

MODELING EFFECTIVE BUDGETING AND PRODUCTION FOR SUSTAINABLE COMPETITIVE ADVANTAGE: EVIDENCE FROM KUFA CEMENT FACTORY, IRAQ

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Abstract: The current study aims at conceptualizing time-driven activity-based budgeting and cleaner production (CP) techniques and their integration in achieving sustainable competitive advantage by applying them at Kufa Cement Factory, an economic unit under the Iraqi Ministry of Industry. The research reached several crucial conclusions. Two techniques are integrated as a hybrid model based on time-driven activity budgeting with CP for the reciprocal relationship between contemporary management accounting techniques. This model gets rid of environmental problems, identifies idle energy as output from the time-driven activity-based budget, and uses it for increasing the production, sales, and profitability. The most important recommendation is that strategic thinking should be leveraged for economic unit management and competitive advantage as it is characterized by strong insights, environmental sensing, etc. It can analyze and interpret the information and has a comprehensive knowledge on various aspects of the economic unit and its requirements. The strategies must be defined to leverage the manpower and resources and translate the goals into victory.

Keywords: TDABB, CP, sustainable competitive advantage, competitive strategies, environmental strategies.

JEL Classification: M4, D57, E39, H60.

1 Introduction

The business environment has changed and is dynamic and vibrant, thanks to diversified customers, modern production methods, exemplary economic growth, etc. However, economic units burden the environmental and societal domains through waste generation, pollution, and resource depletion. In energy plants, using traditional methods and adopting outdated plans and budgets leads to increased production and is also environmentally unsustainable. Thus, the research problem can be formulated based on the following questions: What is the philosophy of time-driven activity-based budgeting (TDABB) technique and its potential in overcoming the issues faced in conventional costing systems? What is the philosophy of cleaner production (CP) technique and its role in product manufacturing at minimal environmental impact and costs of non-value addition activities that consume the resources of

the economic unit? Does integrating the TDABB and CP techniques help in achieving sustainable competitive advantage in light of competitive and environmental strategies?

The current study aims at developing the knowledge framework for TDABB and establishing its contribution to overcome the issues in traditional costing systems, and this motivated us to embark on this research. Furthermore, the CP framework is also studied along with its reflection on product manufacturing to achieve minimum environmental impact, low resource utilization, and cost reduction. The study also integrates both the aspects through sustainable competitiveness in light of competitive and environmental strategies. The current research is an important value addition since it identifies the knowledge frameworks for two techniques, that is, TDABB and CP, and is vital in all the economic units. Furthermore, it intends to identify the

complementary relationship unexplored so far to overcome the problems of traditional economic units and apply modern techniques in accounts and management. The production process does not consider non-valuable activities due to rapid developments and intense competition in the business environment. It intends to increase the production capacity to the aspired limits and achieve a sustainable competitive advantage. To achieve the goals of the study, the researchers relied upon applying the two above techniques on data obtained through field living and personal interviews with officials and workers in the factory – the research sample – and others, as well as the data extracted from the factory records – the research sample.

2 Theoretical side

2.1 Time-driven activity-based budgeting

Traditional costing systems are no longer effective in the resource management or the preparation of budget for the economic units. The latter task depends on the historical data which might mislead at times. The modern cost and administrative accounting techniques resolve these issues based on time-driven activity with an aim to allocate the cost, resources, and time as per the prediction. To raise the efficiency and performance of the economic units, a dynamic costing system is required that meets the increasing complexities in production processes and the business environment. Since the activity-based costing (ABC) activities brought several problems, Kaplan and Anderson developed a new costing technique, that is, time-driven activity-based costing (TDABC) in early 2000s, from which the TDABB technique has emerged.

According to Kaplan and Anderson, TDABB is the exact opposite of TDABC. TDABC starts its application from practical energy represented by time, energy costs, required resources, products, and cost to customers. On the contrary, TDABB identifies the customer requests and determines the energy required to fulfill the requirement. The same methodology has been applied by various scholars in different manners to bring the economic unit to target profitability (Özyürek, 2015). TDABB can be defined as budget preparation in parallel with TDABC in an inverse manner, that is, starts from the expected sales volume based on which

the resources, required to support the production plans, cover the volume of sales (Blocher, et al., 2019).

The current study defines TDABB as a modern technology that assists the economic unit in cost management, finance control, dissemination of appropriate information about value-adding and non-value-adding activities, effective decision-making, and providing dynamic scenarios for the changing business environment through volume planning. The TDABB technique provides appropriate information required for the administration to plan and implement various functions. This is accomplished by integrating or bridging the resources and time-oriented activities for products/services. Thus, it analyzes the cost of each resource to avoid missing any idle resource that may inflate the cost of the product/service. Furthermore, TDABB is an iterative process in which different scenarios are considered for the budget period based on the results of the development process. The predictions are changed from time to time until the results are satisfactory, especially in achieving the targeted profits. Kadhim (2019) listed the following advantages of TDABB:

1. encourages the application of TDABC to calculate product and idle energy costs as secondary outputs during the budget preparation;
2. calculates the profitability of products or customers according to TDABC;
3. assists in product pricing decisions, product design, and customer satisfaction;
4. forecasts the production and sales and assists the managers in planning;
5. increases the profit level of the economic unit by meeting the customers' needs;
6. motivates the participation of functional staff in budget preparation;
7. increases the knowledge and capabilities and identifies the strengths and weaknesses of the economic unit;
8. provides accurate information about the allocation of indirect costs; and
9. achieves a competitive advantage by applying cost leadership strategy (low-cost strategy), differentiation strategy, or both.

The technology further reduces the costs incurred in developing the budget amounts, increases the budget's stability, positively impacts the innovation, continuously improves the budget criteria, and determines the amount of idle/excess staff. Time-driven activity is important in budgeting to achieve competitiveness and continued profitability. So, the budget planned is leveraged to achieve the goals, production, and revenue at calculated costs and time. Following is the step-by-step implementation of TDABB model as per the literature (Kaplan and Anderson, 2007; Öker and Adigüzel, 2010):

1. forecast the sales and production quantities and determine the time vectors;
2. determine different resource groups and the resources consumed;
3. forecast the whole costs of the groups and align them with the performance of the activities and personnel involved;
4. determine the energy requirements from theoretical and practical aspects;
5. calculate the planned energy cost rates through dividing step 3 by step 4;
6. develop the expected time vectors and prepare the time equations; the latter can be changed in case if the improvements can reduce the time taken;
7. calculate the total planned cost of the resources required to meet the expected demand by multiplying step 5 value by step 6 value; and
8. calculate the cost of products/services by combining the costs of materials and direct wages with indirect costs of the departments.

2.2 Cleaner production

The CP concept was first conceived in 1987 to fulfill the current generation's requirements without compromising the needs of future generations. However, sustainable development for product manufacturing is a challenging concept for implementation to achieve sustainable development (Terefe, 2018). The CP concept has drastically changed in the past three decades

in terms of scope and content and has shifted from pollution reduction to innovative production methods for less environmental impact and greener lifestyle. In addition to the basic framework, resource efficiency and three more dimensions of sustainability (such as social, economic, and environment) have been added, individually as well as synergistically. CP is defined as the technology that leverages the natural resources without causing harm and in the most efficient manner at all the stages of a product's life cycle. CP is understood from two aspects such as inputs and the whole production aspect (inputs–processes–outputs). While the former focuses on optimal usage of the resources and energy to reduce waste and emissions, the latter is a comprehensive and integrated preventive approach to reach zero pollution levels while maintaining high-quality products (Ismail, 2014). Two main conditions must be met for CP, such as enhanced economic performance and improved environmental performance. Furthermore, the management must be convinced about the importance of environmental systems management since this approach reduces the costs and also improves the environmental conditions simultaneously. Thus, it achieves sustainable development and provides competitive advantage for the economic unit (Abdullah and Fadel, 2018; Allawi, 2021). The interdependence of both concepts, that is, CP and environmental costs, leads to continuous improvement in the work environment, legal adherence, sustainability, innovations, mitigation of emissions, and the creation of environmental, economic, and social benefits for the economic unit. This CP approach starts with the implementation of environmental policies for costs, production, human resources, and finance (Al-Ajibi, 2021). Improving quality means low cost and high customer satisfaction, thus producing high market returns (Kazem and Abdel-Wahhab, 2013). Environmental auditing (green accounting) correctly calculates the costs to achieve sustainable development and maintain a positive relationship with society by using optimal and efficient alternatives for production and adopting green technologies. This process is key to achieve environmental progress, save costs, and increase the competitiveness.

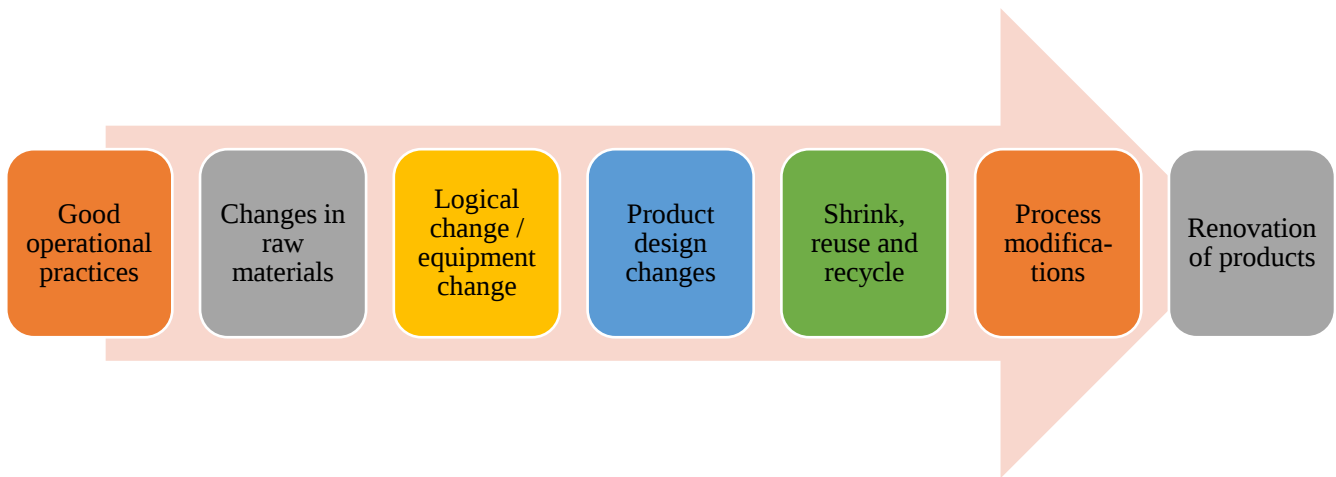


Figure 1. Cleaner production practices
(Source: Authors' own research)

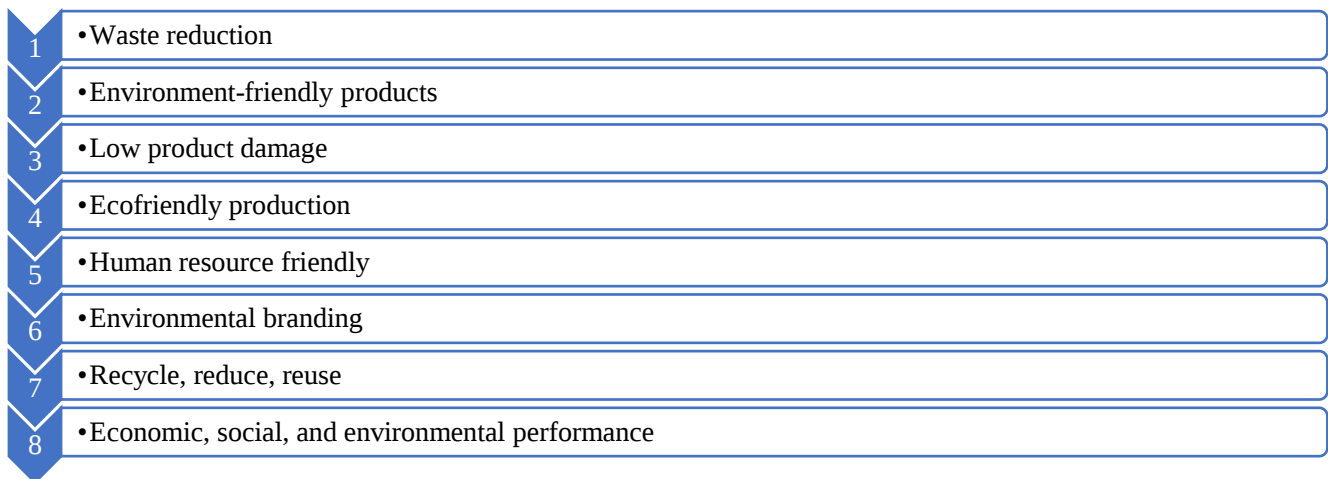


Figure 2. The benefits of CP technique and production processes
(Source: Authors' own research)

Environmental measures must include processes for sustainable production and consumption practices. Many institutions started adopting greener production practices as classified in Figure 1. (Ismail, 2014; Doorasamy, 2016; Al Shabasi, 2017).

2.3 Sustainable competitive advantage

The term "sustainable competitive advantage" denotes leveraging the opportunities for an economic unit to achieve continuous sales in the market. Competitiveness enhances the position of the economic unit with profits and distinguishes the economic unit from its competitors in various fields. Sustainable competitive advantage can be defined as a driving force or a clear basic value of an economic unit to meet the needs of

its customers in a better manner against its competitors.

3 Integrating TDABB and CP techniques

3.1 Role of CP technique in achieving sustainable competitive advantage

Industrial progress and sustainable development concepts should be integrated into economic unit, failing which environmental degradation is inevitable. Loss of competitiveness and unsustainable use of natural resources ultimately lead to the collapse of the industry. Salma and Naima (2018) indicated that the competitive advantage achieved upon environmental management is an opportunity to improve and exploit new markets. Al-Al-Sultani (2020) showed that the CP technique and production processes, when integrated, provides

multiple benefits listed in Figure 2. and outweighs the competitors.

3.2 Role of TDABB in achieving sustainable competitive advantage

Traditional accounting management is outdated now (Kazem, 2020), while the new techniques have control over short- and long-term forecasts. Abdel-Aal (2013) adds that budgets may not support cost-cutting processes, a drawback in today's business environment. The recent development in preparing the budgets based on time-oriented activity adopts continuous improvement and distinct activities of the economic unit. It gets rid of non-value-adding activities and unplanned use of resources, defines practical/actual production capacity, and benefits from idle energy and the knowledge of capabilities. Thus, the novel method identifies the strengths and weaknesses to achieve the objectives and its performance. The time-based budgeting technique positively reduces the cost and produces the highest quality product at a competitive price that outweighs the competitors.

3.3 Common applications of TDABB and CP techniques

Traditional budgets and pollution treatment techniques involve supervision based on administrative centralization, adherence to legislation, inward closure, and

short-term orientation. At the same time, the current economic units have become highly decentralized, innovative, intelligent, and flexible to remain competitive using modern techniques. The TDABB technique determines the processes and resources for products and services through time equations, while CP excludes the pollution before it occurs. Thus, the two techniques share a proactive method that improves the productivity to achieve a competitive advantage based on low-cost strategy and/or a differentiation strategy. In this context, Shanabi and Bin Lakhdar (2017) specified that sustainable competitive advantage is a product of resources and activities that contribute to the formation of this advantage. Mahdi and Nassar (2021) He stressed that the economic unit that implements the value creation strategy enjoys a competitive advantage.

3.4 Integration of TDABB and CP techniques

The integration of both the techniques focuses on leveraging the product redesign practices, minimal usage of natural resources, prevention of mixing hazardous waste with nonhazardous waste, and adjusting the machinery and equipment to reduce emission. Furthermore, the role of cost management process is to be increased in product pricing decisions. This integration can be called as "sustainable budgeting" or "clean activities-based budgeting" as illustrated in Figure 3.

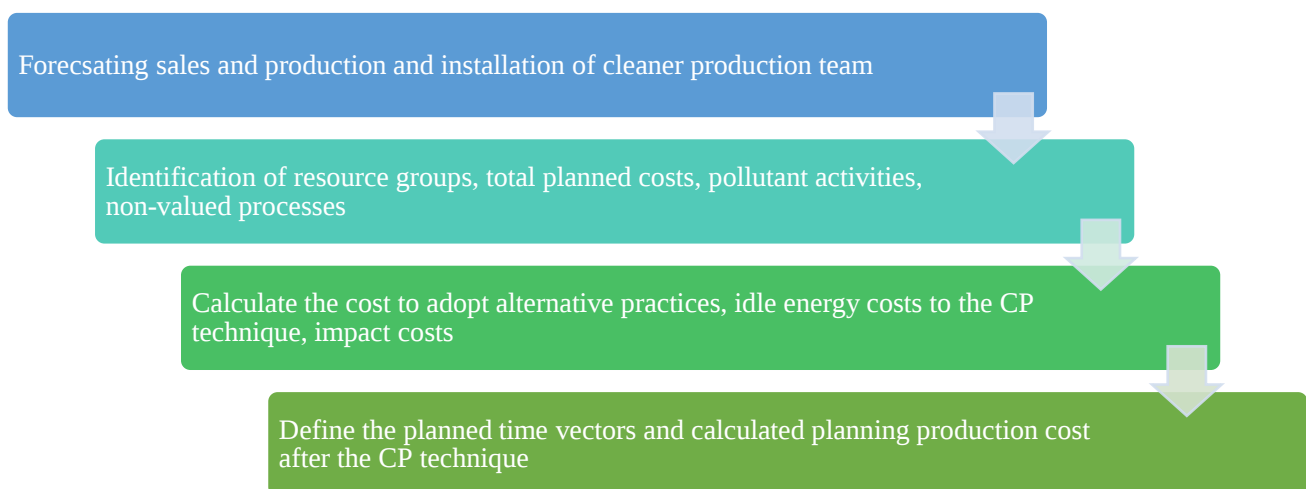


Figure 3. Sustainable budgeting
(Source: Authors' own research)

Through optimal use and allocation of resources/costs, the production process gets improved and its activities are tracked with various tools, thus achieving a sustainable competitive advantage.

It can be said that by integrating both the techniques, a sustainable competitive advantage can be achieved.

4 Methodology

4.1 Research hypothesis and sample

To address the research questions, a basic hypothesis is developed as follows: "The integration between the time-driven activity-based budgeting and cleaner production leads to achieving a sustainable competitive advantage in light of the competitive and environmental strategies in line with requirements of the contemporary business environment." For the current study, Kufa Cement Factory, an Iraqi General Cement Company that falls under the Iraqi Ministry of Industry and Minerals was considered. Its cost accounting system is based on dividing the cost centers and classifying them into two main groups, that is, production centers and service centers.

5 Results

After reviewing the integrated framework, the absence of clear features for applying modern cost, and production management techniques, light will be shed on the application of integrated framework through eight steps as discussed below:

5.1 Forecasting sales and production and CP team establishment

Based on primary and secondary data analyses, the expected sales and production for the next year, 2022 AD, using time- and production-driven activity-based budgeting technique was 1,000,000 tons/year. This would help the factory to reduce the costs and selling price and increase the sales and accordingly the market share too. The CP team members can be chosen from five departments, namely furnaces, production management, quality, environment, and technical along with finance. These members constantly follow-up, study the available opportunities, and evaluate possible measures to reduce the cost and quality to achieve sustainable development.

5.2 Determine the resource groups and their total planned costs

Identification of resource groups and planned costs for various groups is crucial as it falls under direct and indirect costs. Table (1) shows the planned costs for each department.

5.3 Identify activities and processes that pollute the environment and do not add value

Cost management and clean energy techniques are vital. Various activities are performed in this stage, such as interviewing the factory engineers, controlling waste generation through recycling, optimal energy utilization, industrial process modification, and introduction of advanced systems. These procedures bring important developments for product manufacturing as briefed in Figure 4.

5.4 Planned cost calculation to adopt CP-related alternative practices

The implementation of CP practices avoids or reduces the costs identified earlier. This step automatically improves the revenues and profitability of the factory, thus giving it a sustainable competitive ability toward competitors.

A step-by-step procedure is given below:

- a. Recycle/reuse Cement kiln dust (CKD) (0%-15%) in cement production increases its porosity, reduces the cracking strength, and reduces the need for new raw materials. The cost of CKD emitted from the precipitators includes the cost of raw materials (stone, sand, soil, etc.), that is, 12,392 dinars/ton and the cost of getting rid of deposits, that is, 1700 dinars/ton. So, the total planned cost for CKD/ton is 14,092 dinars/ton. The expected cost savings by switching from black oil to dry gas amounts to 19,250 dinars. The dry gas flaring system will improve the quality of the product, the production process, and the supply chain, while reducing resource depletion, costs, and environmental emissions damage compared to the black oil flaring system.

Table 1. Planned costs for the production department for 2022 AD
(Source: Authors' own research)

Production department	Activity	Direct costs	Indirect costs	Total cost of the activity
Quarry	Production	2,344,056,878	1,220,311,122	3,564,368,001
	Mechanical maintenance	2,051,049,769	1,067,772,232	3,118,822,001
	Electrical maintenance	586,014,220	305,077,781	891,092,000
	The breaker	879,021,329	457,616,671	1,336,638,000
	Total costs	5,860,142,196	3,050,777,806	8,910,920,002
Rubber conveyor	Production	1,144,048,606	0	1,144,048,606
	Mechanical maintenance	1,016,932,094	0	1,016,932,094
	Electrical maintenance	381,349,535	0	381,349,535
	Total costs	2,542,330,236	0	2,542,330,236
Raw material mills	Production	4,310,235,864	1,275,830,474	5,586,066,338
	Mechanical maintenance	3,771,456,381	1,116,351,664	4,887,808,045
	Electrical maintenance	1,077,558,966	318,957,618	1,396,516,584
	Water station	1,616,338,449	478,436,428	2,094,774,877
	Total costs	10,775,589,660	3,189,576,184	13,965,165,844
Ovens department	Production	9,682,351,565	1,420,061,194	11,102,412,759
	Mechanical maintenance	8,472,057,620	1,242,553,544	9,714,611,164
	Electrical maintenance	2,420,587,891	355,015,298	2,775,603,190
	Precipitators	3,630,881,837	532,522,948	4,163,404,785
	Total costs	24,205,878,913	3,550,152,984	27,756,031,897
Cement mills	Production	2,968,215,208	1,019,060,166	3,987,275,374
	Mechanical maintenance	2,597,188,307	891,677,645	3,488,865,952
	Electrical maintenance	742,053,802	254,765,041	996,818,843
	Precipitators	1,113,080,703	382,147,562	1,495,228,265
	Total costs	7,420,538,020	2,547,650,414	9,968,188,434
Packing	Production	2,540,433,357	648,577,556	3,189,010,913
	Mechanical maintenance	2,258,162,984	576,513,383	2,834,676,367
	Electrical maintenance	846,811,119	216,192,519	1,063,003,638
	Total costs	5,645,407,460	1,441,283,458	7,086,690,918
	The total costs	56,449,886,485	13,779,440,846	70,229,327,331

RECYCLING
/REUSING
CKD

- CKD cement kiln dust for the year 2021 AD- 92,743 tons
- Recycling/reusing this CKD cement kiln dust helps in cleaner production

Technique
logical
change or
process
modification

- Emission of carbon monoxide, sulfur dioxide, carbon dioxide harms the environment
- Using dry gas instead of black oil is economically and environmentally viable
- Advantages - less price, low emission, efficient combustion, less environmental impact, and ease of circulation

Acquisition of
mechanical
dust
precipitators

- Recovery of cement dust is a compound benefit, that is, reduces pollution and adds value to the production

Creation of a
dry method
production
line

- Raw materials should be in dry state
- Change in logic/equipment
- Less consumption of fuel, raw materials

Replacing
advanced
machines and
systems

- Machinery faults result in delayed production
- Replacement of Fluxo Pump system with highly advanced systems

Figure 4. Industrial process modification and introduction of advanced systems
(Source: Authors' own research)

- b. The factory must install eight mechanical precipitators at a planned cost of 50,000,000 dinars per unit. Accordingly, the planned cost of mechanical precipitators amounts to 400,000,000 dinars, calculated as follows: annual depreciation premium = $400,000,000 \times 5\%$ (percentage of depreciation of machinery and equipment for the cement industry) = 20,000,000 dinars/year

When installing mechanical dust precipitators, it will reduce the emission of volatile cement, reduce the atmospheric/air pollution, protect workers, and benefit from not losing the final product.

- c. The TDABB approach ensures that all the resources such as space, workers, raw materials, waste, etc., are utilized optimally. If a new line for the production of resistant cement by wet method is developed, the purchase cost is estimated at \$15,000,000, equivalent to 22,200,000,000 Iraqi dinars, and the design capacity of the new production line is 3200 tons/day, equivalent to more than two furnaces from the old production lines. However, the fuel consumption is only half that of the current plant. With an annual depreciation rate of 5%, annual depreciation premium = $22,200,000,000 \times 5\%$ (percentage of depreciation of machinery and equipment for the cement industry) = 1,110,000,000 dinars/year

The new production line can operate at a planned production of 1,000,000 tons/year. The rubber conveyor costs are eliminated, a second delivery/sales center is created, and the customer requests are rapidly addressed.

- d. Successful innovation is the way to achieve excellence.

An integrated system was designed, Replacing the old system of controlling cement payment valves with mechanical parts and replacing them with a microcontroller. The old device had many flaws such as huge costs, unsafe working place for workers, environmental pollution, cement instability, etc. With the new device, the expected abundance in cost amounts to 474,000,000 dinars/year. In comparison, the cost of manufacturing the device amounts to 5,000,000 dinars, calculated based on the need for five devices only. Device manufacturing costs = five devices $\times$ 1,000,000 dinars = 5,000,000 dinars.

Thus, this innovation will save huge costs, reduce the flying dust, and increase the working efficiency. The other advantages include stable final product and safe environment for the workers with a possibility of early detection of a fault at its occurrence.

5.5 Planned energy cost calculation based on CP practices

In this step, the planned energy cost (cost per unit time) is calculated for each department of the factory by dividing the total planned cost of direct and indirect activities by the practical energy required for every department, and its outcomes are validated based on the application of CP practices. In this regard, scientific and applied research indicates that the approved percentage as practical energy from the theoretical energy is 80%. Furthermore, the survey with factory professions reflects the possibility of reaching this percentage if contemporary cost management techniques are applied. The theoretical capacity calculation is done based on the number of workers in each department and their working hours for all the activities during many stages in the production processes related to the cement industry as follows:

theoretical energy of the activity = number of workers $\times$ number of days in the month $\times$ number of working hours $\times$ number of minutes per hour $\times$ number of months in the year

Practical energy of the activity = 80% of the theoretical energy of the activity

In terms of practical energy, the cost per unit of time of the planned activity can be calculated by applying the following equation:

planned activity time unit cost = total planned activity cost/activity operational energy

Accordingly, the above equations were applied for every activity of the factory departments to reach theoretical and practical energy values, while the cost per unit time of the planned activity was calculated as follows. Table (2) shows the theoretical and practical capacity of the activities of the quarry department.

Table (3) shows the planned unit time cost for various production departments.

Table 2. Theoretical and practical capacity of the activities – Quarry department
(Source: Authors' own research)

Activity	The number of workers (worker)	The number of days (day)	Work hours (hours)	Theoretical energy (minutes)	Practical energy (minutes)
Production	65	22	8	8,236,800	6,589,440
Mechanical maintenance	64	22	8	8,110,080	6,488,064
Electrical maintenance	18	22	8	2,280,960	1,824,768
Crusher	44	22	8	5,575,680	4,460,544

Table 3. Planned unit time cost for production departments
(Source: Authors' own research)

Production department	Activity	The total cost of the activity	Practical energy of activity/ minute	Activity time unit cost (dinar/min)
Quarry	Production	3,564,368,001	6,589,440	541
	Mechanical maintenance	3,118,822,001	6,488,064	481
	Electrical maintenance	891,092,000	1,824,768	488
	The breaker	1,336,638,000	4,460,544	300
Rubber conveyor	Production	1,144,048,606	3,628,800	315
	Mechanical maintenance	1,016,932,094	6,082,560	167
	Electrical maintenance	381,349,535	1,115,136	342
Raw material mills	Production	5,586,066,338	6,386,688	875
	Mechanical maintenance	4,887,808,045	6,589,440	742
	Electrical maintenance	1,396,516,584	1,216,512	1148
	Water station	2,094,774,877	2,433,024	861
Ovens department	Production	11,102,412,759	14,192,640	782
	Mechanical maintenance	9,714,611,164	11,759,616	826
	Electrical maintenance	2,775,603,190	2,635,776	1053
	Precipitators	4,163,404,785	3,750,912	1110
Cement mills	Production	3,987,275,374	5,879,808	678
	Mechanical maintenance	3,488,865,952	5,372,928	649
	Electrical maintenance	996,818,843	2,433,024	410
	Precipitators	1,495,228,265	1,520,640	983
Packing	Production	3,189,010,913	10,441,728	305
	Mechanical maintenance	2,834,676,367	1,926,144	1472
	Electrical maintenance	1,063,003,638	912,384	1165

5.6 Define planned time vectors for clean activity events

In this step, the time vectors are identified for the events of each factory activity as they are the engines that drive or direct the time spent on the activity. All the cement production activities, their Time Driven, and the planned times that we obtained on conducting

the field survey and interviews with the heads of production departments/divisions are listed. Tables 4, 5, 6, 7, 8, and 9 show the time vectors for the activities at quarry, rubber conveyor, raw materials mills, cement mills, and mobilization departments.

5.7 Planned idle energy cost determination for resource groups by adopting the CP technique

The time-driven budgeting technique, discussed earlier, emphasizes the need to identify and measure the level of energy required for each department/resource. This process leverages the available resources through

efficient exploitation of the idle energy, which in turn allows making short- and long-term decisions for increased productivity and growth.

The cost and percentage of idle energy for each department in the industry are calculated and tabulated in Table (10) based on the planned practical energy.

Table 4. Time vectors for the events of the quarry department activities
(Source: Authors' own research)

Activities/events	Cover dust detection /min	Crushing and conveying of stone/min	Drying and compaction of the stone/min	Crushing and conveying of stone to the conveyor /min	Total /min
Production	5	1.5	0.5	0	7
Mechanical maintenance	2	4	2	6	14
Electrical maintenance	0.5	1	0.5	2	4
The breaker	0	0	0	1	1

Table 5. Time vectors for the activities of the rubber conveyor department events
(Source: Authors' own research)

Activities/events	Receipt of the stone/min	Stone transfer/min	Stone count/min	Total/min
Production	0.5	0.5	0.4	1.4
Mechanical maintenance	2	8	3	13
Electrical maintenance	0.7	1	0.6	2.3

Table 6. Time vectors for the events of the raw materials mills department activities
(Source: Authors' own research)

Activities/events	Receipt of raw materials/min	Mixing and grinding of materials/min	Putty transfer/min	Total/min
Production	0.5	1.6	0.4	2.5
Mechanical maintenance	3	9	2	14
Electrical maintenance	0.75	1	0.5	2.25
Water station	0.75	0.75	0	1.5

Table 7. Time vectors for the events of the furnaces department activities
(Source: Authors' own research)

Activities/events	Receipt of putty/min	Maturation and burning of the putty/min	Clinker leveling/min	Total/min
Production	0.6	0.75	1.2	2.55
Mechanical maintenance	5	15	4	24
Electrical maintenance	0.75	1.6	0.5	2.85
Precipitators	0	1.25	0	1.25

Table 8. Time drivers for the events of the packing department activities
(Source: Authors' own research)

Activities/events	Receipt of clinker/min	Mixing clinker with gypsum/min	Cement crushing and grinding/min	Total/min
Production	1.25	1.75	2	5
Mechanical maintenance	2	7	2	11
Electrical maintenance	0.75	1.5	1.25	3.5
Precipitators	0	1.75	2	3.75

Table 9. Time confrontations for the events of the activities of the cement mills department
(Source: Authors' own research)

Activities/events	Conversion of cement to silo	Bagging of cement	Transportation of cement to suppliers	Total
Production	0.4	0.6	3	4
Mechanical maintenance	1	1	2	4
Electrical maintenance	0.4	0.4	0.5	1.3

Table 10. The total planned cost according to the practical capacity of the quarry department
(Source: Authors' own research)

Activity	Amount of time required for activities/min (1) ^a	Planned costs for activities (2) ^a	Production quantity/ton (3)	Total working energy per minute (1 × 3)	The total planned cost according to the practical energy in dinars (2 × 3)
Production	7	3787	657,310	4,601,170	2,489,232,970
Mechanical maintenance	14	6734	657,310	9,202,340	4,426,325,540
Electrical maintenance	4	1952	657,310	2,629,240	1,283,069,120
The breaker	1	300	657,310	657,310	197,193,000
Total	26	12,773	657,310	17,090,060	8,395,820,630

^aIn the same way for the remaining department

Table 11. Idle energy cost and its ratio to resource groups
(Source: Authors' own research)

Resource groups (departments)	The cost of idle energy	Idle energy ratio
Quarry	515,099,372	5.78%
Rubber conveyor	308,133,545	12.12%
Raw material mills	3,151,759,034	22.56%
Ovens	10,529,908,728	37.93%
Cement mills	-318,713,066	3.19%
Packing	1,418,706,788	20%
The total	15,604,894,401	22.21%

Table 12. The planned cost of the quarry department
(Source: Authors' own research)

Activity	Amount of time required for activities/min	Cost per unit time	Planned costs for activities
Production	7	541	3787
Mechanical maintenance	14	481	6734
Electrical maintenance	4	488	1952
The breaker	1	300	300
Total	26	1810	12,773

Table 13. Total planned costs for the product
(Source: Authors' own research)

Department	Amount
The total planned cost of the quarry department	12,773 dinars/ton
The total planned cost of the rubber conveyor department	3399 dinars/ton
The total planned cost of the raw materials mills department	16,451 dinars/ton
The total planned cost of the department of furnace	26,207 dinars/ton
The total planned cost of the cement mills division	15,650 dinars/ton
The total planned cost of the packing department	8623 dinars/ton
Total planned costs for the product	83,103 dinars/ton

Table 14. Planned final product cost per ton
(Source: Authors' own research)

Statement	Details	Total
Total planned production costs: "The planned production costs are based on the expected production quantity for 2022 and according to table (13)"		
Planned costs of production	83,103 dinars/ton $\times$ 1,000,000 tons/year	83,103,000,000
Combined: The added costs "represent additional costs for the development of a production line and replacement of new equipment and devices"		
Introducing a new production line	1,110,000,000 ¹	
Equipping mechanical precipitators	20,000,000 ²	
Steps switch innovation	5,000,000 ³	
Total costs added	----	1,135,000,000
Subtracted: Excluded costs "represent financial savings to avoid the costs of sediment disposal and recycling of raw materials. And the cost differences of switching from one type of fuel to another, as well as avoiding the costs of obsolete devices"		
Reuse/recycle CKD material	1,306,934,356 ³	
Substitution of fuel from oil to gas	19,250,000,000 ⁴	
Replacing obsolete devices	474,000,000 ⁵	
Total costs excluded	----	(21,030,934,356)
Planned final costs of production	----	63,207,065,644
Planned final product cost per ton	63,207,065,644 dinars/1,000,000 tons	63,207 dinars/ton
1. 1,110,000,000 dinars... See paragraph 5-4-c. 2. 20,000,000 dinars... See paragraph 5-4 -c. 3. 5,000,000 dinars... See paragraph 5-4-c. 4. (14,092 dinars/ton $\times$ 92,743 tons)... Refer to paragraph 5-4-a and paragraph 5-3-a. 5. (19,250 dinars $\times$ 1,000,000 tons)... Refer to paragraph 5-4-b and paragraph 5-1. 6. (474,000,000) dinars... Refer to paragraph 5-4-c.		

5.7.1 Quarry department

The total planned cost of the quarry department according to the planned production level = 8,910,920,002 dinars from Table (1) - the total planned cost according to the practical capacity = 8,395,820,630 dinars from Table (10).

= Total planned cost according to idle energy = 515,099,372 dinars

÷ The total planned cost of the quarry department according to the planned production level = 8,910,920,002 dinars

The percentage of idle energy for the activities of the quarry department = 5.78%

5.7.2 Rubber conveyor department

The total planned cost of the rubber conveyor department according to the planned production level = 2,542,330,235 dinars from Table (1) - the total planned cost according to the practical capacity = 2,234,196,690 dinars, calculated as in Table (10) for the quarry department.

= Total planned cost according to idle energy = 308,133,545 dinars

÷ The total planned cost of the rubber conveyor department according to the planned production level = 2,542,330,235 dinars

The percentage of idle energy for the activities of the rubber conveyor department = 12.12%

5.7.3 Raw materials mills department

The total planned cost of the raw materials mills department according to the planned production level = 13,965,165,844 dinars from Table (1) - the total planned cost according to the practical capacity = 10,813,406,810 dinars, calculated as in Table (10) for the quarry department.

= Total planned cost according to idle energy = 3,151,759,034 dinars

÷ The total planned cost of the raw materials mills department according to the planned production level = 13,965,165,844 dinars

The percentage of idle energy for the activities of the raw materials mills department = 22.56%

5.7.4 Department of furnaces

The total planned cost of the department of furnace according to the planned production level = 27,756,031,898 dinars from Table (1) - the total planned cost according to the practical capacity = 17,226,123,170 dinars, calculated as in Table (10) for the quarry department.

= Total planned cost according to idle energy = 10,529,908,728 dinars

÷ The total planned cost of the ovens department according to the planned production level = 27,756,031,898 dinars

The percentage of idle energy for the activities of the bakery department = 37.93%

5.7.5 Cement mills department

The total planned cost of the cement mills department according to the planned production level = 9,968,188,434 dinars from Table (1) - the total planned cost according to the practical capacity = 10,286,901,500 dinars, calculated as in Table (10) for the quarry department.

= Total planned cost according to idle energy = 318,713,066 dinars

÷ The total planned cost of the cement mills department according to the planned production level = 9,968,188,434 dinars

The percentage of idle energy for the activities of the cement mills department = 3.19%.

5.7.6 Packing department

The total planned cost of the packaging department according to the planned production level = 7,086,690,918 dinars from Table (1) - the total planned cost according to the practical capacity = 5,667,984,130 dinars, calculated as in Table (10) for the quarry department.

= Total planned cost according to idle energy = 1,418,706,788 dinars

÷ The total planned cost of the packaging department according to the planned production level = 7,086,690,918 dinars

The percentage of idle energy for the activities of the packing department = 20%

Table (11) shows the cost of idle energy and its ratio to resource groups.

Thus, the lack of balance between available resources and productive energy leads to idle energy or energy deficit. This idle energy (22.21%) should be invested appropriately by creating a new production line.

5.8 Calculating the planned production cost after implementing the CP technique

The planned product cost can be calculated by collecting the costs of resource groups (departments) after CP technique implementation by multiplying the amount of time required for each activity event and for each department by the time cost required for that event.

Table (12) shows the planned cost of the quarry department.

Similarly, as Table (12) shows, the planned cost is calculated for rubber conveyor, raw materials mills, kilns, cement mills, and packaging. When calculating the planned costs for each department, the total planned cost is arrived at, as shown in Table (13).

After calculating the total planned costs of the product, the final cost per ton was calculated, as shown in Table (14), by adding the costs of the improved production process, exploitation of the idle capacity by creating a new production line, and excluding the costs of activities that do not add value and pollute the environment.

The integration of two techniques helps in overcoming the obstacles, consolidating the strengths, achieving efficient use of available resources, and keeping pace with competition challenges. The traditional products currently in force amounted to 63,207 dinars/ton, according to the proposed integrated systems, which is consistent with the research hypothesis, that is, "The integration between time-driven activity-based budgeting and cleaner production leads to achieving a sustainable competitive advantage in light of competitive and environmental strategies in line with the requirements of the contemporary business environment."

6 Conclusion

The following conclusions were arrived at:

1. Environmental strategies reduce the costs by following the activities of production departments and through recycling/reusing the waste.
2. The integration of TDABB and CP techniques helps in achieving a sustainable competitive advantage and increased product value since the techniques have cost reduction, innovation of value-adding activities, processes, and devices, identification of value-adding and non-value-adding activities, and environment-polluting activities in common.
3. An interrelationship model is arrived at between contemporary managerial accounting techniques and productivity. This model benefits from the idle energy, which acts as the output from TDABB and as an input to CP in a new production line to increase production, sales, and profitability.

The economic unit management should utilize strategic thinking to achieve competitive advantage as it is characterized by insight, environmental sensing, and the ability to analyze and interpret information. It possesses comprehensive knowledge on various aspects of the economic unit and defines the strategies that lead management to properly direct resources, raw materials, human resources, etc. A comprehensive knowledge team should be created from all the divisions to apply the TDABB and CP techniques. Various training programs/workshops should be conducted to increase the efficiency and efficacy of the workers. This hybrid approach helps in cost reduction, high product quality, less time consumption, continuous improvement, building strong relationships, increased customer loyalty, etc., A new production line to leverage the idle energy should be set up to improve the productivity, thus making a winning move.

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