid rain. FCA in its strictest sense would encompass these costs. While the future of FCA is to extend cost analyses to absorb these external impacts, no firms today are moving in this direction. Most companies do not even have their internal corporate costs in order, let alone an ability to externalize them. However, one application of ECA that has more realistic applications and has evolved in its usage is TCA.

TCA is concerned only with costs to the company itself. Unlike FCA, TCA does not consider both internal and external (or societal costs). White and Savage (1995) support the idea that TCA is an ECA method that allocates both direct and indirect environmental costs to products, processes, and services. This cost allocation begins by analyzing business processes and deciding which competitive priorities of the business to examine. For example, does the company want to concentrate its TCA efforts solely on manufacturing or should they look at the process from research and development to sales? Although this seems like a basic question to ask, many companies overlook a great number of opportunities that are present by examining only one aspect of their business (Fig. 1).

Next, a company must examine all of the costs that go into a process. The reason for this is that many of today's inefficient allocation decisions can be attributed directly to the fact that most environmental costs are hidden in general overhead categories. These costs are usually grouped in two ways. The first set is manufacturing, which deal primarily with product costs. The second set, sales and general administrative overhead, deal with period costs. Although they may seem similar, product costs are those costs the firm has incurred to make the product while period costs are those the firm considers to be part of operating the business itself. Both categories can include items from production equipment and materials to human



Source: Finding Cost Effective Pollution Prevention Initiative (Global Environment Management Initiative)

Fig. 1. Total Cost Assessment can encompass any combination of business activities.

Table 1
Typical costs included in overhead

Manufacturing OH	General Administrative OH
Disposal costs	Research and Development
Maintenance	Human Resources
Waste treatment	Legal Affairs
Safety equipment	Environmental Compliance
Supplies	Marketing

Source: accounting and capital budgeting for environmental costs workshop (Environmental Protection Agency).

resources and research and development costs (Table 1).

According to accounting standards, companies are supposed to take costs not directly measurable or assignable and place them in a general overhead category (Savage and White, 1995). However, by doing this managers are unable to recognize certain costs as environmental costs. This is where the most important phase of TCA begins. A comprehensive cost/benefit inventory is an essential part of any financial analysis, particularly for environmental projects. Identifying all costs and savings associated with a TQEM program is the first and most important step in TCA. One way for companies to accurately account for environmental costs is by breaking all of the processes down into what is known as the "Four Tiers". By doing this, managers will create categories that will encompass all the environmental costs. This will allow companies to recognize these costs as environmental costs and guide them to better capital budgeting decisions. These categories consist of direct costs, hidden costs, contingent liability costs, and less tangible costs. Each is described below.

Direct costs: those costs that are directly linked to the product, process, or service. Out of all TCA components, direct costs are the easiest to identify and quantify. These can be typically found in traditional data sources that most companies employ and can include items such as: capital expenditures, equipment installation, project engineering, material, labor and waste management.

Hidden costs: those costs that are typically hidden in general overhead categories. There are two important steps to identify and quantify them. First, the company must identify those environmental laws and regulations that are applicable to their business. Then the company must estimate the current costs of complying with those regulations both now and in the future. In most cases this data is also easily obtainable under current accounting systems and includes such items as compliance reporting, education and training, legal support, sampling, and testing.

Contingent liability costs: those costs usually associated with liabilities that result from waste and materials management. These costs are divided into two main categories. First, the costs associated with accidental releases, and second, those costs that result from legal damages or personal injury. Unlike the other categories discussed so far, contingent liability costs are not easily attained. These costs usually have to be estimated and there are various ways to go about this process. Many companies rely on past experience while others study similar businesses within the industry. Both have about the same accuracy and are used equally.

Less tangible costs: these costs are considered to be the benefits obtained by an improved corporate image. Less tangible costs are the most subjective and controversial of those listed so far. Like contingent liability costs, they are very difficult to attain and also very troublesome to estimate. Most companies that account for less tangible costs measure them according to increased revenues or decreased expenses due to improved corporate image. These costs can include goodwill, community acceptance, and an improved image. Other examples include lower product acceptance by consumers, strained employee/union relationships, negative corporate image, and strained customer/supplier relationships.

After reviewing the background of TQEM and conceptual frameworks for capturing environmental costs, an opportunity emerges for research involving the use of TQEM and TCA. The development of both the framework for this study and the interview protocol is based on a review of the literature. Conducting research to fill this gap in the literature will provide managers with a new evaluation tool for environmental programs using existing metrics. Presented with the opportunity to fill this gap, a multi-method approach was chosen to develop a framework and solicit information from practitioners (Table 2).

4. Research methodology

The purpose of this study was to identify the cost measures being used by companies and how these

Table 2
Four tiers of costs

"Four Tiers"	
Direct costs	*Hidden costs*
Buildings	Regulatory Compliance
Equipment Installation	Environmental Monitoring
Project Engineering	Legal Support
Material	Sampling and Testing
Labor	Education and Training
Waste Management	Utilities
Contingent liability costs	*Less tangible costs*
Accidental Releases	Corporate Image
Legal Damages	Community Goodwill
Settlement for Remedial Actions	Customer Acceptance

Source: finding cost effective pollution prevention initiatives (Global Environmental Management Initiative).

measures could be used in evaluating TQEM investments. Since the focus of this research was exploratory in nature (rather than confirmatory), qualitative data collection methods were used. Field-based data collection methods were used to ensure that the important measures were identified. Eisenhardt (1989) has also demonstrated that field-based data collection methods also help develop an understanding of why these measures might be important. A small detailed sample fit the needs of the research more than a large-scale survey would have.

The method followed was similar to the grounded theory development methodology suggested by Glaser and Strauss (1967). In instances where a well-developed set of theories regarding a particular branch of knowledge does not exist, Eisenhardt (1989) and McCutcheon and Meredith (1993) suggest that theory building can best be done through case study research. Comparative literature reviews of TQEM research confirms it is at an early stage of development as expressed by Klassen, (1993), Klassen and Whybark (1999a), Porter and Van der Linde (1995b), Bhat (1998), Angell and Klassen (1999), and Curkovic (2003). In this stage of theory building, a key objective is to capture and characterize the different types of environmental costs used by firms.

There are some pitfalls to case study analysis as revealed by Eisenhardt (1989), including lack of simplicity or narrow and idiosyncratic theories. A primary disadvantage of the case research approach is the difficulty in drawing deterministic inferences, and there are limitations in terms of the external validity of the study. Cook and Campbell (1979) claim these limitations are often addressed by using large samples, or using "before" and "after" quasi-experimental designs. However, due to the lack of theory building in the area of TQEM and environmental cost measurement systems, it is important to use the case study approach to identify similarities and differences among firms. While causality can never be shown in case studies, analysis of data collected from multiple sites can help support the generalizability of results.

5. Sample selection

Cook and Campbell (1979) suggested that random samples of the same population be used in theory testing research. However, the sample selected for qualitative research such as in this study should be purposeful as suggested by Eisenhardt (1989) and Miles and Huberman (1994). The goal of this study was to identify the environmental cost measures being used across company settings. Furthermore, the research set out to address a variety of TQEM investment outcomes.

The first step was to identify firms located in the Midwest (Wisconsin, Minnesota, Michigan, Ohio, Illinois, and Indiana) recognized as being at the leading edge in the implementation and use of TQEM programs. The ultimate number of firms selected would reflect considerations such as proximity, industrial diversity, and accessibility of critical management personnel. These firms would be studied using on-site visits and telephone interviews. This first step would serve as a type of focused benchmarking. The researchers identified and contacted companies that have developed cost systems for measuring environmental initiatives through both the literature and the researchers' knowledge of such firms. Companies and organizations responded with manuals, reports, and data on measuring environmental costs.

An initial idea of the level of TQEM and cost measurement implementation at each potential firm was obtained through preliminary screening over the telephone. Some of the questions used in making our initial assessment can be found in Appendix A. Twenty firms were initially contacted and screened. After the initial screening, which also addressed the willingness of the company to participate, 11 firms were again contacted and site visits were arranged. The interviews were conducted with managers responsible for portions of cost measurement at each site. Some titles of the people interviewed included: Manager of Environmental Policy, Director of Strategic Environmental Initiatives, Corporate Environmental Manager, and Manager of Corporate Environmental, Health, and Safety.

6. Interview protocol

Eisenhardt (1989) suggested that a researcher should have a well-developed interview protocol before making the site visits. A structured interview protocol was used at all of the firms. The interview protocol, included in Appendix A, was developed based on the researchers' general understanding of TQEM and cost measurement. The protocol was pre-tested at four companies and then used for the 11 firms included in this study. Minor changes were made to the protocol after the pre-test. Questions focused on previous and current cost measurement systems, and the roles and experiences of the players involved. Interviews were conducted in the respondents' facilities and discussions focused on the consideration of cost measures as an important part of their TQEM investments.

Research in the field of qualitative research by Eisenhardt (1989), Miles and Huberman (1994), and Yin (1994) show that qualitative theory building research is an iterative process. Eisenhardt (1989) suggested that data collection and data analysis should be done simultaneously. In other words, the data from one case is collected and then analyzed before the next replication is performed. Improvements in the protocol can be made between replications by collecting data in this manner. Important issues that are raised in early cases can be included in the protocol for subsequent replications. This ability to refine and improve upon the protocol between cases is a significant advantage of this type of research. For the sake of clear explanation, the data collection and analysis are described separately in the following sections. However, the actual process was one where a case was collected, analyzed, the protocol was improved upon, and then the next case was collected.

7. Data collection

The primary data collection was done using structured interviews in a field setting. Eleven firms were visited over a 1-year period. The companies were located in 6 Mid-Western states: (1) Michigan; (2) Ohio; (3) Indiana; (4) Illinois; (5) Wisconsin; and (6) Minnesota. Structured interviews at each company generally took place with the environmental manager. Data were collected following a strict interview protocol. The primary researcher was accompanied on all visits by a second researcher who reviewed all field notes prior to final coding. The use of multiple interviewers at every firm helped limit possible biases introduced by a single researcher. The field notes identified responses to all of the protocol questions, answers to other questions that were raised during the interview and tour, and other information such as company publications. Follow-up phone calls to all the non-participants claimed conflicts with proprietary information, or a lack of time. The protocol focused on the metrics being used, where they were being used, and the role of management in environmental initiatives. General information on the respondents and company can be found in Table 3.

Table 3
Profile of companies and respondents

Company*:	Respondent:
1. Annual Sales Revenue	(1) Job title
2. Publicly vs. Privately Held	(2) Length of time involved in environmental initiatives; & time in current position
	(3) Nature of formal education
	(4) Current job responsibilities
*All companies are US based	(5) Previous job responsibilities
C1: Beverage producer	
1. >$15 Billion	1. Director of STRATEGIC environmental initiatives
2. Public	2. 27 years; 6 years
	3. BS in civil engineering, MS in env. engineering, MS in environmental management
	4. International environmental affairs, pollution prevention, and environmental performance measurement
	5. General environmental affairs and environmental engineer

Table 3 (*continued*)

C2: Auto Powertrain Manufacturer	
1. >$15 billion	1. Senior Environmental Project Engineer
2. Public	2. 6 years; 3 years
	3. BS in mechanical engineering, MBA in operations management
	4. Environmental compliance for two manufacturing facilities
	5. Facilities engineering
C3: Office furniture manufacturer	
1. >$1 billion	1. Waste Reductions Recycling Coordinator
2. Private	2. 15 years; 15 years
	3. BS in mechanical engineering
	4. Create a solid and hazardous waste reduction program, monitoring waste cost and volumes of materials recycled
	5. Supervisor of grounds, plant custodians, and waste handlers for area sites
C4: Automotive manufacturer	
1. >$15 billion	1. Director of Stationary Environmental Energy
2. Public	2. 10 years; 2 years
	3. BS and MS in mechanical engineering, MS in automotive engineering, and MBA
	4. Environmental planning, compliance assurance, energy planning, and utility relations/regulations
	5. Vehicle certification, plant management, and international
C5: Office furniture manufacturer	
1. >$1 billion	1. Director of Corporate Environmental Engineering
2. Public	2. 18 years; 4 years
	3. BS in microbiology and public health, MBA in management
	4. Corporate management of environmental programs and compliance
	5. Staff level environmental projects
C6: Tool and die shop	
1. >$30 million	1. Plant Manager
2. Private	2. 3 years; 3 years
	3. BA in business administration
	4. Manage one manufacturing facility which includes environmental compliance
	5. Manufacturing foreman
C7: Utilities service provider	
1. >$10 billion	1. Manager of Environmental Policy
2. Public	2. 7 years; 4 years
	3. BS in agricultural economics
	4. Development of environmental policy, goals, and management systems for operating subsidiaries
	5. Governmental affairs, federal and corporate strategic planning
C8: Chemical manufacturer	
1. >$15 billion	1. Global Director of Environmental Stewardship
2. Public	2. 8 years; 3 years
	3. BS in chemical engineering
	4. Environment, distribution, health, and safety information systems
	5. Plant manager and Director of EH&S for Asia/Pacific
C9: Medical equipment manufacturer	
1. >$5 billion	1. Director of Corporate Environmental Health, and Safety
2. Public	2. 15 years; 15 years
	3. BS in chemistry, MA in liberal studies
	4. Environmental compliance and information systems
	5. Environmental engineer
C10: Direct-sales business	
1. >$1 billion	1. Manager of Corporate Environmental Health, and Safety
2. Public	2. 5 years; 5 years

Table 3 (*continued*)

	3. BA and MA in chemistry 4. Environmental compliance, industrial hygiene, worker health, product safety, and toxicology 5. Group leader for analytical chemistry and microbiology
C11: Computer hardware manufacturer	
1. >$15 billion 2. Public	1. Corporate Environmental Manager 2. 15 years; 6 months 3. BS in zoology and biology 4. Corporate level functions for environmental activities, develop policy, provide training, strategic planning, and remediation 5. Air and waste compliance manager

8. Data analysis

The researchers participating in this project relied primarily on the methods of qualitative data analysis developed by Miles and Huberman (1994), which consist of anticipatory conceptual model development and simultaneous data collection, reduction, display, and conclusions testing. After the above steps were taken, the authors went back to the literature to look for similar frameworks upon which to build. Overlapping research methods were used in order to provide a broader approach to capturing environmental costing practices.

The reasons for using a single method or paradigm "qualitative, or quantitative" according to Creswell (1994), are pragmatic, such as the extensive time required to use both paradigms adequately, the expertise needed by the researcher, and the desire to limit the scope of the study. The multi-method, or "triangulation" approach highlighted by Denzin (1978), Jick (1979) and Brewer and Hunter (1989) is based on the assumption that any bias inherent in particular data sources, investigators, and methods would be neutralized when used in conjunction with other data sources, investigators and methods.

The two main components of data analysis included within and across case analysis. As recommended by Yin (1994), within case analysis helps examine TQEM and cost measurement systems in a single context, while the across case analysis served as a form of replication where the constructs of interest in one setting were tested in other settings. One concern was controlling for the affects of the researchers' a priori beliefs as to the reasons why cost measures were or were not used. This was accomplished a variety of ways. First, the primary researcher wrote up the field notes prior to coding. The secondary researcher, who also went, reviewed these notes. By using a variety of secondary researchers, a second unbiased person reviewed the notes. Any discrepancies between the primary researcher and the secondary researcher were clarified through follow-up contact with the respondents.

The second step taken was intended to mitigate against confirmation bias. That is, the amount of within case analysis performed before the cross case analysis was limited. Miles and Huberman (1994) note that the acts of coding and data reduction are actually forms of data analysis. In other words, the act of coding could lead to confirmation bias problems in future cases. Therefore, coding for within case analysis was limited to categorizing the individual case on previously identified constructs and identifying interesting new issues to pursue at future sites. We were more open to alternative explanations raised in future replications by avoiding comparisons early in the research.

The between case analysis consisted of looking for patterns of firms' experiences with TQEM across the various organizations. Between case analysis is facilitated by using a variety of tools to reduce the amount of data and to display the data in a meaningful fashion as suggested by Miles and Huberman (1994) and Yin (1994). Data reduction was done primarily through categorization. A number of categories were formed based on the literature. Through a process of combination, renaming, and redefining, the data was reduced to main concepts that were most frequently noted as reasons for using cost measures.

9. Results

As would be posited from the literature review, the results showed that all of the companies actively and accurately measured direct costs (e.g., those costs that are directly linked to the product, process, or service). Direct costs included: (1) depreciable capital costs/operating expenses; and (2) waste management/disposal costs. Depreciable capital costs and operating expenses represent investments in technology and operating practices needed to implement TQEM investments (i.e., equipment, materials, and labor). Waste management costs would include hauling, storage, handling, waste-end fees and taxes, and insurance and liability; disposal costs include all of the direct costs associated with waste disposal (i.e., solid and hazardous waste, and off-site recycling). The main reason cited for their usage was that the data is easily derived from their current accounting systems and little estimation is required. The costs considered and used most frequently were the waste management costs that necessitate TQEM investments in the first place (e.g., air emissions, wastewater, energy, hazardous waste) (see Table 4).

The literature posited that most companies would accurately measure hidden or regulatory costs. These are the costs associated with pollution practices (i.e., notification, reporting, monitoring, testing, record keeping, training, inspection, labeling, permitting). However, some of the companies actually said they measured these hidden costs the worst (C1, C5, C7, C10). C1 said these costs are usually charged to and buried into overhead accounts. C5 said regulatory driven costs such as reporting are difficult to measure because they are mixed into other project costs. C7 added that hidden costs are largely staffed costs, and relatively small compared to capital and operating expenses, so less attention is paid to them.

Also, as expected from the literature, contingent liability costs (e.g., those costs usually associated with liabilities that result from waste and materials management) and less tangible costs (e.g., those costs considered to be the benefits obtained by an improved corporate image) were the most difficult to measure. Many of the companies discovered that, although important, estimating these categories is rather difficult because methodologies for doing so are not well developed, are very subjective (which leads to very large margins of error), and are very time consuming (C1, C2, C7, C9). Such contingent and less tangible costs have yet to be included in the capital budgeting process for any of the respondents. It is in these two categories that most managers felt the greatest need for improvement exists.

Supporting similar results from Pil and Rothenberg (2003) several companies cited ongoing efforts to reduce the amount of hazardous material, air emissions, and waste water used in production which also resulted in less waste and better quality products from the process itself. These types of changes had easy to measure changes on items such as waste disposal, but they also had less tangible benefits such as improved image and reduced liabilities. However, these less tangible benefits were not a part of the cost/benefit analysis because they were too difficult to quantify and the margins of error were too high. The respondents also felt that the majority of all environmental costs were contingent (e.g., future regulatory compliance and liabilities such as Superfund). Their conventional accounting systems were not designed to assess these contingent costs. The literature suggests that some managers avoid quantifying liabilities because this admission of known risk may be used against the company (e.g., future Superfund litigation associated with hazardous waste). However, none of the respondents were concerned with future tort as a barrier to quantifying these risks but were very concerned with the methodological barriers.

Four companies (C1, C2, C5, C11) said that their current cost accounting systems are not supportive of measuring environmental costs. C11 is trying to look at Activity Based Costing for environmental

Table 4
Responses to cost category questions

Costs	Do you measure this cost category?	Do you plan on measuring this cost category in the future?
Direct costs	11 out of 11	All companies plan on measuring
Hidden costs	5 out of 11	Two of remaining 6 companies
Contingent liability costs	9 out of 11	All companies plan on measuring
Less tangible costs	1 out of 11	Three of remaining 10 companies

expenses, but currently most of their facilities' environmental costs are part of the facility's costs or are buried in the costs for other facilities. C2 expressed a need to be able to associate environmental costs to complement manufacturing costs. C5 said their current cost accounting systems fail to isolate and identify costs as environmentally related: meaning they are usually mixed into total project costs and are hard to capture. Furthermore, C5 was certain that costs varied significantly by product line for storing waste, controlling emissions, monitoring, off-site disposal, and inspection. Not only do these costs vary by product and process in the same facility, but they also spread throughout multiple staff functions (e.g., quality, production, purchasing, environment, etc.). This implies that modifying current cost measurements systems not only requires better tracking and allocation, but also requires cross-functional integration.

Current accounting systems are also not set up to capture most cost categories; meaning, costs are usually buried in total project cost (C2, C5, C9). These companies argued that the weakest part of their cost measurement system was not the probabilistic nature of contingent liability and less tangible costs. Instead, it was the omission of costs because their accounting systems buried them in overhead where they were misallocated. For example, the labor and supervision of training, labeling, testing, record keeping, reporting, manifesting, etc., are all TQEM related costs. Most companies said these types of costs were usually assigned to general overhead accounts. They were not allocated to the product or process that was responsible for their activity. C5 even cited that when these costs are allocated to the corresponding activity for the purposes of capital budgeting, the basis for allocation (such as labor used per unit of production) may not correctly relate the overhead costs to the activity generating the cost. Even if incentives for improved cost allocation are put in place, shifting TQEM-related costs to specific products and processes may be unwelcome to managers if the end result is a product line looking less profitable. It is very unlikely that environmental costs are driven equally by different products and process.

The companies were also asked to describe a recent project requiring at least $5000 that was a compliance driven-investment (focus is on only meeting the requirements of regulatory agencies). Descriptions of the investments included: correcting a storm water management system design flaw (C2), a system to monitor and track waste water (C3), installation of an air abatement system (C5), purchasing a fluc gas scrubber which removes sulfur dioxide from utility boiler emissions (C7), and the development of an employee commuter program under clean air regulations (C11). All of these investments required at least one year to complete. The only cost measurements used in the decision-making process for these investments included operating, waste management, and disposal costs. The companies acknowledged that having some form of cost measures helped, but not having a more exhaustive list (especially for regulatory-driven costs) limited the evaluation of alternatives. These compliance-driven investments were determined to have little or no cost savings and no foreseeable payback period. The respondents felt that this was largely a function of the investments being compliance-driven, but also by the lack of cost measures to better assess investment alternatives.

The results of this study should not imply that no good investments are being made. The companies were also asked to describe a recent project requiring at least $5000 that resulted in benefits which exceeded the investments made. A description of the investments made included: placing vertical balers in manufacturing areas (C3), installation of paint removal process (C5), separate disposal of paper products for recycling throughout the plant (C6), and bio-mass fuel co-firing (C7). Their reasons for undertaking the investments included: increasing revenue on recycling and decreasing material handling and hauling costs (C3), reduce toxicity of waste and waste management costs (C5), increase revenue on recycling (C6), and cost reductions (C7). All of the investments took less than 1 year to complete. All the respondents used some form of cost measurement, but again, the focus was on direct costs (operating, maintenance, and waste management). C3 said the cost of disposal was eliminated and they actually received a profit after handling, sorting, baling, and shipping were taken out. C5's capital costs were in the millions but the payback period was 2 years. C6's costs included: contract disposal service which supplied containers, creating areas for locating large disposal containers within each building. However, the benefits included: intangible goodwill, recycled paper paid for disposal service and reduced disposal costs of other non-paper products (less waste/month). Once again, a payback period of less than 2 years. C7's costs included: small additional capital for fuel handling, administrative costs for monitoring boiler performance to determine possible performance degradation, risks—untried fuel mix introduced into process—possible equipment damage. Benefits—lower fuel costs, reduced sulfur dioxide emissions (no sulfur in bio mass fuel), assisted customer in waste disposal—we burned their waste (intangible benefit).

When asked about the investments made, all of the investments had a focus on process rather than others such as product or packaging. In fact, each of the 11 companies was asked the general focus of their organization's TQEM investments. All 11 said "process". Two companies (C8 and C10) also included product and packaging, but all included process. This seems counter intuitive since the literature posits that the most appropriate place for considering TQEM issues is in the design phase. The reason for this is because the amount of waste generated is a direct consequence of decisions made during design. However, the literature also acknowledges there is a lack of appropriate measures and tools for capturing the environmental impact of designs.

These case studies are important because they show how economic benefits can be combined with the implementation of environmental initiatives. The case studies also describe the factors affecting the implementation of environmental initiatives, how firms measure success, and the resulting costs and benefits attributable to obtain TQEM. Lastly, a major output yielded by the case studies is a catalog of the various cost measures (see Table 5).

10. Using Total Cost Assessment

Once a company has developed a system to classify and account for all the costs associated with various projects, they can begin the long and difficult process of evaluating their processes. The first step in the evaluation process is to break each procedure down and classify its costs into the "four tiers". By identifying all of the direct costs, hidden costs, contingent liability costs, and less tangible costs companies can begin to "screen" their processes. The purpose of screening is to provide management with a quick "snapshot" of each process so they can compile cost information and determine opportunities for improvement. By breaking each process into its respective cost units one is better able to determine which process has the highest possibility for improvement. An example of this approach can be seen in the analysis of four waste streams (Fig. 2).

Following the "screening" procedure it then becomes necessary that they prioritize and choose which processes they would like to improve. To do this companies must take the processes that they feel have the greatest room for improvement and develop alternatives to them. This usually entails performing a process flow analysis and determining if certain strategies would refine the procedure in question. For example, companies have been known to simplify the process or find a more suitable way to perform the process. The main goal of all of these is to find a process that would be more environmentally friendly and help the company improve their bottom line.

After the "screening" process has been completed and the company has decided which procedures it would like to improve, there is still much more to do. Although various alternatives have been developed they still must be evaluated under the corporation's capital budgeting system before they are undertaken. For those firms that have a system in place to facilitate TQEM, a different evaluation technique exists. This method, known as TCA, is similar to traditional capital budgeting techniques except that it strives to include all costs and benefits associated with each alternative. Often, under traditional analyses, many costs and savings that are associated with environmental projects are not considered. However, by using TCA those costs and savings that are important in environmental projects are now used as inputs to evaluate the project the same way one would evaluate more traditional items. Once all the costs and savings that accompany each project are identified, TCA then uses financial tools familiar to many businesses for rating each investment. The techniques for deciding this can vary but the most popular are described below.

Net present value (*NPV*): Net present value analysis uses the concept of present value to evaluate capital projects. This concept "discounts" the dollars received in future periods by the amount of interest that could be earned today.

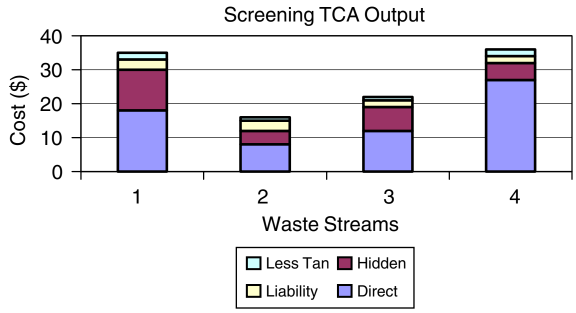
Internal rate of return (*IRR*): The IRR is the interest rate that, when used in a present value analysis, will produce a net present value of zero.

Profitability index (*PI*): The profitability index is another method that uses some form of NPV. This

Table 5
A TQEM cost framework

External failure: costs associated with the occurrence of environmental issues (e.g., waste) outside of the manufacturing facility	*Internal failure:* costs directly related to the occurrence of environmental issues within the manufacturing facility		*Appraisal:* costs involved in the direct appraisal of environmental issues both in the plant and in the field	*Compliance-driven:* costs which are mandated by local, state, & federal agencies/governments, and cannot be classified into one of the previous cost categories	*Prevention:* costs associated with the design and planning of a TQEM program
**Contingent liability costs:* future liability costs—treatment or storage in tanks, transportation land disposal, soil & waste removal & treatment, groundwater removal & treatment, surface sealing, personal injury, economic loss, real property damage, natural resource damage, superfund, corrective action, worker illness, downtime for accidents	**Waste Management:* hauling, storage, handling, waste-end fees/taxes, hauling insurance	**Reporting costs:* generators biennial report, primary exporters annual report, TSDF biennial report, release, fire, explosion, & closure reporting, supplemental MSDS report, excess of applicable threshold report, hazardous pollutant emissions reporting, industrial users' continued compliance reports, toxic standards annual compliance report, injury and illness reporting each occurrence, injury and illness annual summary, fatality or hospitalization report, occupational injuries and illness survey	**Environmental audits*	**Notification costs:* exportation of hazardous waste notification, foreign source notifcation, permit confirmation, local notification of operations, manifest discrepancy notification, facility changes notification, startip, monitoring, & operations change notificationWEEE-RoHS	**Administration & systems planning*
**Less tangible costs:* lower product acceptance by consumer, negative corporate image, negative impact on sales, lower borrowing capability, strained distributor relations	**Labeling costs:* pre-transportation labeling, hazardous waste package marking, transporter placecarding, hazardous chemical labeling	**Medical surveillance costs:* hazardous waste, medical surveillance program	**Incoming test & inspection & laboratory acceptance*	**Reporting costs:* LQG exception report, SQG exception report, primary exporters exception report, TSDF unmanifested waste report, requested MSDS report, inventory report, tier II reporting by request, national pollutant discharge elimination system permit reporting requirements	**Planning* (engineering work)—Incoming, in-process, final inspection Special processes planning data analysis Procurement planning Vendor surveys Reliability studies
	**Manifesting costs:* generators off-site transport manifesting, transporter shipment manifest, TSDF standard manifesting	**Contingent liability costs:* penalties and fines (RCRA, CAA, CWA, SDWA, TSCA, FIFRA)	**Checking labor*	*Preparedness/proactive equipment (maintenance) costs: internal communicating alarm system, fire control equipment, NPDES backup or auxillary facilities, restricted exposure to certain constituents	**Measurement & control equipment*
	**Recordkeeping costs:* exporter's reports & notification records, manifesting records, operating record, excess of threshold documentation, notification determination records, startup, shutdown, & malfunction records, toxic pollutant effluent discharge compliance records, occupational injuries & illness log & summary, medical surveillance program records	**Less tangible costs:* strained employee/union relations, strained supplier-customer relationship, decreased productivity due to worse employee relations, added future regulatory costs, lower worker retention, worse relationship with regulators	**Laboratory or other measurement service*	**Closure/post closure assurance facility specific costs*: financial assurance for closure and post closure	**Qualification of material*

	**Notification costs:* emergency follow-up notification, supplier notification requirements, hazardous emissions waste notification, national pollutant discharge elimination system, hazardous pollutant discharge notification, toxic pollutant discharge notification, industrial user slug loading notification, material safety data records	**Training:* SOG emergency response coordinator, SQG waste handling & emergency training, personnel training, TSDF emergency response coordinator training, initial assignment & addition of hazard training, & hazardous waste training	**Setup for test and inspection*	*Insurance *& special taxes requirement-specific costs:* financial responsibility requirements, taxes on certain chemicals **WEEE—RoHS*
		**Studies & modeling costs:* final status TSDF detection monitoring program, groundwater outline of interim status TSDFs, final status TSDF compliance monitoring program, emergency & contingency plan procedures, cost estimate for facility closure, hazard communication program, safety & health program, emergency response program	**Outside endorsements*	
			**Maintenance & calibration* **Product engineering review & shipping release* **Field testing* **Inspection costs:* facility/ inspection & inspection schedule, LQG tank inspections, SQG tank inspections, fire department inventory inspections, point source inspections, compliance inspections **Monitoring & testing costs:* hazardous waste chemical & physical analysis, groundwater monitoring, groundwater monitoring/ land-based interim status TSDFs, emissions control performance testing, continuous monitoring system, continuous opacity monitoring system, hazardous pollutant testing, hazardous pollutant monitoring, effluent stream monitoring & sampling, pretreatment standards monitoring, daily toxic pollutant sampling	



Source: Finding Cost Effective Pollution Prevention Initiative (Global Environment Management Initiative)

Fig. 2. Screening TCA output.

measure, also known as the benefit–cost ratio, is the present value of a project's cash flows divided by the initial investment paid out by the company.

Payback period (*PB*): The payback period is actually exactly what it says. It is the expected number of years that a project must remain in operation until the company recovers their initial investment.

To assess how TCA works in practice, the authors offer and refer to the following example of a TCA project analysis from one of several firms that collaborated with the Tellus Institute (White and Savage, 1995). The company's manufacturing facility is a specialty paper mill that produces a variety of uncoated and on-machine and off-machine coated papers, as well as carbonizing, book, and release base papers. The coating used is latex (i.e., non-solvent) formulation containing clay, styrene butadiene, starch, and polymers. This example was chosen because it is a powerful illustration of the value of a TCA approach.

The traditional company analysis consists of the required capital costs and only those operating costs and savings that the company typically includes in financial analyses for projects of this type. The TCA contains these and other operating costs and savings, which were developed in the course of the case study. In this project, a number of cost items appear in the TCA that are either partially or entirely omitted from the traditional company analysis. These include savings in raw material costs, a savings in fresh water usage and costs, and associated fresh water treatment and pumping; a savings in energy use for fresh water heating; and a savings in wastewater pumping and wastewater treatment fees.

Table 6 shows the financial impact of the omitted savings by comparing the traditional company and TCA analyses. This project, with a capital cost of $1.47 million, yields an annual cost savings of $350,670 with the traditional company analysis, versus $911,240 in the TCA. (NPV over a 15-year time horizon jumps from $360,301 to $2.8 million. And IRR over 15 years increases from 21% to 48%. At the same time, the payback period declines from 4.2 to 1.6 years. In sum, the TCA/Company differential in a TQEM investment was substantial enough even without inclusion of some of the more indirect, less tangible financial benefits that may well occur.

Given this familiarity of TCA, its importance should not be overlooked. Through implementing TCA a company incorporates both normal costs and savings related to a project as well as environmental costs and savings associated with that project. This allows the company to be more accurate when performing a TCA and identifying its costs and revenue streams. Realizing this, it becomes obvious that companies that implement TQEM systems and enact TCA have more information available for decision making.

Table 6
Comparison of original financial analysis vs. Total Cost Assessment

	Original analysis	TCA
Capital costs	$1,469,404	$1,469,404
Net operating savings/(costs)		
Direct costs		
Material	($150,000)	($150,000)
Labor	($10,000)	($10,000)
Waste Management	$510,770	$630,000
Hidden costs		
Utilities	($100)	$200,000
Regulatory compliance		$76,240
Education/training		$30,000
Contingent liability costs		
Accidental releases		$70,000
Legal damages		$65,000
Less tangible costs		
Goodwill		$51,240
Total operating savings/(costs)	$350,670	$911,240
NPV (10 years @ 12%)	$47,696	$2,073,607
NPV (20 years @ 12%)	$360,301	$ 2,851,834
Pay back period	4.20	1.60
IRR(10 years)	17%	46%

Source: environmental accounting: principals for the sustainable enterprise.

This approach to accounting is intended to equip decision-makers with more accurate information. First it must be recognized that TCA does not promote any type of specific pollution prevention project. It instead supports an evaluation of the full costs and savings associated with alternative investments and processes. However, if processes are not measured, it becomes increasingly difficult to effectively and efficiently manage and have accountability for the processes. Many corporations have found it very beneficial to use a Plan-Do-Check-Act (PDCA) system for developing their commitment to TQEM. The PDCA system is a method for continuous process improvement based on the concept that a process must be fully understood before it can be improved. Thus, this same approach is recommended for the TCA approach since there is still a need to better understand these approaches and provide useful information for managers. A corporation that makes use of a PDCA system would look like this:

Plan: Decision-makers identify a gap between the current situation and the desired situation. This could be due to a lack of necessary cost information or some other type of dilemma.

Do: Once a plan has been developed a company needs to put it into practice. This plan is usually acted out on a smaller scale first to avoid large financial consequences.

Check: After the plan has been placed into action it then becomes necessary to see if the gap identified in the planning stage is actually closing.

Act: In this final stage management examines and communicates the results of the project. They then decide whether all of the necessary information is present and whether it assisted them in their decision-making process.

The PDCA system is frequently used in evaluating TCA and TQEM. Other approaches that have been used can include cause and effect diagrams, check sheets, model building, and the Pareto criterion analysis. All attempt to accomplish a better understanding of processes. Thus, new and unique tools do not have to be developed. TCA can be accomplished using existing tools and problem solving methods that managers and accountants are already familiar with, but have overlooked. Thus, there is a potentially short learning curve for implementing TCA in management if frameworks such as the one proposed in Fig. 3 are applied.

This TQEM–TCA framework is developed jointly out of the site visits, interviews, and the literature. What results includes a number of useful cost measures and procedures used to carry out a TCA. The framework helps managers better assess the total costs of their environmental efforts, and aid in decision making in these areas. The framework can also help these managers to "sell" such initiatives to corporate-level executives who are often concerned with the cost of environmental compliance and improvement.

11. Conclusions

In conclusion, TQEM strives to do one thing: improve a company's decision-making process. This is attained by incorporating all of the costs and savings in each investment alternative and then performing a TCA on each one. In the past, projects that supported TQEM were at a disadvantage compared to other alternatives because TCA was not used. Through this assessment, projects that support TQEM now stand a chance in the capital budgeting arena with other traditionally more profitable projects.

Two major outputs yielded by the case studies, interviews, and literature review were (1) a catalog of the various cost measures and procedures used to implement and carryout a TQEM–TCA and (2) the TQEM–TCA framework itself. This cataloging activity not only describes the tools and measures but also indicates how these measures can be used, and the types of expected outcomes and conditions most conducive to their use. This framework and catalog consolidates information from a field that is currently considered fragmented, can help improve industrial practices and strengthen the theoretical base necessary for sound decision making.

At the heart of this framework are several important concepts. The first is that TQEM can never be effective if advocated on the basis of qualitative measures or ethical needs (i.e., "moral imperatives"). Rather, TQEM is effective only when it is shown that its benefits exceed its costs. In other words, TQEM programs must be shown to be economically justified and valid. Second, TQEM can only be pursued effectively when accompanied by a set of well-defined, easy-to-use, quantitative measures. As the old adage in TQM puts it, "what gets measured, gets managed."

Fig. 3. TQEM–TCA framework.

Future research for this study would be a demonstration of the TQEM–TCA framework itself. Ultimately, the purpose of this study was to determine the feasibility of a TQEM–TCA model as a basis for directing and evaluating TQEM investments. To do this, one option available is to take a sample of data (representing one major waste stream and one process) from a participating test site and to build a computer simulation model of this stream and process. This model would then be subjected to a series of conditions and the results evaluated using the TQEM–TCA framework. This demonstration would also identify the ease of use, extent of data requirements and the types of decisions facilitated by the data provided by the TQEM–TCA framework.

Appendix A

Initial Assessment Questions:

1. Do you have an environmental management system (EMS)?
2. Do you have a system for capturing environmental costs?
3. What is your overall impression with your EMS and environmental cost measurement system?

4. What type of costing information do you use for resource allocation decisions?
5. Have you been involved with LCA or ECA?
6. What is your overall impression LCA and ECA?
7. Would you allow researchers to visit your company?

Interview protocol:

- job title;
- name of respondent(s);
- name of interviewer(s);
- company;
- primary product(s);
- primary customer(s);
- how long have you been involved with environmental initiatives?
- What is the length of time in your current position?
- What are your current and past job responsibilities?
- What is the nature of your formal education?
- To what extent would you agree that the environmental function within your company receives committed executive-level attention and representation (strongly disagree to strongly agree)?
- To what extent would you agree that the environmental function within your organization takes a proactive or leadership role (strongly disagree to strongly agree)?
- What is the general focus of your organization's environmental initiatives (i.e., products, process, or packaging)?

Answer the following questions based on the "Four-Tiers" of environmental costs (e.g., Direct Costs, Hidden Costs, Contingent Liability Costs, and Less Tangible Costs):

- To what degree does this cost measure provide assistance in the decision-making process of capital investments or environmental initiatives?
- To what degree does this cost measure provide assistance for reporting or compliance-driven purposes (both internal & external, with external considering either stakeholders or regulatory agencies)?
- To what degree does this cost measure provide assistance for problem identification (can be done for internal purposes or to flag internal regulatory problems)?
- To what degree is information for the cost measure readily available to users for decision-making, reporting, and/or problem identification purposes?
- How difficult is it to gather and compile information for this cost measure?
- How much time is required to compile information for this cost measure?
- To what degree is this cost measure used for compliance-driven investments (focus is only on meeting the requirements of regulatory agencies)?
- To what degree is this cost measure used for revenue/profit driven investments (good investments in which the benefits received exceeded the investment made)?
- If your company does not measure a cost category, please explain why.
- Which cost categories do you feel your company measures the best?
- Which cost categories do you feel your company measures the worst?
- Where are the greatest needs for improvement in your environmental cost measurement system?

Environmental Projects: Please briefly describe a recent project requiring at least $5000 by your organization that was a compliance-driven investment:

- describe the investment;
- type of investment (i.e., product, process, packaging);
- why was the investment undertaken?
- What was the length and time required to complete the investment?
- What was the respondent's level of involvement?
- To what extent were environmental cost measures used in the decision making process of investment?
- Upon implementation of the investment, describe the nature of the costs and benefits.

Environmental Projects: Please briefly describe a recent project requiring at least $5000 by your organization that resulted in benefits that exceeded the investments made:

- describe the investment;
- Type of investment (i.e., product, process, packaging);
- why was the investment undertaken?
- What was the length and time required to complete the investment?

- What was the respondent's level of involvement?
- To what extent were environmental cost measures used in the decision making process of investment?
- Upon implementation of the investment, describe the nature of the costs and benefits.

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