Asia-Pacific Management Accounting Journal, Volume 4 Issue 2, 29-42, 2009

A CASE STUDY ON THE IMPLEMENTATION OF MFCA IN SMEs: HNJC COMPANY

Zhu Weidong
Nukumi Ryoichi
Zhang Chen
Cheng Pinlong
Management School, Hefei University of Technology, China

Abstract

With the enhanced awareness of environmental protection, the importance of MFCA (Material Flow Cost Accounting) is gradually increased. This paper discusses the background, environment cost and benefit, and performance evaluation of MFCA in SMEs (Small and Medium Enterprises) for the case of HNJC Company. Several changes for happened in HNJC after MFCA introduced the process and tools of environmental management accounting, cost and revenue accounting and performance evaluation based on MFCA. From the case study, we found that HNJC reduced the output of waste or poor products in various processes and made successful technology investment on the production chain to transform the production process after the implementation of MFCA.

Keywords: MFCA; environmental costs; environmental benefits; environmental performance evaluation

The Background to the Implementation of MFCA in HNJC Company

HNJC company, founded in December 1995, is a Japanese-funded SME located in Hefei, China, its with the main products include construction machinery cab, the fuel oil tank, the hydraulic fluid tank, and the hangar. The company's organization structure is divided into four departments' management, manufacturing, finance and human resources. Output has been increasing since 2004. Environmental management accounting has been implemented in HNJC Company driven by factors many factors shown in Figure 1. HNJC started to implement environment management accounting in December 2008.

ISSN 1675-3194

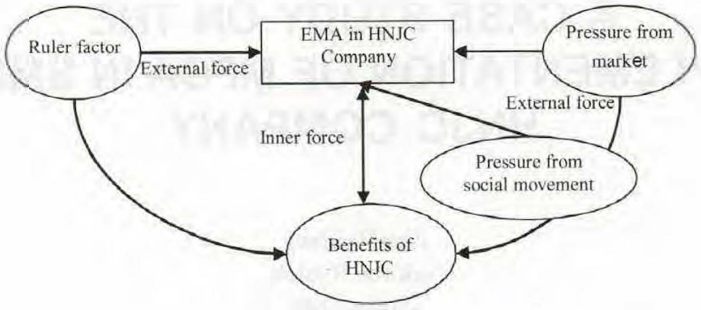

Figure 1: Analysis on Driving Factors on EM of HNJC

Literature Review

MFCA (Material Flow Cost Accounting) developed by the Institute of Management and the Environment in Germany is a tool for measuring the flow and stock of materials, in the production process in both physical and money units. It is based on an input-output analysis of material flow and applies a different cost allocation procedure. MFCA regards the relevant material flows as cost collectors, and therefore allocates the costs of the company's production operations to these material flows.

Material Flow Analysis began in the 1960s with the publication of two articles, *Metabolism of Cities* (Wolman, 1965) and *Material flow analysis of the American economy* (Ayres, 1969). During the period of 1970s to 1980s, environmental protection focussed on ways to reduce the risk of toxic materials. Since the 1990s, German scholars have investigated flow management and material flow cost accounting. Based on the sustainable development thought, Schmidt-Bleek (1994) and Von Weizsacker, Lovins and Lovins (1995) proposed four-time factor or ten-time factor resulting in "loss of material form" hypothesis. The target of Eco-efficiency and material flow accounting project (Eco-Efizienz-Project) established by the Management and Environment Association (IMU) in Germany Augsburg University was by the means of flow management to reduce the pressure on the environment and costs, while improving economic efficiency and environmental efficiency. Dr. Stefan Enzler and Dr. Markus Strobel (2001) discussed the basic idea of traffic management and traffic management tools. Flow management is aimed at re-organizing and building the entire process of production of material flow and energy flow. A company can be regarded as a material flow system in flow management. Strobel and Redman (2000) discussed in detail the content of material flow cost accounting, including the material flow cost accounting objective, the basic ideas and methods. The objective of material flow cost accounting is based on enterprise economic goals and environmental

objectives of coordination requirements, to quantify the various factors to determine the improvable segments in material flow to turn waste into resource, optimize and integrate all environmental protection technologies of the enterprise, to increase material utilization efficiency and reduce emissions of corporate environmental loads. These two scholars made further amendments to refine their theory. At the beginning of 2000, Japanese scholars conducted an in-depth study of MFCA (Nakajima, 2003).The Ministry of Economy, Trade and Industry (METI) studied environmental cost accounting within the framework of the provisions of accounting technology around the world. NITTO DENKO has used MFCA as the environmental management cost control tool since 2000, with good results.

The current research on cost of the material flow still has shortcomings, for the following reasons: (1) material flow cost accounting in the current study is only exploratory. Many deep-rooted principles, classification and data integration methods are subject to further research; (2) MFCA is based on enterprise management information systems in developed countries, (3) MFCA in SMEs is still lagging behind.This paper addresses the need to combine cost accounting practices with building a MFCA system adapted to SMEs in China.

Research Method

This investigation used the case study approach. It analyzed the status of the HNJC's company's cost management and the need and motivation for using MFCA, the application characteristics of MFCA in SMEs and compared the cost flow change of the company before and after the implementation of MFCA and information transparency. It established the performance evaluation index system to assess implementation performance of MFCA. The case study was based on the implementation of MFCA specific operations in HNJC, from November 2008 to May 2009. Implementation was effected through the following measures:

1. *Internal employee education*. Through publicity and education of employees so that employees understand the importance of the MFCA to enterprise. The MFCA project can help an enterprise to cut costs, reduce pollution and make profit.
2. *Setting up of the MFC Project Working Group in HNJC*. Figure 2 shows the MFCA Project implementation system of HNJC.
3. *Selection of the management tools and methods of MFCA*. HNJC did not use the six tools completely in implementing the environmental management accounting. Only two tools (Table 1), namely environment protection equipment investment and the MFCA, were used. HNJC had not been involved in mass production; hence, it was unable to implement a environmental protection cost plan system and Life Cycle Costing tools unlike most large-scale enterprises.

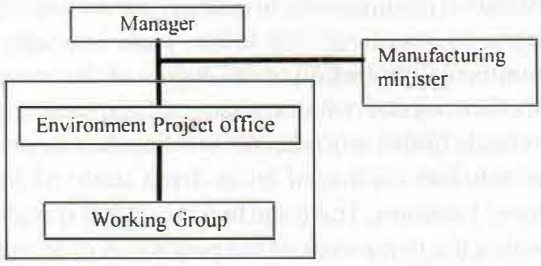

Figure 2: MFC Project Implementation System of HNJC

Table 1. Deliberation of the Implement of Six EMA Tools in HNJC

EMA tools	Yes/ No	Reasons
Environmental protection cost plan system	No	No product
Life Cycle Costing	No	No product
Environmental protection equipment investment	Yes	Correspondent procedure equipment
MFCA	Yes	Correspondent procedure
Environment budget method	No (Temporarily)	Insufficient EA personnel
Environmental performance evaluation system	No (Temporarily)	Insufficient EA personnel

Owing to the resource constraints and the size of enterprise, it was not possible to hire some environment accountants to implement the environment budget method and the environmental protection achievement examination system. With the cooperation of Hefei University of Technology, HNJC company used environmental protection equipment investment and material flow cost accounting. The main process is shown in Figure 3.

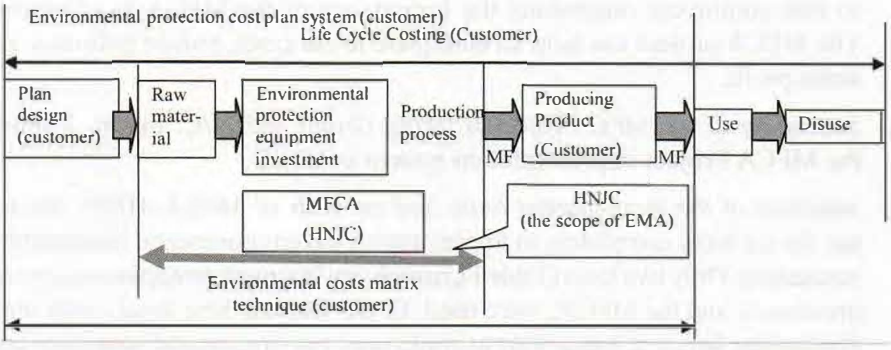

Figure 3: Relations between HNJC's and Customer Environment Accounting Method

4. *Cost flow accounting*. When recording and calculating cost, HNJC separated positive product cost from bad product cost (Figure 4 and 5). By implementation of MFCA, HNJC could calculate accurately the bad products in each procedure, take appropriate measures to reduce the number of negative qualities, and use waste treatment plants to reduce exhaust emissions or turn waste into treasure (Table 2).
5. *Performance evaluation of MFCA in HNJC*. Few SMEs follow MFCA practices in China. Analysis of environment costs and benefits based on MFCA in HNJC (section 4 and 5 in this paper), makes it possible to assess the performance of MFCA practised in HNJC (section 6 of this paper). By using the influence on natural environment and the organization operation ability from enterprise environment management as first-class indicators, this paper proposes the environment performance evaluation of HNJC (Table 7). We found the performance of MFCA in HNJC was good (B) using the first-level indicators. The results of this study draw attention to the application value of our MFCA method for the SMEs in China.

Analysis of Environment Costs of HNJC Based on MFCA

The flowing production was used since MFCA was implemented in HNJC, waste gas was reduced on each working procedure, and quality goods were significantly increased. Working procedures before and after implementing MFCA were contrasted respectively in HNJC (see Figure 4 and Figure 5). After implementing MFCA, the company addressed the environment issue seriously, and each working procedure contact considered reducing waste gas, making the ratio of input and output even more rational, guaranteeing product quality.

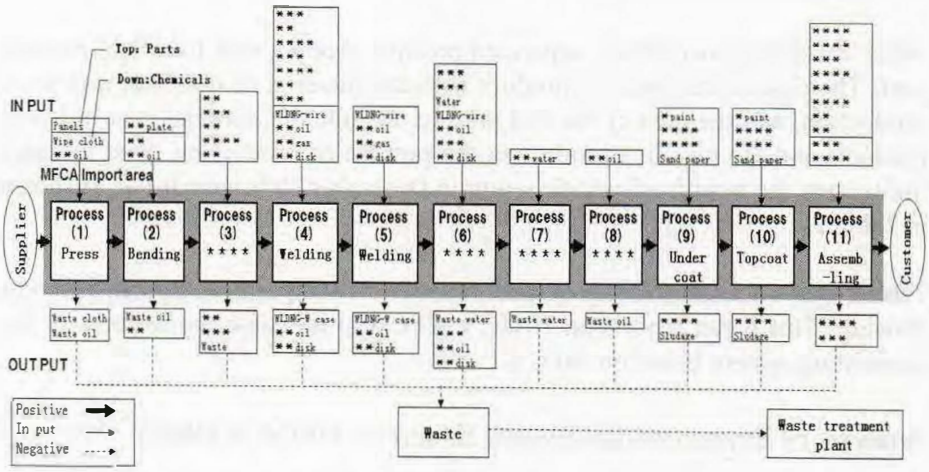

Figure 4: The Process of Hydraulic Fluid Tank After MFCA Inducing in HNJC

Since MFCA was brought in HNJC, the method of the monthly record of MFCA on cost accounting has been applied to record quality and bad products. In the measurement of input costs, waste or wasted resources and defects are classified and recorded in the processing. The main production procedure can be seen as Figure 5.

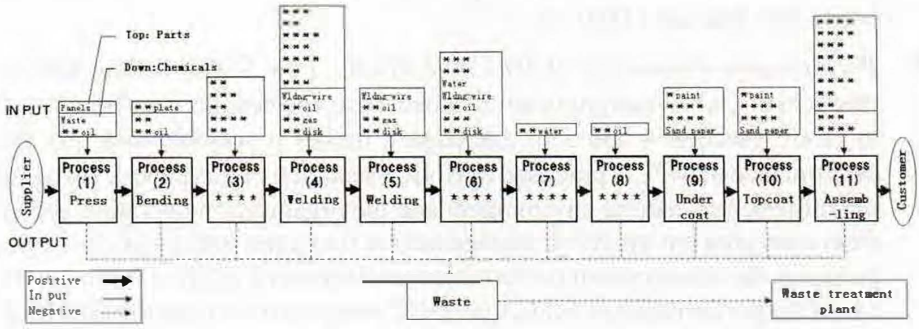

Figure 5: The Process of Hydraulic Fluid Tank before MFCA Inducing in HNJC

Changes in procedure have taken place after implementation of MFCA, as shown in Figure 4 and Figure 5. Before implementing MFCA, HNJC did not consider the waste generated in each working procedure. It only took the output products and useful products into account. Yet after implementing MFCA, HNJC not only considered the waste produced by each procedure, the amount of wastewater and sludge, but also the calculation of the amount of the material in each procedure. By the implementation of MFCA, HNJC can calculate accurately the number of bad products in each procedure, take appropriate measures to reduce the number of negative qualities, and use waste treatment plants to reduce exhaust emissions or turn waste into treasure.

When recording cost, HNJC separated positive product cost from bad product cost. The cost of the positive product includes material cost in the process of production, and the cost of the bad product include the material cost of waste products and the negative product in the process of production. Due to space limitations, the records of specific inputs in December 2008 were listed, as shown in Table 2.

Table 2 shows a detailed record of specific materials of input and output in materials flowing. This paper reports on HNJC's MFCA to illustrate the features of the accounting system based on MFCA.

Analysis of Environmental Benefit Based on MFCA in HNJC

The ultimate goal of the implementation of MFCA is to maximize profits. Under the modern business organization model with agent system, the shareholders,

Table 2: MFCA Positive and Negative Product Cost Calculation

Fuel Tank		[kg]	Amount [yuan]	Hydraulic Tank	Amount [kg]	Amount [yuan]
Title input	Outer plate	91696.46	626745.30	Outer plate	33276.14	227442.42
	Parts	5927.81	94188.60	Parts	23419.10	431440.02
	Bending Plate	5849.94	39984.34	Plate	25877.54	176872.99
	Paint	1472.23	50382.09	Paint	1170.92	40070.52
	Pharmacy	2757.15	30078.00	Pharmacy	2192.86	23922.27
	Sewage	871268.10	11029.54	Sewage	678104.30	8153.48
	Other	1641.50	45876.34	Other	1241.88	36680.89
	Total	980613.19	898284.21	Total	765282.74	944582.58
Positive	Outer plate	91696.46	626745.30	Outer plate	33276.14	227442.42
	Parts	5927.81	94188.60	Parts	23419.10	431440.02
	Bending Plate	5849.94	39984.34	Bending Plate	25877.54	176872.99
	Paint	968.98	33256.67	Paint	770.67	26450.21
	Pharmacy	0.00	0.00	Pharmacy	0.00	0.00
	Sewage	0.00	0.00	Sewage	0.00	0.00
	Other	1511.03	36276.70	Other	1135.71	25834.34
	Total	105954.22	830451.62	Total	84479.16	891489.50
Negative	Outer plate	0.00	0.00	Outer plate	0.00	0.00
	Parts	0.00	0.00	Parts	0.00	0.00
	Bending Plate	0.00	0.00	Bending Plate	0.00	0.00
	Paint	503.25	17125.42	Paint	400.25	13620.31
	Pharmacy	2757.15	30078.00	Pharmacy	2192.86	23922.27
	Sewage	871268.10	11029.54	Sewage	678104.30	8153.48
	Other	130.47	9599.64	Other	106.17	7397.03
	Total	874658.97	67832.59	Total	680803.58	53093.08

care about profitability. However, with globalization, the profit is not only measured in monetary terms, the content and meaning include the connotation and extension of the profit and the relationship between profit and environmental activities, generating so long-term profits. Due to the changes of shareholders' profit motive, managers need to coordinate immediate economic profits with long-term economic interests (Chen, 2003). HNJC uses daily records to consider environmental benefits, and to make decisions, depending on the output model.

From Figure 6, we can see the reduction of input-output of the fuel oil tank except in February. The Proportion of Hydraulic fluid tank's input-output is more optimistic, basically increasing.

Before implementation of MFCA, what was demonstrated in the accounting was only total quantity of the total investment, the positive and negative in HNJC, while the quantity of concrete consumable material each link was unable to be calculated precisely, making it impossible to calculate the quantity of consumable material per unit product precisely (Table 3).

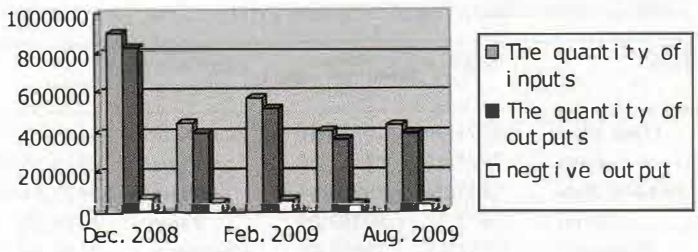

Figure 6: Input Number of Hydraulic Fluid Tank, Output Number of Non-defective and Negative

The cost of materials of each hydraulic tank and the negative and positive output were calculated after the implementation of MFCA (Table 4 and Table 5). The number of material flow is the database of material flow cost accounting (Anjo, 2003). The steps of HNJC's accounting are as follows: Firstly, each transferred material was shown by the physical units at each time, and the amount of the actual flow was allocated to each material flow in the material flow model. Quantity data can be got by converting the database of HNJC. Secondly, to determine both the beginning and the end stock amount in each number center, we can observe the estimated amount of material flow not only from each procedure, intermediate products, finished products and unclassified waste material, but also according to the raw materials showing all materials. The input material refers to material from outside. The accounting of input material tracking starts from when

Table 3: Input of Hydraulic Fluid Tank, Output of Non-defective and Negative (kg)

	Dec. 2008	Jan. 2009	Feb. 2009	Mar. 2009	Apr. 2009
Input	898,284.2	445,043.0	573,937.3	407,669.3	435,203.9
Output (Positive)	830,451.6	398,856.2	517,327.0	369,215.2	399,418.2
Output (negative)	67,832.6	46,186.8	56,610.3	38,454.2	35,785.7

Table 4: Hydraulic Fluid Tank of HNJC (Unit)

	Dec. 2008	Jan. 2009	Feb. 2009	Mar. 2009	Apr. 2009
Unit Number	1,069	594	680	722	661

Table 5: Input Quantity of Hydraulic Fluid Tank, the Non-defective and Negative (kg/unit)

	Dec. 2008	Jan. 2009	Feb. 2009	Mar. 2009	Apr. 2009
Input	840.3	749.2	844.0	564.6	658.4
Output (Positive)	776.8	671.5	760.8	511.4	604.3
Output (negative)	63.5	77.8	83.3	53.3	54.1

materials are obtained from outside, and then through all of the material flow and the number centers, as shown in Figure 4, after 11 procedures until the materials leave the circulation system eventually in the form of the product or waste material. By the implementation of MFCA, all intermediate products, finished products and residual waste materials are classified by a net materials bill. For the material used, only when the same measurement units are used for recording, their total collection can be added as a whole. Based on these input materials, according to the material flow structures of the material flow model, Differential Computation can be used for material investment in each period (Burritt, Hahn and Schaltegge, 2003). The difference between various number centers can be shown by differential calculation, while the difference of materials between the beginning and end inventory, entering and leaving each number center is also shown.

As shown in Figure 7, in the view of the changes of input and output of bad products in each hydraulic tank, the trend of the negative output is obviously relative downward, and the trend of the change of the positive product and negative product also can be seen from Figure 8 and Table 6. Due to relatively high output of positive products, the total amount of input in HNJC needs to be reduced. According to the detailed data, the material flow cost can be calculated. Firstly, all the data need to be checked, including data integrity, consistency, single data format, as well as key materials data and flow data, the relevance of materials net. Secondly, the calculation, in order to identify the amount of the raw materials on each semi-finished and finished product, the stage of the raw materials would need to be restored.

Performance Evaluation of MFCA in HNJC

Performance analysis of enterprise environment management should be carried on synthetic evaluation from two dimensions, dominant performance and recessive

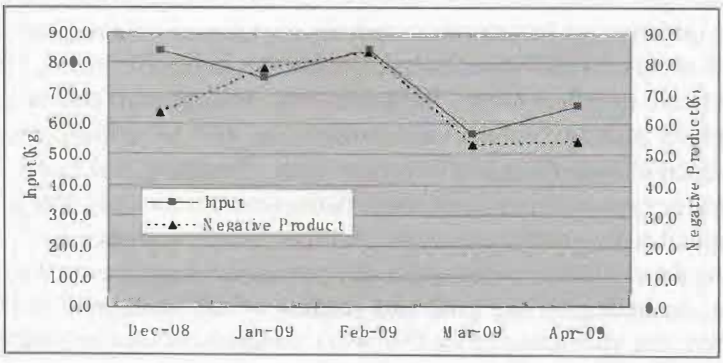

Figure 7: Changes of Negative Product for Each Unit of Input and Output (kg)

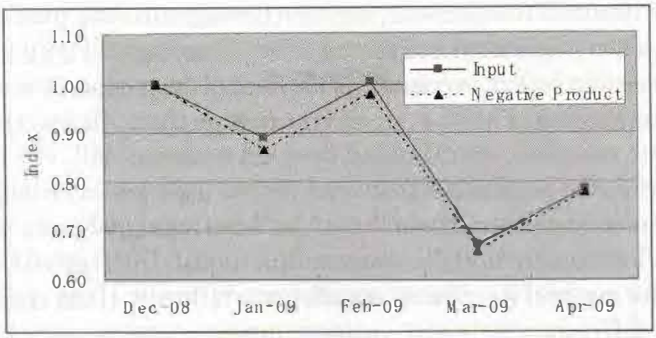

Figure 8: Changes of Negative Product for Each Unit of Input and Output (index)

Table 6: Changes of Negative Product for Each Unit of Input and Output (index)

	Dec. 2008	Jan. 2009	Feb. 2009	Mar. 2009	Apr. 2009
Input/output	1.00	0.89	1.00	0.67	0.78
Negative product	1.00	0.86	0.98	0.66	0.78

performance (Hao, 2005). The former is the validity of enterprise environment, displaying the influence on the natural environment from the enterprise environment management, which is mainly under the control of government on environment management, the market pressure, request of benefit counterparts outside enterprise, so the enterprise must satisfy the environment standard requested and make great effort on the environment administration, most of which is dominant, the measurable indicator, which is also the result that the enterprise carries on the environmental management under the external pressure (or compelling force). The latter relates with enterprise's survival and development, displaying the influence on enterprise' own operation ability from enterprise environment management, promoting enterprise to take the environmental management measure on its own initiative, and to adopt internal driving force of voluntary environment agreement, most of which is recessive, Qualitative Indicator (Milne, 1996). The two aspects are interdependent. Environmental management can be carried to fundamentally promote enterprise development, and for enhancement of the environmental management performance (Lang, Heubach, and Loew, 2005). A good indicator system of environmental management is not only able to carry on environmental management appraisal correctly and comprehensively, but also forecast the development of enterprise environment management (Wang, 2002). Therefore, according to the goal and request of the enterprise environment management, the instruction of the IS014031 standard and design principle of the indicator system, there became the indicator system of the environmental management performance in Japan in 2000. Based on the construction principle

of the indicator system of the environmental management performance in Japan in 2000, this article has constructed the indicator system of performance evaluation of HNJC (Table 7). The indicator system of the environment management performance has two first-level indicators, the influence on natural environment and the organization operation ability from enterprise environment management respectively. The former influence includes two second-level indicators, the management indicator and the operation indicator respectively. Environmental compliance, EMS, Attention to Environment, Environment Target, Investment on pollution control, Environmental Education and Training, and Relations with Community are the subordinate indicators of environmental management.

The subordinate indicators of the operation indicator include the load rate of pollution, energy efficiency and resource utilization and so on. The latter influence includes five second-level indicators, including foundation management, organizational innovation, technical innovation, learning capability, market incentives and so on. The reengineering and organizational reforms are included in the indicators of organization innovation. Patents, technology standard and facilities equipment are included in the indicators of technological innovation. The second-level indicators of learning capability are individual learning, the team leaning and organization learning. The indicators of market driving force include the degree of customers' satisfaction and the degree of staff's satisfaction. These indicators can appraise environmental management performance of HNJC systematically, comprehensively and effectively. The first goal of the performance appraisal may be to contrast the data with those of the other companies of the same profession; the second goal is to inspect the profit of its own company. In the aspect of performance, according to the process of MFCA, HNJC company performance evaluation plan based on MFCA carries on partial Evaluation for HNJC. We found the performance of MFCA in HNJC was good (B) according to the first-level indicators.

Conclusion

In full consideration of external environmental impacts and the pressure of government, HNJC selected and attempted to apply parts of environmental management accounting tools. Its results were remarkable. On the one hand, it had improved the HNJC's cost accounting system, reflected by the cost of the "negative" product, which will help enterprise decision-making. By distinguishing between positive and negative cost flow in the production, the management of HNJC (1) specified the internal operation norms and management standards to reduce the output of waste or poor products in various processes; reduced the cost that stemmed from the negative products; (2) detected waste material flow in production. They made technology investment on the production chain to transform

Table 7: Environment Performance Evaluation Based on MFCA in HNJC

Target		First Level		Second Level		Third Level	
Target	Rank	Indicator	Rank	Indicators	Rank	Indicators	Rank
Business environment performance evaluation Based on MFCA	B	The impact on natural environment	B	Management	B	Environmental compliance	A
						EMS	A
						Attention to Environment	B
						Environment Target	B
						Investment on pollution control	C
						Environmental Education and Training	B
						Relations with Community	B
				Operation	B	load rate of Pollution	A
						Energy efficiency	C
						Resource utilization	B
		The impact on organization Operational capability	B	Basic Management	B	Organization and management	B
						Quality and ability of manager	B
						staff's Quality and ability	B
				Organizational Innovation	C	Reengineering	B
						Organizational reform	C
				Technical Innovation	C	Patents	C
						Specification	C
						Facilities and equipment	B
				Learning Capability	B	Individual learning	A
						Term learning	B
						Organization learning	B
				Market Incentives	B	Customer's Satisfaction	A
						Personnel's Satisfaction	B

Notes: A: Excellent, B: good, C: average, D: poor, E: very poor
Reference: Deloitte Environmental Report Checklist

the production process. Two technology investments received benefits, one of which was "Circulating Water System" which recycled the pressure testing water to reduce sewage discharge, while the other was "Thinner Recycling Machine" which the thinner used in wash gun and, reduced air pollutants emissions. Additionally, it had reduced production costs, enhanced the competitiveness of products and reduced environmental risks. After the implementation of MFCA, the evaluation of HNJC's environmental performance increased, and the community's recognition and trust were enhanced. The successful practices in HNJC attest to the importance of the implementation of MFCA in SMEs.

Acknowledgement

This paper was the interim result of the key program in 2009 of Accounting Association of Anhui Province (KT201). The sponsor of this paper is program A16-09 from National Development and Reform Commission. We also want to express our gratitude to anonymous reviewers for their helpful comments.

References

Anjo, Y. (2003). Environmental Management and Material Flow Cost Accounting [J]. *Environmental Management*, (available only in Japanese), 39, 7: 19-25.

Ayres, Robert U. and Kneese, Allen V. (1969). Production, Consumption, and Externalities [J]. *The American Economic Review*. 59, 3: 282-97.

Burritt, R.L., Hahn, T. and Schaltegger, S. (2003). *Towards a Comprehensive Framework for Environmental Management Accounting–Links between Business Actors and Environmental Management Accounting Tools* [M]. New York: International Federation of Accountants.

Chen, H. (2003). Theory and Empirical Study on Counterparts' Benefit in Enterprise [A], *Zhejiang University Proceeding*.

Environmental Industries Office, Environmental Policy Division Industrial Science and Technology Policy and Environment Bureau Ministry of Economy, Trade and Industry (2007), *Guide for Material Flow Cost Accounting* [Act].

F. Schmidt-Bleek, Coworkers. (1994). *Wieviel Umwelt braucht der Mensch?, MIPS, das Mass für ökologisches Wirtschaften [C]*. Birkhäuser, Basel, 2, 8: 407-490.

Hao, C. (2005). Theoretical Model and Empirical Literature Commentary on Relations between Enterprise Environment Achievements and Economical Achievements [J] *Horizontal*. 11: 43-47.

Lang, C., Heubach, D. and Loew, T. (2005). Using Software Systems to Support Environmental Accounting Instruments. In P.M. Rikhardsson, M. Bennett, J. J. Bouman, & S. Schaltergger (Eds.), *Implementing Environmental Management Accounting: Status and Challenges*. [M]. Dordrecht: Springer. 143-168.

Markus S. (2001). Flow Cost Accounting, Relieving Stress on the Environment by Means of Flow Management [A], *Institute fur Management und Umwelt.*

Markus S., Redmann. (2000). Flow Cost Accounting, Cutting Costs and Relieving Stress on the Environment by Means of An Accounting Approach Based on the Actual Flow of Materials [A], *Institute fur Management und Umwelt.*

Milne, M.J. (1996). On sustainability, the Environment and Management Accounting [J], *Management Accounting Research.* 7: 135-161.

Nakajima, M. (2003). Introducing Material Flow Cost Accounting for Environmental Management Accounting System [A], *International Symposium on Environmental Accounting.*

Schmidt-Bleek, F. et al. (1994). Carnoules Declaration of the Factor Ten Club [C], *Wuppertal*, October.

Smolnik, Stefan., Huth, C. and Nastansky, L. (2001). Distribution of Workflow Process Knowledge in Organisations [J]. In N. Gronau (Ed.), Wissensmanagement, Systeme-Anwendungen-Technologien. 115-132.

Stefan Enzler and Markus S. (2001). Flow Cost Accounting, Relieving Stress on the Environment by Means of Flow Management, Institute fur Management und Umwelt.

Von Weizsäcker and Robert K. (1995). Public Pension Reform, Demographics, and Inequality. LSE STICERD Research Paper No. 11. Available at SSRN: http://ssrn.com/abstract=1094736

Wang, L.Y. (2002). *Environment accounting and achievements* [A]. Beijing: Propaganda Center of State Environmental Protection Agency, 10: 23-24.

Weizsacker, E.U., Lovins, A. and Lovins, L. (1995). Faktor Vier. Doppelter Woblstand-balbierter Naturverbraucb [C], *Droemer Knaur*, Munich.

Wolman, A. (1965). The Metabolism of Cities. *Scientific American Journal.* 213, 3: 179-190.