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Application of Activity-Based Costing to Green Industry for Profitability and Performance Enhancement -- Recycling of Blast Furnace Slag as an Example

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Abstract

To pursue more comfortable living human beings have overexploited resources, accumulated large amounts of waste and damaged the natural ecological environments, resulting in extreme climates. Slag produced by blast furnaces in the steel industry may be recycled grinded to slag powder, a building material and cement substitute, which may reduce cement mining and create multiple economic benefits. In the case study, Activity-Based Costing (ABC) is experimentally employed to the first-phase slag powder production and the second-phase ultrafine slag power and cement production. Modification of the activities flow has improved the activities effectiveness and saved the indirect costs, thus enhancing the company's competitiveness and profitability.

JEL classification numbers: JEL: M00, M40, M41, M49
Keywords: Small and Medium Size Enterprise (SMEs), Green Industry, Activity-Based Costing (ABC), Water- Quenched Blast Furnace Slag, operation analysis

1 Introduction

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Due to the extreme climate in the twenty first century, United States and Canada in the northern hemisphere were extremely cold in January 2017. In Canada, the temperature was even as low as 50 degrees Fahrenheit. Meanwhile, Australia in the southern hemisphere faces the hot wave attacks. Sydney's temperature soars up to 47.3 degrees Celsius, breaking the record of nearly past eighty years. The threats posed by extreme weather to mankind are visible everywhere, and nations have had to slow down the most difficult problems that humankind faces in the 21st century by signing the Paris Accords. The reason for such extreme weather on earth is that human beings have been over-exploiting the Earth's resources in pursuit of a more comfortable and safer life. How to effectively solve over-exploitation of resources and the environmental protection are the most important key issues at this stage. With regard to environmental protection and waste recycling, we can make the best use of resources, extend their life cycle, and recycle and reuse them to effectively prevent the waste of resources and over-exploitation. The so-called "cycle" is like a seasons change, year after year, so that the life of resources can be extended and reused, and the natural ecological environment can be sustained. Chang and Chen [3] suggested that under the uprising environmental awareness the traditional industries at this point need effectively integrate environmental and energy issues into the cores of industrial development to enhance their industrial competitiveness. Thus, besides meeting the central economic policies, they may also create opportunities in the green energy industry and enhance waste recycling to achieve the best action effectiveness in the "global energy saving and carbon reduction".

Furnace slag is originally a waste produced in the iron-making process of a fully integrated steel mill and becomes by-product after recycling. After being grinded to fine powder so called "blast furnace slag powder", the slag immediately becomes a high-value green building material product, so called "Water-Quenched Blast-Furnace Slag Powder" or "Blast Furnace Slag Powder", which can not only improve concrete application quality but also reduce cement consumption. The previous environmental pollution problem caused by slag can also be prevented through effective recycling.

Blast furnace powder added cement, so-called blast furnace cement, has superior strength and special resistance to erosion of sea water and sulfate etc. Therefore, in Japan blast furnace cement is used in the construction of dams, bridges, tunnels and seawalls, for instance, Seto Bridge. It is also used in the construction of Taipei 101 Building and the Six-Light facility of Taiwan-Plastic Incorporation in Mai-Liau. In Taiwan and the advanced industrialized countries of Europe and America, it has already been widely utilized in construction (Chang and Xu) [4]. Its usage in Taiwan has been over 30 years since Year 1983. According to the production reports of China Steel and Dragon Steel, approximately 365 million tons of water-quenched blast-furnace slag is produced. Through recycling the slag may become a valuable product to partially substitute cement, which helps to

reduce mountain cement mining. In the densely populated Taiwan Island, cement mining is extremely improper in terms of the potential environment impacts.

Besides environmental benefits, is recycling water-quenched blast-furnace slag profitable? Therefore, this research applies activity-based costing (ABC) system actively promoted by two American scholars Cooper and Kaplan [8] to explore the profitability of recycling the furnace slag for the case company. Meanwhile Activity-Based Management (ABM) is also employed for the case company to improve the activities flow, activities efficiency and cost analysis and to obtain accurate and reasonable cost information as crucial reference for the decision-making of the top management, helping to optimize production and marketing strategy, and thus to enhance corporate profitability and performance.

The case company is a professional grinding plant for the recycled furnace slag in the green manufacturing industry, only producing slag powder in the first phase. Shortly after its establishment, a second production line was set up to extend the related products from slag powder to ultrafine slag powder and cement. The case company, a small-medium enterprise, recycles the water-quenched blasted-furnaces slag produced by iron-making process in fully integrated steel mills as raw materials and converts them to excellent green building materials through grinding process by automated machinery.

Although grinding process belongs to convectional technologies, fully automated and computerized high level production is indispensable under the highly competitive environments of manufacturing business in the twenty first century, which helps the industry to deal with the competition, man power shortage and production structural change as well as to satisfy customers' requirements. Due to the complexity of the activities process, how to improve the activities process, reduce activities items, enhance activities efficiency and reduce manpower and power consumption is crucial for the case company to improve its profit margin and business performance.

Secondly, due to the industrial specificity, the procurement of raw materials is conducted under the contractual system and therefore the annual volume, price and production output are constrained by the suppliers with limited bargaining space. Besides, approximately 8% moisture content of the raw materials makes the material costs increased by 8%. In addition, since the automated activities system is adopted, the cost of electricity is huge, the machinery and equipment are expensive, the depreciation expenses are high, and the maintenance and repair are of paramount importance. Any machinery failure will be costly and complicate the cost allocation. Therefore, it is imperative for the management to construct a set of realistic cost allocation system, which can provide accurate timely detailed costing information of raw materials and resource consumption to mitigate the water content problem and accordingly to formulate the production and marketing

strategies, helping the company to improve its industrial competitiveness, business performance and profits.

Experimental results show that with ABC the case company found that distorted costing differences and cross subsidies phenomenon exists among the individual product costs. The reason is that the manufacturing expenses are apportioned in proportion to the production volume such that the expenses of production line machine maintenance and preparation for product change may not be accurately taken into account, particularly obvious to the low-volume product. Therefore, the research results provide more accurate, realistic and timely cost information to assist the company to formulate the best production and marketing strategies and improve its business performance. Secondly through the ABC product gross profit rate analysis, for the case company to achieve the largest profit the production and marketing strategies should be laid out for the first phase to produce slag powder and for the second phase to produce ultrafine slag powder and cement. Furthermore, the discontinuation of the second-phase slag powder production will reduce the second-phase activities items and cut down the activities drivers, which will not only increase activities efficiency and reduce machine hours, but also save on electricity and other expenses and increase the profit margin of the case company. In addition, it is obviously unreasonable that raw material price includes the sales of 8% water contents. The research data should be used to negotiate with the suppliers for 8% price deduction for the water contents, which will save about 19.2 million yuan of raw materials expense each year. Thus the case company can improve activities profit and performance each year.

Due to the difficulty in the financial information collection and the complexity in the costing calculation process, most SMEs are lack of interest in the implementation of ABC. In this study, ABC is introduced to construct the costing models for in-depth analysis. The research result confirms the existence of potential problems of costing distort and cross subsidies in the costing system of SME. This research also helps the case company to calculate the timely product costing more accurately, eliminate waste, improve activities procedures for better efficiency and optimize the production and marketing strategies to enhance business operating profit. Therefore, it is recommended that SMEs should implement fully automated and computerized activities and introduce ABC to enhance their competitive advantage in the global industry.

This paper consists of six sections. The first section, the introduction, has discussed the importance of recycling and reusing the waste resources in protecting natural environments, creating multiple economic benefits, increasing the profitability and competitiveness of green products, saving energy, reducing carbon dioxide and maintaining sustainable development of ecological environments. The second section reviews the literature. The third section describes the research method, application of Activity-Based Costing, (ABC) to

model construction. The fourth section analyzes the case company with the ABC system model and the results are reported in the fifth section. Finally, the conclusions are drawn in Section Six along with the research limitations and the suggested future research directions.

2 Literature Review

2.1 Green Industry

Global climate change leads to global warming, constantly causing abnormal climate extremes in recent years. Instead of due to climate deterioration, global warming is mainly caused by excessive resource consumption and over development. At this moment it will be inevitably difficult for the humans to stop abusing the natural resources. The most obvious example is electronic communication products, which are being constantly modified and updated to allure the craving consumers. Therefore, sustainable development which simultaneously meets the needs of comfortable life and the conservation of ecological environments is a crucial subject for human beings in this century when facing the extreme global climate change.

Four seasons, spring, summer, autumn, winter, are cycling endlessly. Similarly, if humans can learn from the Mother Nature and constantly recycle the wastes of consumed products or production process to close the loop of product life cycle "Resources > Production > Sales > Consumption" just like endless seasons change, then the development will be sustainable and meanwhile the ecological environments will be well conserved.

Chang and Chen [3] suggested that as long as an enterprise can improve the technology to make the pollution generated by products or production process harmlessly or environmentally friendly, then it may be considered in the Green Industry. Blast furnace slag powder made from recycled water quenched blast furnace slag by grinding process is a government-certified green product of fine building materials, which is not only used in the domestic and foreign constructions but also can achieve the functionality of energy saving and carbon reduction, an excellent low carbon green product [18]. Therefore, according to the green industry definition of Chang and Chen [3], the production of blast furnace slag powder may be regarded as a Green Industry.

2.2 Traditional Costing System (TCS)

For a long time the traditional manufacturing has been labor intensive so that in the production process the direct labor and the direct materials weight extremely heavily in the product costing and in contrast the manufacturing overheads weight relatively less. In the previous industrial production environments, the product costing which is assessed by direct labor (hour) and direct materials is directly

attributed to the products so consequently the manufacturing costs are shared by the products. Under the circumstances at that time, such costing system is not improper and generally accepted as a matter of course. Therefore, two professors at Harvard University in the United States, Cooper and Kaplan [8] pointed out that the product cost calculation in the traditional costing system attributes the direct materials and direct labor to the product costs, while the manufacturing expenses are allocated by two stages. First, the manufacturing expenses are allocated to the corresponding cost centers according to their functionalities or activity characteristics, and then the manufacturing overheads are evenly attributed to all products according to volume-related criterion. Furthermore, Kaplan and Cooper [19] suggested that actually many traditional costing systems did not successfully allocate the management and marketing expenses to the production cost centers according to the direct labor hours or worker hours (as illustrated in Figure 1).

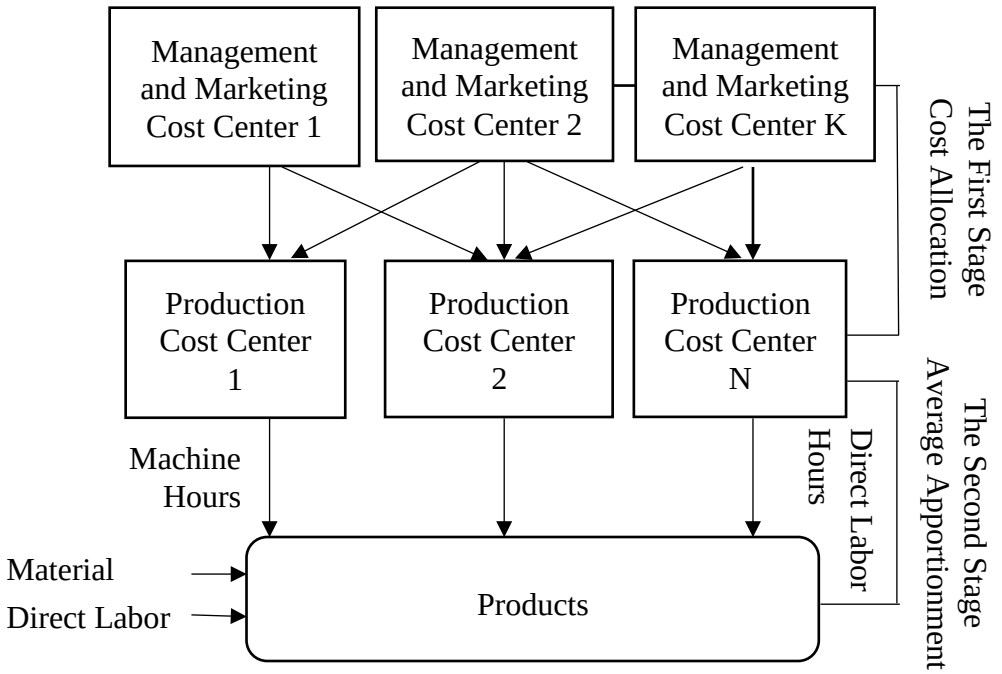

Figure 1: Two-Stage Allocation of the Traditional Cost System

Kaplan & Cooper (1988)

In the traditional costing system the manufacturing overheads are assigned by unit base. That is too simplified and not rigorous enough to accurately estimate the resource expenses, leading to potential costing calculation distortions by the enterprises (Miller & Vollmann) [21]. Besides, Cooper and Kaplan [8] also suggested that traditional costing system does not consider the diversification of products, resulting in product costing distortion and cross-subsidies. In addition, Howell and Soucy [17] also considered that for enterprises in the constantly

changing environments the traditional costing system is already unable to meet the needs of internal activity control and the purposes of accurate product costing and inventory assessment. At last, Brimson [2] pointed out that many manufacturing overheads change with product variety and complexity rather than with direct material quantity and amount of money, direct labor (hours) and machine hours.

In recent years, due to the rapid progress of computer application software system and innovation in science and technology, as well as the intensified global competition, manufacturers generally automate their productions. This trend reflects to the realistic phenomena such as the gradual reduction of the number of direct labors in many industries. Machinery and equipment for computerized automatic production are not only expensive but the associated expenses of depreciation, repair, maintenance and utilities are also high. These changes naturally cause a significant increase in the indirect costs, which leads to the allocation of indirect overhead based on direct labor. Therefore, the costing calculation is apt to be misleading and distorted. Consequently, in order to reduce costing distortions, many industries began to replace "direct labor hours" with automated "machine hours" as a basis for indirect overhead allocation. However, it was subsequently found that the "machine hours" allocation was not entirely the best solution to the allocation of indirect overhead. Therefore, Weygandt, Kimmel, & Kieso [26] pointed out that product design and engineering overheads are not related to "machine hours" and instead are related to the number of product varieties of the company.

2.3 Activity-Based Costing System (ABC)

Traditional costing system due to the evolution of times and circumstances results in many shortcomings and it gradually cannot adapt to and meet the needs of the business, so Cooper and Kaplan [8] and Raffish and Turney [23] suggested companies to adopt ABC because they believed the features of ABC can compensate for the difficult problems in the traditional cost accounting system. In addition, Weygandt, Kimmel, & Kieso [26] pointed out that companies with complex manufacturing processes have to use multiple allocation bases to accurately calculate product costs, and ABC is a method with multiple bases to allocate indirect costs.

Cooper and Kaplan [8] regarded the activity-based costing system as a new way of thinking, which provides clear cause-effect relationship among cost objectives, activities and resource requirements, thereby helping to reduce the shortcomings of cost attribution distortion in the traditional costing systems. Since cost-allocation is susceptible to distortion and accounting personnel tends to mistake product cost calculation, Cooper and Kaplan [9] specifically emphasized that the purpose of the activity-based costing system is mainly to pursue the real costs. Hilton et al. [15] considered that primary function of the activity-based costing (ABC) system is to manage product profit margins of individual customers

as well as accordingly to estimate the costs of similar new products as references for the pricing and quoting decisions of the top managements.

Although the activity-based costing system (ABC) has existed since the mid-1980s and been developed for many years, academia still has different positive and negative views on this costing system. For example, Raffish and Turney [23] considered that the activities-based costing system (ABC) can link the activities of different divisions and provide the activities details to identify overall costing information. Secondly, Witherite and Kim [27] indicates that the implementation of the activities-based costing system has many advantages for the companies such as product profitability assessment, performance evaluation of divisions according to cost difference, high-level competitive advantage assessment, resource and cost estimation, and decision for the allocation of cost drivers and internal service recipients. They will mutually generate interaction and then create maximum synergies. In addition, Kaplan and Anderson [20] explained the activities-based costing system can more accurately calculate product costs, reduce waste and improve the effectiveness of business performance. Global competition leads to meager profits in industries and the enterprise need be more competitive than their peers in order to maintain a sustainable business with better profit margins. Yu [29] believes that the profit advantage is a combination of the most profitable strategic operation model, the most cost-competitive advantage and the most effective activities flow. ABC is the only management tool that helps companies to achieve those three advantages by integrating their vision, process, indicators, management information and action plans for them.

Although ABC has many merits and may well benefit the enterprises, it also has its demerits. Horngren [16] and Christensen and Demski [7] considered ABC is lack of theoretical basis. Greenwood and Reeve [13] also explained ABC is short of predictive information and cannot predict how the expenses are influenced by some decision. Besides, Geishecker [14] pointed out that data collection and compilation are the major challenges in the implementation of ABC.

2.4 Purpose and Effect of ABC Application

ABC establishment has its advantages and disadvantages. However, the original purpose of ABC implementation is mainly to address the issue of cost-allocation distortion in the traditional costing system whose single model of cost attribution does not match with the actual activities conditions, resulting in cost-allocation distortion. However, Turney [24] believes that activities-based costing system has two main objectives: (1) to improve the accuracy of product costing by changing the category and number of cost allocation factors and (2) to provide timely information with ABC for the improvement of product portfolio and pricing strategies.

The early ABC is a one-dimensional model and its concept may be explained by a

two-stage allocation model. The first stage of activities-based costing system is mainly to establish the cause-effect relationship between resources and product expenses. First, resource expenses are allocated to different activities through resource cost drivers to enhance the accuracy of product costing and simultaneously to improve the combined strategies for the pricing, production and marketing of cost objectives (products, services and customer), as shown in Figure 2.

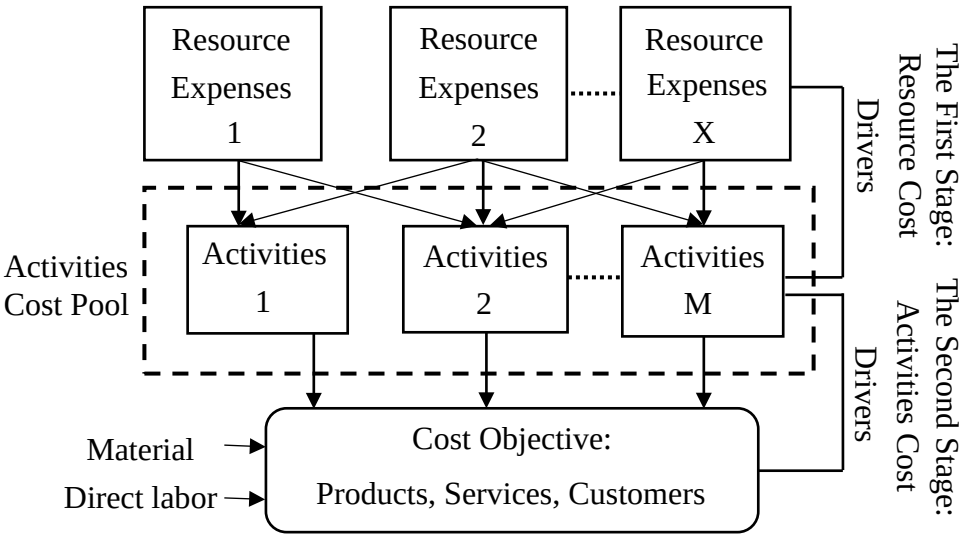

Figure 2: Two-Stage Apportionment of the Activities-Based Costing
Kaplan & Cooper (1988)

In the second stage the activities expenses are allocated to cost objectives such as products, services and customer. The allocation bases in the first and second stages are respectively called resource cost driver and activities cost driver by Cooper and Kaplan [9]. Under ABC, enterprise resource expenses are consumed for the execution of activities while cost objective is the requester of activities. Hence, the early ABC system focused on the accuracy of the product costing. Through improving the over-simplified single basis for unit cost allocation of the traditional costing system, ABC corrected such shortcomings as costing distortion and cross subsides.

The principle of cost accounting system is to truly reflect the activities cost of the product objective, which is the initial purpose of ABC establishment. However, during the ABC establishment, many enterprises found that much ABC information may be extended to the management level. Therefore, after accumulating many years of research experiences, Turney [24] proposed a"Two Dimensional Activities-Based Costing System Model"to enhance its structure as illustrated in Figure 3.

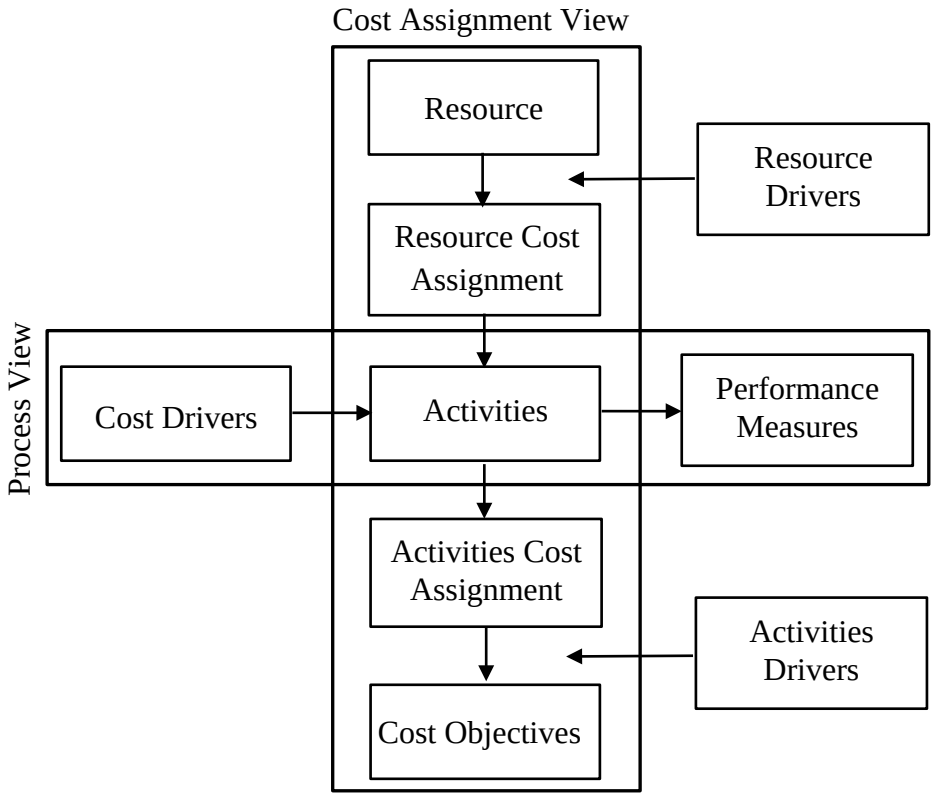

Figure 3: Two Dimensional Model of ABC System
(Turney, 1991)

Two-dimensional ABC system model consists of two main viewpoints: cost assignment view and process view. As shown in figure 3, the vertical cost assignment view describes the entire costing activities of ABC, whose modes includes three major elements: resources, activities and cost objectives as well as two assignment stages: resource cost assignments and activities cost assignment; using resource drivers to link resources and activities and using activities drivers to link activities and cost objectives. On the other hand, as described by horizontal process view, Activity-Based Management is introduced into ABC, with key elements such as cost drivers, activities and performance measures. Adding the management functionality to the process view is mainly to provide the activities process related accurate costing and operation information as well as the activities difference analysis. Combined with Process Value Analysis (PVA) for the performance evaluation and analysis of the activities, hopefully ABC can provide timely strategic and operational information to the top managements as business management guideline for better cost management of the organization.

2.5 ABC establishment procedure analysis

Two scholars particularly designed the establishment procedure of ABC. First,

Cooper [10] argues that ABC design should be based on the principle of providing the best possible benefit at the lowest cost and that the complexity of work depends on the diversification of the performance objectives and product mixes that the top management expects ABC to establish. Cooper [11] proposed to design an ABC system in five steps, summarized as follows: (1) aggregating activities, (2) reporting activities cost, (3) identifying activities centers, (4) selecting the first-stage cost drivers, and (5) selecting second-stage cost drivers. Cooper believed that cost driver selection must consist of three elements, namely, correlation level, cost measurement, and behavior impact.

Second, Turney [24] proposed six steps in the establishment design of ABC, including detailed rules and more specific methods as briefly described as follows. (1) Identifying activities. The principle of activities execution should include matching each other, resolving conflicts by activities summary, combining minor activities items, clear and consistent activities. (2) Reorganizing the general ledger: follow the rules to combine relevant accounts, attribute them to the department level and adjust the general ledger. (3) Establishing activities centers with rules as follows. Integrate activities in the departments, establish activities center according to activities attributes and utilize hierarchical activities center to establish information center. (4) Identifying the resources drivers. Costs should be attributed directly or by the cause-effect relationship as much as possible to avoid the arbitrary attribution. (5) Determine the activities attributes. (6) Select activities drivers. Important selection criteria include: consistent with activities category, well correlated with activities consumption, minimizing activities drivers, stimulating performance, capable of real-time cost measurement and without duplicated evaluations.

Although both Cooper [11] and Turney [24] have unique discussions for ABC establishment steps, here under the consideration of the practical operation of SMEs, the ABC establishment steps proposed by Turney [24], closer to the actual practice of SMEs, can be implemented with fewer obstacles.

3 Research Methodology

In this study, experimental analysis of ABC establishment design will inevitably involve the case company financial information, activities flow and cost driver analysis. In-depth investigation and analysis will be conducted for the current costing system implemented by the case company to determine whether the resource costs are properly attributed and whether the activities costs are correctly allocated. Therefore, a green industry company is selected as the case study object for the empirical research with ABC to analyze the operating profit and performance of the case company.

The establishment design of this study will be described from such four aspects as research method, research object, case company introduction, and research method.

3.1 Research Method: An Experimental Case Study

The main purpose of this study is to investigate the phenomena and problems in the case practice theoretically and experimentally in order to enhance the competitiveness of the case company in the green industry and to improve its management performance and operating profits. Meanwhile, through the multiple economic benefits created by recycling in the green industry, the idea of reducing cement mining will be promoted so as to address global climate change and global warming issues and to maintain the global natural ecological balance. Therefore, this study adopts the case study method to conduct empirical quantitative research and select a case company in green industry for experimental research.

For ABC to resolve the potential costing distortion problem in the traditional costing system where the costs are allocated by single attribution mode, over simplified and not rigorous enough, Turney [24] suggested two main purposes of ABC. (1) Improve the accuracy of product costing by changing the attribution category and quantity of individual cost factors. (2) Utilize ABC to provide timely information to improve product mix and pricing strategy. However, the establishment and design of ABC, inevitably involving many data and materials, requires the analysis of the enterprise's financial statements and production activities flow, proper allocation of activities costs, accurate cost calculation, and cost analysis and modification of the activities flow. Chen [6] pointed out that a case study is to describe many relevant facts, provide the status of the problem and search for feasible solutions to the problem. It must describe the true story faithfully and state one or several central questions objectively.

Therefore, in order to increase the credibility and effectiveness of this study, ABC is applied to a selected green manufacturing company for case study. The company's organizational structure and production processes will be thoroughly explored and the financial information, operating costs and present costing system of the case company will be interpreted and analyzed. Meanwhile we visited the case company to directly observe the activities flow and collect data. Through in-depth discussions with the top management, activities resource costs are truly reflected and correctly allocated so as to provide timely accurate product costing information for the formulation of production and marketing strategies to improve the company's operating performance and profit.

3.2 Study Object

Following the case pilot approach proposed by Eiler and Ball [12], this research selects a professional mill of water-quenched blast-furnace slag powder, a small-medium enterprise green manufacturing industry in Taiwan, as the target of

experimental study and adopts ABC system as the case study tool. The case company uses furnace slag generated from fully integrated steel mill as raw materials, which were recycled, grinded and converted into slag powder, an excellent green building Portland material. That can reduce cement mining, suppress carbon emissions, reduce environmental pollution, promote ecological balance and create multiple economic benefits.

Small-Medium Enterprise (SME) plays a pivotal role in Taiwan's economic miracle, which has been affirmed by many researchers domestically and abroad. According to the statistical data of Taiwan's SMEs Office in 2016, the total number of SMEs in Taiwan reaches about 1.4 million, accounting for 97.73% of the total number of enterprises. Obviously SMEs make a considerable economic scale in Taiwan's economic structure with indispensable functions in promoting Taiwan's economic development. Trade globalization causes intense enterprise competition but how should SMEs in Taiwan improve their competitive advantages to face the global competition is seldom investigated from the aspect of accounting particularly by applying ABC. Therefore, the study selects a water-quenched blast-furnace slag grinding plant in the green industry as the research object. It is of special significance for the case company to solve the problem of environmental degradation caused by huge amount of waste, reduce the exploitation of cement mines, cut down carbon emissions, promote the sustainable development of ecology, create diversified economic benefits, and strengthen the competitive advantages of green industry in the world.

3.3 Case Company Background Introduction

The case company, in green manufacturing industry, initially only produced blast furnace slag powder. After its establishment, a second production line is added to increase production capacity of slag powder and also to produce ultrafine slag powder and cement to meet customer demands.

Although the grinding process is a traditional technology, the case company considers the fierce competitive environment in the 21st century manufacturing industry and the traditional manpower shortage, highly computerized automatic production is an essential measure against competition in the industry. The product costing structure is changed with the production structure to meet various customer demands and services; for instance, rapid delivery and a variety of small quantity product orders. However, for the traditional costing system, production and marketing strategies tend to be production-oriented, labor-intensive and maintaining a safe stock of products. Even in the traditional industry, due to the industrial specialness the case company adopts fully computerized automatic activities. Although the first phase production line only produces slag powder, the second phase produces slag powder, ultrafine slag powder and cement. Seemingly simple, but due to the complexity of the activities process, how to use ABC system to improve the activities flow, reduce the activities items, improve

activities efficiency, reduce power consumption and avoid manpower waste in order to increase profits and improve performance is crucial for the growth of the case company.

Second, the upstream suppliers of the case company are fully-integrated steel mills. Procurement of the furnace slag raw materials is conducted through annual contracts with annual total volume control and the prices are adjusted according to the supplier output and market prices, resulting in an oligopoly market. Therefore, the bargaining space for the price of raw materials is limited. Besides that, due to annual total supply volume control, the case company must seriously control the raw materials inventory as well as the production and marketing strategies to avoid over inventory of products and raw materials. In addition, the production adopting fully computerized automatic activities system to replace the direct labor with machine hour causes huge electricity expenses. Although fully computerized automatic production replaces manual labor, machinery depreciation accounts for the largest share of manufacturing overheads. Furthermore, since the machinery and equipment are very expensive, their maintenance and repair became more important. Otherwise, failure of machines would be a very costly problem and the subsequent activities cost allocation would be complicated issues. Therefore, for the issues of activities flow modification and cost allocation, the top management of the case company need to set up a costing system in line with the company's current activities so as to provide timely accurate cost information and details of resource consumption, with which the production and marketing strategies are to be formulated to improve the company's industrial competitiveness.

Taiwan's furnace slag powder industry, established for more than 30 years, produces environmentally friendly products certified by the government. Besides being excellent building materials for the domestic construction industry, furnace slag powder also helps to reduce carbon dioxide emission so it is an excellent low-carbon and environmentally friendly product. The use of furnace slag powder as a concrete admixture can improve the late compressive strength and durability and save the cost of concrete. Therefore, furnace slag powder, ultrafine furnace slag powder and furnace cement are highly regarded by the downstream customers. The major customers include ready-mixed concrete industry, public constructions, contractors, construction companies, and building materials firms. The relevance among upper, middle and lower streams of the furnace slag powder industry is shown in Figure 4.

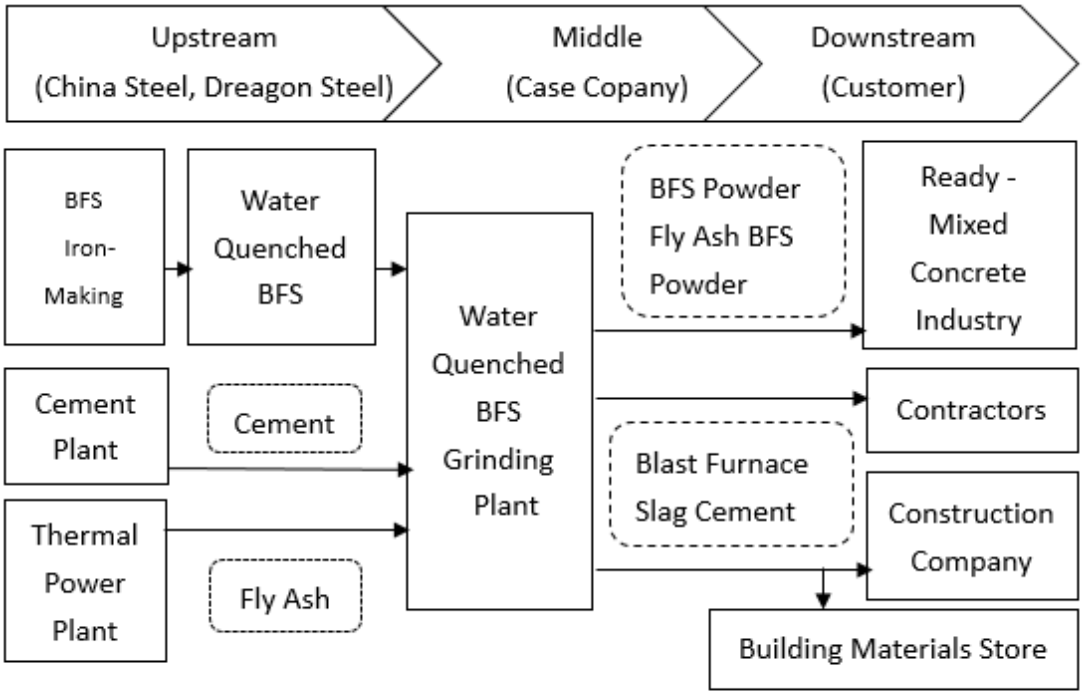

Figure 4 the Upstream, Middle and Downstream of the Relevance

Source: Case Company

3.4 Case Company Production Process

To actively face the serious competition in the 21st century manufacturing industry, production activities of the case company are fully automated and computerized. The activities flow chart provided by the case company and verified by direct observation on the entire manufacturing process is initially divided to activities centers according to activities gathering area and activities attributes. The main purpose of the study is to achieve the economic benefits of a full enterprise transformation through activities modification, activities procedure improvement, activities value analysis, activities cost reduction and timely provision of financial information. For simplicity, in this study the production activities are divided to six major activities centers including Raw Material Transportation Activities Center, Raw Material Stacking Activities Center, Drying Activities Center, Grinding Activities Center, Product Stacking Activity Center and Product Distribution Activity Center, as illustrated by the production activities flow chart in Figure 5.

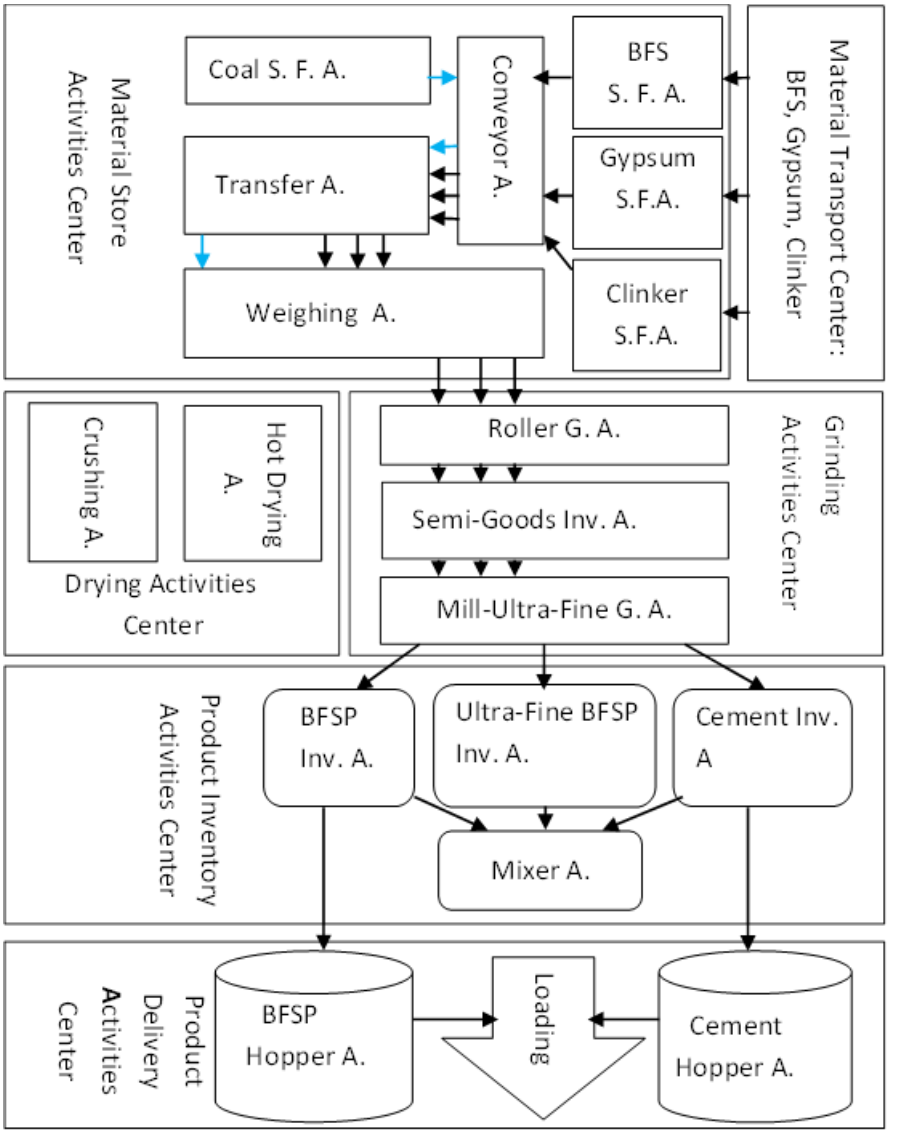

Figure 5: Production Process of the Case Company

Source: Case Company

3.5 Study method

Since Turney's [24] ABC establishment steps are closer to the enterprise practice, they can reduce the barriers of ABC implementation in the case company. Therefore the ABC design steps, rules and methods proposed by Turney [24] are utilized as principal guidelines for the study. Second, the information obtained from the interview with the case company and direct observation on the activities process is used as a reference. The steps for this experiential case study are described as follows.

(1) Data Collection: Case study data usually cannot be directly obtained from data library and are closer to the activities practice of the case industry. Moreover, information sources should be multi-faceted for better credibility of the case study results. Therefore, based on the above data collection principle, besides the company's organizational chart, employee head count of individual activities departments, and the financial statements, other information collections such as manufacturing activities flow chart, activities drivers, cost drivers, and resource drivers are also very important for ABC implementation.

(2) Identify Activities: Activities arrangements first need take the required activities functionality into account. Thus, the organizational chart and product manufacturing flow chart provided by the case company need be used as reference to improve the activities flow and efficiency. Merger or abolition of activities must meet the requirements of ABC system.

(3) Reorganize the Ledger: Because the company are implementing ABC, the general ledger costing account must be reclassified by consolidation and adjustment. Moreover, in this step the ledger also need be combined with the identified activities and then attributed to the activities centers to meet the requirements of ABC, in order to facilitate the planning of future resource attributions.

(4) Establish Activities Centers: Establishment of activities centers is a large feature of ABC. Therefore, the establishment of each activities center should first be based on the company’s strategic functionality requirements for the activities center, and various activities should be aggregated into activities centers. The main purpose is to establish the most basic management unit to enhance activities efficiency and to shorten or improve the activities flow so as to reduce activities costs, facilitate costing analysis of individual activities centers, provide various timely financial information, and achieve the comprehensive economic benefits of activities aggregation.

(5) Identify Resource Drivers: When completing ledger reorganization, resources identifications, and activities center establishment, ABC in the first phase assigns resource attributes to a various activities or activities center, and then identify what the resource drivers are.

(6) Select Activities Drivers: The second stage activities cost attribution of ABC is to allocate the accumulated activities driver costs of individual activities centers to product objectives. The propriety of activity driver selection affects the costing accuracy of product objectives and the pricing strategy of sales. Therefore, careful selection of activities drivers becomes the key indicator.

(7) Identify Cost Objective: In the first phase of ABC the resources costs are

attributed to activities and then in the second phase of activities cost attribution the activities driver costs accumulated in individual activities centers are allocated to the cost objectives. Therefore, the cost objectives are the final attributes of ABC activities costs and also the final resources consumers. Due to the clear cause-effect relationship between activities drivers and cost objectives, costing information embedded in the product objective can provide accurate timely cost objective information as an important reference for the managers to formulate the best production and marketing strategies.

4 Case Analysis for the Application of ABC Establishment Model to the Case Company

4.1 Relevant Data Collection for the Case Company's Resource Expenses

To investigate and analyze the case company, we must first understand the case company's background, organizational structure, financial data and information, production processes and other internal statuses. Especially for the case study with ABC establishment research, the case company's interviews, direct visits and various information collections are indeed necessary. The key information includes the activities flow chart, production records, power usage records, organizational chart, various financial statements, and employee head count and job responsibilities. In addition, it is also required to collect information of activities relevant resource drivers and cost objective relevant cost drivers. Although data collection is critical, however, direct observation of the activities practice is even more crucial. Moreover, it is really necessary to discuss with the finance staff the situations of financial attribution and the resource allocation as well as to investigate the activities flow with the plant manager and relevant activities personnel. The above actions are of great importance for the researchers to establish successful ABC. (Note: Some of the financial data and activities relevant details provided by the case company are confidential and not to be disclosed.)

Then, this study constitutes six major steps to analyze the case company according to the ABC establishment design steps, rules and methods proposed by Turney [24] as well as the case company specific information. Table 1 is a list of resource expenses provided by the case company.

Table 1: Resource Expense Statements

Resource Name	Amount (Unit: NT$)
Rent Expense	16,360,481
Shipping Expenses	44,961,571
Repair(s) and Maintenance Expense	8,935,487
Utilities Expense	91,279,776
Insurance Expense	2,417,657
Fuel Expense	10,093,915
Depreciation Expense	110,341,190
Various Amortization	13,733,812
Miscellaneous Expense	1,050,824
Consumption Expense	28,923,948
Testing Expense	905,954
Other Manufacturing Expenses	1,840,311
Total	330,844,926

Source: Case Company

4.2 Identify the Case Company Activities

To establish ABC, companies need to change their concepts and shift the focus of costing analysis from resource expenditure items to activities items. Only with this converted costing analysis, companies can really control the costs for raw materials procurement, and actual activities expenses for new product objectives (Kaplan & Cooper) [19]. Therefore, arrangement of activities items in the activities flow chart should be optimized according to the organization production capacity and the complexity of the activities flow in order to improve activities efficiency and reduce activities costs.

In this study after we visited the case company factory to directly observe the activities process to verify the activities flow chart provided by the company, and discussed in depth with the chief accountant and plant director, basic principles for the activities are defined based on the criteria proposed by Brimson & Antos [1] such as the activities should be viable, understandable and with combined financial and non-financial performance indexes. According to such criteria, after careful assessment 23 activities are identified and consolidated as Table 2.

Table 2: Activities Item for Case Company

No	Activities Item	Brief Name
1	Blast Furnace Slag Transport Activities	BFS Tran. A.
2	Clinker Transport Activities	Clinker Tran. A.
3	Gypsum Transport Activities	Gypsum Tran. A.
4	Raw Coal Stacking Field Activities	Coal S.F.A.
5	Blast Furnace Slag Stacking Field Activities	BFS S.F.A.
6	Gypsum Stacking Field Activities	Gypsum S.F.A.
7	Clinker Stacking Field Activities	Clinker S.F.A.
8	R. Material Conveyor Activities	Conveyor A.
9	Transfer Tower Activities	Transfer Tower A.
10	Raw Material Weighing Activities	Weighing A.
11	Coal Crushing Activities	Crushing A.
12	Hot Air Drying Activities	Hot Drying A.
13	Roller Coarse Grinding Activities	Roller G. A.
14	Semi-finished Goods Inventory Activities	Semi-Goods Inv. A.
15	Vertical Mold Coarse-Fine Grinding Activities	Coarse-Fine G. A.
16	Ball Mill Fine Grinding Activities	Mill Fine G. A.
17	Ball Ultra-Fine Grinding Activities	Ultra-Fine G. A.
18	BFS Powder Product Inventory Activities	BFSP Inventory A.
19	Cement Inventory Activities	Cement Inventory A.
20	Superfine BFSP Inventory Activities	Superfine BFSP Inv. A.
21	Mixer Activities	Mixer A.
22	BFS Powder Hopper Activities	BFSP Hopper A.
23	Cement Hopper Activities	Cement Hopper A.

Source: Case Company & This Study

4.3 Reorganize the Case Company Ledger

Due to the implementation of ABC, the expense subjects of general ledger must be consolidated and adjusted for reclassification. After discussing with the case company's finance department manager and plant director, the general ledger provided by the case company is reorganized according to the three principles proposed by Brimson [2]: (a) merging related subjects, (b) breaking down resource cost to departmental level and (c) adjusting non-economic subjects. The resources attributions are re-identified and through resources reorganization, merger and classification adjustment, the company general ledger resources

attributions are redistributed. For example, the costs directly invested in production activities such as staff salaries, food expenses, overtime pay and retirement pension are adjusted to the attribution to direct labor costs. After the reorganization and identification of various resources, the details are shown in Table 3.

Table 3: Reorganize the Ledger for Case Company

Resource Name	Classification Description
Rent Expense	Plant land rent, transportation vehicles and other rental costs.
Shipping Expenses	Raw material handling costs.
Repair(s) and Maintenance Expense	Housing and buildings, machinery equipment, equipment, transportation equipment, miscellaneous equipment and other repair expenses.
Utilities Expense	All kinds of machinery and equipment, water and electricity charges.
Insurance Expense	Insurance costs for housing and buildings, machinery equipment, equipment, transportation equipment, miscellaneous equipment etc.
Fuel Expense	Truck and excavator diesel fuel costs.
Depreciation Expense	Depreciation for housing and buildings, machinery equipment, equipment, transportation equipment, miscellaneous equipment, etc.
Various Amortization	Various amortization for housing and equipment, machinery equipment, equipment, transportation equipment, miscellaneous equipment, etc.
Miscellaneous Expense	Miscellaneous expenses for housing and buildings, machinery equipment, equipment, transport equipment, miscellaneous equipment etc.
Consumption Expense	Consumption costs for hot air stove and dryer burn raw coal, fuel oil etc.
Testing Expense	Testing costs for machinery and equipment, equipment, transportation equipment, miscellaneous equipment etc.
Other Manufacturing Expenses	Those which cannot be classified in the above manufacturing expenses are included in this subject.

Source: Case Company & This Study

4.4 Establish the Case Company Activities Centers

Establishing activities center is a major effort of ABC. Therefore, through direct observation of production activities process and discussion with the finance

department manager and plant director, this study follows the activities center establishment rules proposed by Turney [24]: (a) Integrate departmental properties to activities. (b). Utilize the requirement of activities attributes. (c). Establish hierarchical information system with hierarchical activities centers. Through the above three principles and with the consideration of case company's fully computerized automatic activities system and the functional strategy requirements of the establishment, a most basic management unit is established as activities center in order to improve activities processes, enhance activities efficiency and reduce activities costs . After careful assessment the establishment of six activities centers is identified, as detailed in Schedule 4.

Table 4: Activities Center of Case Company

No.	Activities Center	Item
1	Raw material Transport Center	4
2	Raw Material Store Activities Center	7
3	Drying Activities Center	3
4	Grinding Activities Center	3
5	Product Inventory Activities Center	4
6	Product Delivery Activities Center	2

Source: Case Company

4.5 Identify the Case Company Resource Drivers

When ABC in the first phase attributes the resources expenses to activities or activities centers, the resources drivers need be identified. For example, the case company allocates rents to the activities centers and the resource drivers are calculated based on the floor area occupied by individual activities centers. Turney [24] believed that resource expenses had better be directly allocated according to the cause and effect relationship. Besides, Ostrenga [22] considered that direct attribution can provide the most accurate information. Therefore, this study follows the above principles and after detailed discussion with the case company's financial manager and plant director, the resource drivers and activities resources are identified and summarized in Tables 5 and 6 respectively.

Table 5: Identify Resource Drivers

Resource Name	Resource Drivers
Rent Expense	Assigned to the activities centers according to plant floor area used by the individual activities items.
Shipping Expenses	Directly attributed to Raw materials transportation activities center.
Repair(s) and Maintenance Expense	Individually attributed to the respective activities according to actual utilities expenses rate of the individual activities items.
Utilities Expense	Individually attributed to the respective activities according to actual utilities expenses rate of the individual activities items.
Insurance Expense	Individually attributed to the respective activities according to actual utilities expenses rate of the individual activities items.
Fuel Expense	Assigned to Raw materials transportation activities center and dryer activities center.
Depreciation Expense	Individually attributed to the respective activities according to actual utilities expenses rate of the individual activities items.
Various Amortization	Individually attributed to the respective activities according to actual utilities expenses rate of the individual activities items.
Miscellaneous Expense	Individually attributed to the respective activities according to actual utilities expenses rate of the individual activities items.
Consumption Expense	Assigned from the activities such as hot air stove, dryer, vertical and ball mill coarse-fine grinding to the respective activities centers.
Testing Expense	Individually attributed to the respective activities according to actual utilities expenses rate of the individual activities items.
Other Manufacturing Expenses	Individually attributed to the respective activities according to actual utilities expenses rate of the individual activities items.

Table 6: Activities Resources Allocation

Unit: NT $ thousand

Activities Center	Activities Item (brief name)	Manufacturing Cost														
		No.	Rent Expense	Shipping Expenses	Repair(s) & Maintenance	Utilities Expense 1	Utilities Expense 2	Insurance Expense	Fuel Expense	Depreciation Expense	Various Amortization	Miscellaneous Expense	Consumption Expense	Testing Expense	Other Manu. Expenses	Total
R. M. Transport A. C.	R. M. Transport A.	1	4,908	35,969	268	4,735		73	5,047	3,310	412	31		27	55	54,835
		2	3,272	8,992	179		1,289	48	3,533	2,207	275	21		18	37	19,871
Raw Material Store Activities Center	Coal S.F.A.	1	16		8	138		2		105	13	0		1	2	285
		2	1		0		7	0		6	1	0		0	0	15
	BFS S.F.A.	1	31		17	275		5		210	26	2		2	3	571
		2	2		1		15	0		11	1	0		0	0	30
	Gypsum S.F.A.	2	16		9		43	2		110	14	1		1	2	198
	Clinker S.F.A.	2	654		357		2,492	97		4,415	549	42		36	74	8,716
	Conveyor A.	1	82		45	818		12		552	69	5		5	9	1,597
		2	82		45		728	12		552	69	5		5	9	1,507
	Transfer A.	1	41		22	409		6		276	34	3		2	5	798
		2	41		22		364	6		276	34	3		2	5	753
	Weighing M. A.	1	90		49	922		13		607	75	6		5	10	1,777
		2	90		49		817	13		607	76	6		5	10	1,673
Drying Activities Center	Crushing A.	1	294		161	1,109		44		1,986	247	19		16	33	3,909
		2	196		107		739	29		1,324	165	13		11	22	2,606
	Hot Drying A.	1	654		357	4,494		97	1,009	4,414	549	42	14,462	36	74	26,188
		2	982		536		5,477	145	505	6,620	824	63	11,570	54	110	26,886
Grinding Activities Center	Roller Coarse G. A.	2	491		1,340		9,323	363		16,551	2,060	158		136	276	30,698
	Semi-goods Inv. A.	2	327		447		3,093	121		5,517	687	52		45	92	10,381
	Coarse-Fine G. A.	1	2,290		1,787	32,721		483		22,068	2,747	210	1,446	181	368	64,301
	Mill Fine G. A.	2	491		1,787		10,902	484		22,068	2,747	210	1,446	181	368	40,684
	Ultra-Fine G. A.	2	491		894		6,230	242		11,034	1,373	105		91	184	20,644
Product Inventory Activities Center	BFS Powder Inventory A.	1	164		90	1,546		24		1,103	137	10		9	18	3,101
		2	327		179		1,289	48		2,207	275	21		18	37	4,401
	Cement Inventory A.	2	164		89		602	24		1,103	137	11		9	18	2,157
	Superfine BFSP Inv. A.	2	82		45		301	12		552	69	5		5	9	1,080
	Mixer A.	2	49		27		172	7		331	41	3		3	6	639
Product Delivery Activities Center	BFS Powder Hopper A.	1	8		4	99		1		55	7	1		1	1	177
		2	8		5		88	1		55	7	1		0	1	166
	Cement Hopper A.	2	16		9		43	2		110	14	1		1	2	198
	Total		16,360	44,961	8,935	47,266	44,014	2,418	10,094	110,342	13,734	1,050	28,924	906	1,840	330,844

Source: Case Company & This Study

4.6 Select the Case Company Activities Drivers

Activities driver selection becomes the key indicator for the success of ABC implementation, mainly because the activities and cost objectives must be connected by activities drivers which are also the measurement unit of activities results. Therefore, the choice of activities drivers reflects the measurement correctness of activities results.

Although fully computerized automatic activities system is adopted by the case company, raw materials procurement in the raw materials transportation activities center is delivered by truck and "Loading Trip / Ton" is selected as the measurement unit of activities driver for activities cost driver. "Machine Hours / Ton" is selected as the measurement unit of activities drivers for the other activities centers. It is noteworthy to note that the activities driver for the procurement of raw materials selects "Loading Trip / Ton" instead of "Batch / Trip". The former uses "Tone" to calculate the freight charges and the drivers would load more raw materials per trip. In contrast, since the latter is charged by trip, the drivers tend to load fewer raw materials to increase the trips for more transportation compensations. Therefore, planning activities drivers cautiously not only can ensure cost calculation of cost objectives meeting the accuracy requirements but also can reduce the costs. To this end, after in-depth discussion with the case company's financial manager and plant director, the activities drivers are selected as shown in Table 7 in details.

Table 7: Select Activities Drivers for Case Company

Activities Center	Activities Item	Select Activities Drivers
Raw material Transport Center	Blast Furnace Slag Transport Activities	Loading Trip / Ton
	Clinker Transport Activities	Loading Trip / Ton
	Gypsum Transport Activities	Loading Trip / Ton
Raw Material Store Activities Center	Raw Coal Stacking Field Activities	Stacking Machine Hours / Ton
	Blast Furnace Slag Stacking Field Activities	Stacking Machine Hours / Ton
	Gypsum Stacking Field Activities	Stacking Machine Hours / Ton
	Clinker Stacking Field Activities	Stacking Machine Hours / Ton
	R. Material Conveyor Activities	Conveyor Machine Hours /Ton
	Transfer Tower Activities	Transfer Machine Hours / Ton
	Raw Material Weighing Activities	Weighing Machine Hours / Ton
Drying Activities Center	Coal Crushing Activities	Crushing Machine Hours / Ton
	Hot Air Drying Activities	Air Drying Machine Hours / Ton
Grinding Activities Center	Roller Coarse Grinding Activities	Coarse Machine Hours / Ton
	Semi-finished Goods Inventory Activities	Inventory Machine Hours / Ton
	Vertical Mold Coarse-Fine Grinding Activities	Coarse-Fine Machine Hours / Ton
	Ball Mill Fine Grinding Activities	Mill Fine Machine Hours / Ton
	Ball Ultra-Fine Grinding Activities	Ultra-Fine Machine Hours / Ton

Product Inventory Activities Center	BFS Powder Product Inventory Activities	Inventory Machine Hours / Ton
	Cement Inventory Activities	Inventory Machine Hours / Ton
	Superfine BFSP Inventory Activities	Inventory Machine Hour / Ton
	Mixer Activities	Mixer Machine Hours / Ton
Product Delivery Activities Center	BFS Powder Hopper Activities	Hopper Machine Hours / Ton
	Cement Hopper Activities	Hopper Machine Hours / Ton

Source: Case Company & This Study

For ABC establishment, after selection of activities drivers, the amounts of activities costing drivers and the subsequent allocation rates of individual activities (centers) are calculated. Finally the summation of individual activities allocation rates of each product objective is its indirect costs as detailed in Table 8. In addition, the company's production lines are divided into the first phase and the second phase. In the provided financial statements the various activities driver amounts are all year-round data and the actual drivers in Table 8 are also divided into the first and second phases. Meanwhile, furnace slag powder is produced in both the first and second production lines. Therefore, the indirect cost allocation rate of furnace slag powder also need to be classified as the first and second phases, which can be used as a costing difference analysis of the production lines to compare the pros and cons. Finally, please note that if some of the data in the table are not shown, they are the confidential financial information of the case company and cannot be disclosed.

Table 8: Activities Drivers and Manufacturing Overhead Allocation List-2015

Unit: NT$

Activities Center	Activities Item (brief name)	No.	Estimated manufacturing Overhead (1)	Estimated manufacturing Overhead (2)	Activities Drivers	Actual Drivers		BFSP M.O. Allocation Rate		Superfine BFS M.O. Allocation Rate	Cement M.O. Allocation Rate
						No.1	No.2	No.1	No.2		
Raw material Transport Center	BFS Tran. A.	1、2	54,835,928	2,424,231	Loading Trip / Ton	530,265	530,265	108	108	108	
	Clinker Tran. A.	2		17,287,549	Loading Trip / Ton		387,320				45
	Gypsum Tran. A.	2		158,966	Loading Trip / Ton		3,498				45
Raw Material Store Activities Center	Coal S.F.A.	1、2	285,501	15,027	Stacking Machine Hours / Ton	458,290	313,550	1	0	0	
	BFS S.F.A.	1、2	571,005	30,053	Stacking Machine Hours / Ton	458,290	438,970	1	0	0	
	Gypsum S.F.A.	2		198,551	Stacking Machine Hours / Ton		37,626				5
	Clinker S.F.A.	2		8,715,422	Stacking Machine Hours / Ton		495,409				18
	Conveyor A.	1、2	1,596,260	1,505,658	Conveyor Machine Hours /Ton	458,290	533,035	3	3	3	3
	Transfer Tower A.	1、2	798,129	752,829	Transfer Machine Hours /Ton	458,290	533,035	2	1	1	1
	Weighing A.	1、2	1,777,562	1,673,197	Weighing Machine Hours /Ton	458,290	533,035	4	3	3	3
Drying Activities Center	Crushing A.	1、2	3,909,050	2,606,034	Crushing Machine Hours /Ton	327,350	313,550	12	8	8	
	Hot Drying A.	1、2	26,188,551	26,886,205	Air Drying Machine Hours /Ton	458,290	533,035	57	50	50	
Grinding Activities Center	Roller G. A.	2		30,698,091	Coarse Machine Hours /Ton		533,035		58	58	58
	Semi-goods Inv. A.	2		10,381,979	Inventory Machine Hours /Ton		533,035		19	19	19
	Coarse-Fine G. A.	1	64,302,628		Coarse-Fine Machine Hours /Ton	458,290		140			
	Mill Fine G. A.	2		40,683,883	Mill Fine Machine Hours /Ton		533,035		76	76	76
	Ultra-Fine G. A.	2		20,643,320	Ultra-Fine Machine Hours /Ton		388,802			53	
Product Inventory Activities Center	BFSP Inventory A.	1、2	3,101,919	4,400,676	Inventory Machine Hours /Ton	458,290	388,802	7	11		
	Cement Inventory A.	2		2,157,373	Inventory Machine Hours /Ton		533,035				4
	Ultra-Fine BFSP Inv. A.	2		1,078,686	Inventory Machine Hours /Ton		388,802			3	
	Mixer A.	2		638,618	Mixer Machine Hours /Ton		219,485				3
Product Delivery Activities Center	BFSP Hopper A.	1、2	177,385	166,109	Hopper Machine Hours /Ton	219,485	219,485	0	1		
	Cement Hopper A.	2		198,551	Hopper Machine Hours /Ton		219,485				1
	Total		157,543,918	173,301,008		4,743,420	8,609,329	335	338	382	281

Source: Case Company & This Study

4.7 Identify the Case Company Cost Objectives

The case company belongs to the green manufacturing industry as a professional grinding plant for all kinds of ore and the relevant salary expenses are directly attributed to the direct labor. Therefore, the unit cost of the ABC product objectives = direct raw materials + direct labor + manufacturing expense allocation rate. Finally, comparing the unit cost calculations of various product objectives by ABC and the traditional costing method, we not only found that since the traditional costing adopts average allocation and the associated unit costs calculated by the product output and the machine hour are different but also the unit costs of single production line and multiple-product production line are different, affected by activities flow, activities items and production output. Thus, many of the advantages of ABC can be found and the details are listed in Table 9.

Table 9: The Case Company's Cost Objective Calculation List-ABC Unit: NT$

Name	No.1		No.2	
Cost Objectives	BFS Powder	BFS Powder	Ultra-Fine BFSP	Cement
Direct Material	477	477	477	1,160
Direct Labor	19	56	56	56
M.O. Allocation Rate	335	338	382	281
ABC Unit-Cost	831	871	915	1,497

Source: This Study

4.8 Production and Marketing Analysis

The ABC costs calculated according to Table 9 and the unit costs calculated by various allocations of the traditional costing are listed in Table 10 for the production and marketing cost analysis as follows

Table 10: Cost Analysis of Production and Marketing Unit: NT$

Name	No. 1		No.2	
Cost Objectives	BFS Powder	BFS Powder	Ultra-Fine BFSP	Cement
Direct Material	477	477	477	1,160
Direct Labor	19	56	56	56
Traditional Overhead Rate- Average	*347*	*133*	*133*	*133*
Traditional Overhead Rate-output	*347*	*60*	*8*	*331*
Traditional Overhead Rate-Machine hours	*344*	*136*	*144*	*119*
Overhead Rate-ABC	335	338	382	281
Traditional Unit-Cost - Average	*843*	*666*	*666*	*1,349*
Traditional Unit-Cost - output	*843*	593	*541*	*1,547*
Traditional Unit-Cost - Machine hours	*840*	*669*	*677*	*1,335*

ABC Unit Cost	831	871	915	1,497
Distort Costs-Output/ABC (%)	↑1.45%	↓31.92%	↓40.88%	↑10.02%
Market price 12/2017 (NT$)	900~1,000	900~1,000	1,000~1,200	1900~2,200
Traditional Production Costs & Midmarket - Gross Profit Rate	11.26%	37.58%	50.82%	24.54%
ABC & Midmarket Price - Gross Profit Rate	12.53%	8.32%	16.55%	26.98%

Source: Case Company & This Study

First of all, for the first phase production line, a single product line, traditional costing and ABC lead to similar manufacturing overhead allocation rate. In contrast, for the second phase production line with a variety of products, the manufacturing overhead allocation rates are significantly different especially the allocation rate for the output Through the cost analysis of production and marketing in Table 10, with ABC unit cost the production and marketing strategy may be planned as analyzed below.

(1) From Table 10, it is learned that the production cost of furnace slag powder for the first phase is 831 yuan, which is 40 yuan lower than the second phase cost of 871 yuan, so the first phase production of furnace slag powder meets the lowest cost principle. Second, the sales margins are 12.53% and 8.32% respectively for the first and second phases so the first phase is in line with the principle of maximum profitability. Thus, in terms of both production and sales, the first phase is the optimal production and marketing strategy.

(2) The gross profit rates of the second phase ultrafine furnace slag powder and cement are 16.55% and 26.98% respectively, which are much higher than 8.32% gross profit rate of furnace slag product. Therefore, this study result suggests that stopping the second phase production of the furnace slag powder and expanding the production of ultrafine furnace slag powder with its excess capacity will not only save indirect costs, but also improve the operation performance and profit of the case companies.

Through the comparative analysis above, obviously the variety of products on the same production line may cause the cost distortion when the product production category is changed without taking into account the cost of machine maintenance activities. Therefore, it is apparently unreasonable to allocate manufacturing costs in proportion to the output. It is not so called that the largest output leads to largest cost allocation and the least output leads to the least cost allocation.

5 Study Results

First of all, through the ABC application, cross subsides variation phenomena exist among all the product costs in the case company. The main reason for this is

that the manufacturing overheads of the case company are allocated in proportion to the output such that for production of diversified products on the same production line, when the product production category changes the cost of machine maintenance activities is not taken into account, leading to the costing difference, especially obvious for the low-volume product. However the difference is not as large for the production of a single product line.

Second, as shown by Table 8, the allocation rate of manufacturing overhead for each activities and activities center may be clearly defined, providing timely accurate analysis of costs and difference for the relevant activities. Combined with process value analysis (PVA) such information may be used to measure, evaluate and analyze the activities efficiency. Meanwhile top management can use the analysis information of the production and marketing costs in Table 10 to reformulate the production and sales strategy in time as a guideline for the business operation so as to let the organization demonstrate the synergy effect of cost management.

In addition, ABC can provide timely cost information; in particular, the cost of raw materials procurement activities related product objectives. In terms of 240 million yuan (NT $) furnace slag procurement of the case company, top management may use the research data to negotiate with the suppliers for the cost deduction due to the 8% moisture content of raw materials, potentially saving 19.2 million yuan (NT $) of procurement costs each year, which can not only create a win-win situation, but also enhance the company's profitability and business performance.

Finally, this study found that ABC can help to formulate production and marketing strategy in time and let the case company’s first phase production line specialized in the furnace slag powder production and the second phase specialized in the production of ultrafine furnace slag powder and cement, discontinuing the furnace slag powder product of the second phase product line. Such modification will simplify activities process, increase productivity, save indirect costs, enhance industrial competitiveness and expand enterprise profitability and business performance.

6 Conclusions and Suggestions

6.1 Study Conclusions

This study based on case study technique selects a furnace slag professional grinding plant in the green manufacturing industry as the experimental study object. Through the application of ABC theory and structure with various information obtained from the case company, this study find the differences from current costing system such as costing variations, distortion and cross subsides.

Through this study, we can calculate the cost calculation more accurately, eliminate waste, review the system of activities process improvement and reorganize the resources. The following conclusions can be drawn:

(1) Through the ABC construction model case analysis, the activities centers of the case company are constructed. The activities resource allocation list provides the resource expenses and the associated allocation information of the case company's production lines for the top management to easily justify the differences and rationality as a reference for an alternative solution to activities process improvement, electricity consumption and transportation cost reduction and business performance enhancement.

(2) Table 8, the activities drivers and manufacturing overhead allocation list, clearly displays the actual drivers of individual activities of each phase as well as the allocation rates of individual activities and product objectives. It may help to more precisely and in time to calculate the product costs, avoid wastes, improve activities flow, enhance production efficiency, formulate the best marketing strategy, increase market competitiveness and expand operating profit and business performance.

(3) During ABC establishment, it was found that the procurement of raw materials accounts for the largest cost and the associated 8% water content contributes to higher freight rates charged by ton. From the supply chain analysis point of view, reducing the expenses of raw materials procurement is an important decision. The so-called purchase cost is the summation of procurement activities costs and purchase price of raw materials. Shipping cost is also one of procurement activities costs. Therefore, top management should consider adjusting procurement strategy to reduce procurement costs and increase operating profit.

(4) Through ABC establishment, the establishment steps are exhaustively tested and analyzed, and the relevant activities staffs participated in the discussion, which can achieve considerable cognition to ABC, thus reducing the conflict between departments and educating employees the costing concept. That not only motivates them to improve activities efficiency, but also helps the company aim at reducing costs, enhancing industrial competitiveness and increasing profits.

6.2 Study Restrictions and Suggestions to the Future Research Directions

For experimental case studies, it is crucial to faithfully describe the case company particularly when applying ABC establishment analysis. Many details in the collected relevant financial information and activities processes are inevitably involved in the confidential materials. However, in order to present the value of academic research and enhance the reliability and validity of the study, reliable data and alternative information are referred to as much as possible. The case company adopts fully computerized automatic activities system and through

experimental study with ABC, although the required information may be lacking and some portions cannot be reasonably explained, the results show that ABC can be applied to more accurately calculate the cost, eliminate waste, review and improve the activities process, and promote enterprise profitability and business performance. As a result, the case company already has the foundation to implement ABC and the follow-up studies are recommended to be further expanded to ABM. Through ABM implementation, the study may be further extended to an integrated costing system for the case company to enhance their profitability and business performance.

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