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The Impact of Green Activity-Based Costing in Reducing Costs in the Oil Refinery in Southern Iraq

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Abstract

Because of the increasing phenomenon of global warming and environmental pollution and a large number of international and local pressures to pay attention to environmental issues and for competitive purposes, the oil refinery in southern Iraq suffers from a problem in increasing the volume of pollution it causes, which required attention to measure the size and cost of this pollution by determining and measuring environmental costs. On the other hand, the refinery uses a traditional costing system. Accordingly, this study came to solve this problem by applying costing technology based on green activity and studying the effects of this technology in reducing the costs of the refinery, including environmental ones, to reduce the negative environmental impact of the refinery, Where the GABC technology is one of the modern management accounting techniques and one of the green accounting tools that work to identify green activities and allocate indirect costs, including environmental ones. This technology helps managers in the future to build a green decision based on the information it provides to form the best combination of environmentally friendly products at the lowest costs with Preserving environmental resources, i.e., the optimal use of them, reviewing the production processes and activities of the refinery, and making them environmentally friendly. The applied results showed a significant impact of costing technology based on green activity in reducing refinery costs by Determining and measuring environmental costs and carbon emissions, in addition to the fair and more accurate allocation of indirect costs, including environmental costs.

Keywords: *Green Activity-Based Costs, Green activities, Cost reduction.*

Introduction

195 countries signed the Paris Agreement in December 2015 to solve the problem of environmental climate change because they believe that such agreements will significantly reduce the risks and impacts of climate change and achieve the goal of making financial flows consistent with the path of reducing Gas emission (Unfccc, 2016; Aslan & Batmaz, 2022). Misusing available resources affects the generation of abnormal weather and global warming, and reducing Gas emission is the goal of every country (Tsai, 2018). The solution to the pollution problem depends on a combination of pollution prevention and environmental management techniques, which are two keys to achieving environmental protection and reducing costs (Hsieh et al., 2020), in addition to the use of modern management accounting techniques that provide management with the necessary information to achieve these goals

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Using green accounting that focuses on efficiency and effectiveness in the optimal use of resources and integrating environmental functions with manufacturing processes (Dura & Suharsono, 2022; Ahmadi et al., 2022) and using the information it provides to make decisions that contribute to protecting the environment and reducing costs. There are two objectives of green accounting, one of which is to verify how industrial companies affect the environment and society, and the other is to enhance environmental efficiency. However, integrating this accounting with the company management system is still challenging in some countries, including Iraq, due to the need for more information on environmental costs (Vijayalakshmi & Harishkumar, 2019) in traditional cost systems. Environmental costs are often hidden in companies and difficult to identify; therefore, the management must focus on Determining and managing environmental costs on time to achieve environmental efficiency and reduce negative environmental impact (Antic, 2021).

The oil refining industry is one of the major industries in Iraq, and the production processes are accompanied by the emission of a lot of Gas emission resulting from the burning of crude oil, a non-renewable natural resource (Hashim et al., 2020; Catalina-García, 2022). Green accounting and technologies must be included in Iraqi oil refining operations to reflect the positive environmental impact in the short and long term. Academic researchers have used mathematical models to calculate the cost of emissions in many fields, such as airlines, green buildings, electronic industries, paper recycling and medical industries (Tsai et al., 2019).

This study focuses on the importance of applying GABC technology because of its impact on reducing refinery costs through fair and accurate allocation of indirect costs, including environmental. In addition to the value of the information it produces, it allows the management to make decisions and formulate strategies that reflect the extent of the sustainability of partnerships. The responsibility of determining costs based on ABC activities is very laborious in the oil refinery because it does not have the ABC system at all (Demdoum et al., 2021; Hawra Mohamed Ali, 2023), and therefore the refinery needs to integrate green accounting with what it represents from the environmental activity-based costing system EABC with traditional ABC to form GABC technology, the application of cost based on green activity is the basis for the success of the process of measuring environmental costs, and not the other way around. The oil refinery should apply this technology to solve the pollution problem caused by the refinery and reduce its costs. Therefore, the study assumes (the use of green activity-based costing (GABC) technology contributes to the distribution of indirect costs more fairly and accurately, including environmental costs, thus reducing costs).

Literature review

Companies are exposed to many significant pressures regarding reducing their pollutants, but their accounting systems and strategic management cannot solve them readily. Therefore, academics focused on finding accounting methods that provide valuable information that helps the company's management to know the causes of pollution, waste places and costs of pollutants, including costing technology based on green activity. The researchers (Abd-Allah & Abdlkadm, 2023; Khuddush & Prasad, 2022) mentioned that GABC is applied to renewable energy management categories to provide information about Determining resources for the entire process and the cost of the product accurately to improve opportunities, which is a helpful accounting method that can track direct and indirect product costs based on activities as well as the cost of emission Greenhous gases leading to environmentally friendly products. (yang) considers that cost estimation based on green activity is a valuable method for allocating costs for the green electric power system, where resources, classification of activities, and identification of cost drivers contribute to accurately measuring the green electric power system and economic benefits that help increase sustainable development and enable decision makers to have a deep understanding of the various allocations and thus provide More costs for the power plant (Yang, 2018; John et al., 2022). As well as researchers (Hsieh et al.) GABC is a two-stage accounting method that is an extension of modern cost accounting to increase the accuracy of calculating indirect costs and then tracking these costs through activities to products (Hsieh et al., 2020). (Al Mashkoor) explained that GABC technology helps companies maintain a positive impact on environmental performance and assists decision-makers in developing strategies to enhance environmental performance (Al Mashkoor, 2022; Laucirica, 2022).

Green Abc

The activity-based costing (ABC) system appeared due to the large number of criticisms directed at the traditional cost systems (TCS) to allocate and distribute indirect costs to the cost objective based on the activities consumed by the cost objectives (product / service) more accurately. (Horngren) described it as one of the best optimization tools for the costing system by determining individual activities as indirect cost centers and then allocating the costs of these activities to cost object such as products, services or customers based on the idea that activities consume available resources and cost objects consume activities to the extent they benefit from those activities (Datar & Rajan, 2021; Ramdev, 2023). However, with the many repercussions on the environment and the increasing pollution caused by companies to maintain the continuity of life, introducing some adjustment to the (ABC) system would be appropriate to better achieve the management's objectives. These modifications to the (ABC) system were initially proposed by the US Environmental Protection Agency (USEPA). As the traditional cost drivers that measure economic aspects only were supported by drivers related to carbon dioxide emissions emitted from production processes and also associated with other environmental aspects, these modifications can be considered a positive step in helping management decisions towards greener (sustainable) products through the use optimization of available resources and energy conservation (Marinho Neto et al., 2018; Wyatt, 2022). GABC technology is a method for calculating environmental costs by Determining the activities that the company consumes and measuring them within the framework of the company's environmental cost accounting that focuses on activities, then including the cost of the resources consumed in activity accurately, and finally allocating the final activity costs to products or services through cost drivers (Huang & Yanhua, 2015; Narikbayeva et al., 2023). Most of the steps, procedures and principles of cost based on green activity are compatible with the ABC system, with the difference that the first helps measure the cost saving as a result of reducing the cost of raw materials during the period of recycling and reuse, as well as bearing the complexities in production (Abd-Allah & Abdlkadm, 2023). (Al-Mashkoor et al.) Explained that applying GABC is a helpful solution to avoid the defects of previous costing systems (ALMashkoor et al., 2023). The successful application of the green activity-based costing technique requires many steps, namely:

1- Determine the cost objects and the quantity of production.
2- Determine the direct economic costs.
3- Determine green activities.
4- Determine the indirect environmental and economic costs.
5- Determine the cost drivers and activity drivers.

6- Allocation indirect costs to green activities.
7- Calculating the costs of green activities.
8- Allocation costs of green activities to products.
9- Collect direct and indirect costs of products.

Figure (1) shows the steps for implementing the GABC technique:

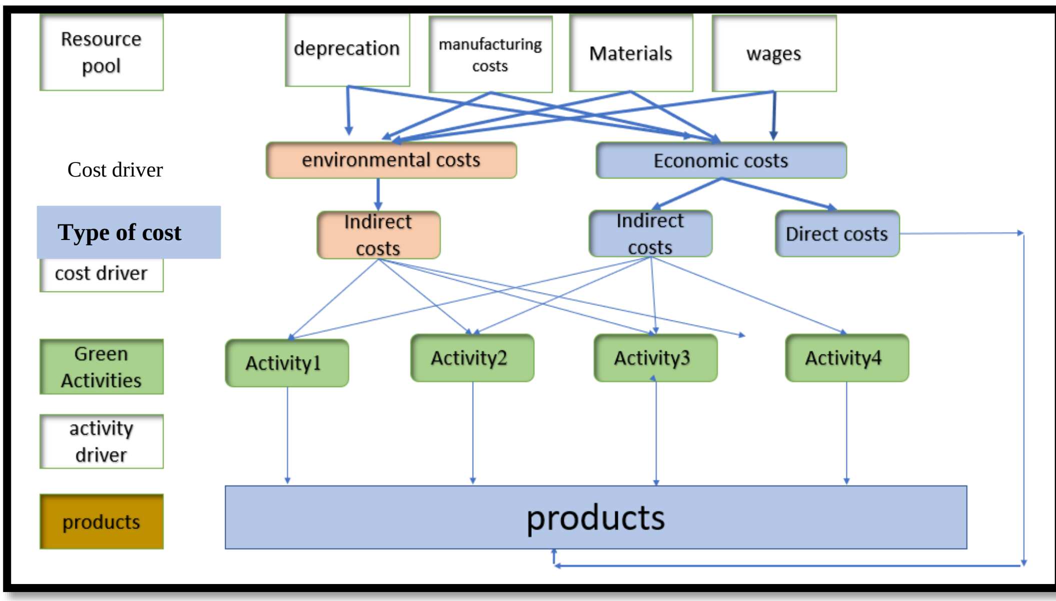

Figure (1) Steps to implement the GABC technique

(Antic, 2021), (Hsieh et al., 2020) and (Oncioiu et al., 2019) determined advantages of the GABC:

1- Determining and measuring environmental costs.
2- Allocating more accurate environmental costs to cost drivers than traditional costing systems and ABC.
3- Contribute to determining a more realistic cost through allocation and accurate control.
4- Improving the decision-making process because it provides non-financial information also.
5- Allows the discovery of chances by analyzing the environmental cost of the company's activities and determining potential events that can lead to income generation (such as material reuse).
6- Contribute to a higher competitive characteristic when reducing environmental costs.

Application method

This study proves how the GABC technology affects the cost reduction of the oil refinery in southern Iraq, as it is one of the large production factories producing many products, including (kerosene, jet fuel, gas oil, fuel oil, liquid gas and gasoline). The activities of the production process are accompanied by many pollutants that affect the environment, in addition to a rise in costs and the inability of the applied traditional cost system to provide information on the cost of environmental impacts, so this technology will be used according to the steps mentioned in (pg. 6):

1- Determine the cost object and production quantity

Table 1: Cost object and production quantity

NO.	products	Output quantity (m3)
1	kerosene	787,447
2	Gas oil	1,640,509
3	fuel oil	4,726,640
4	liquid gas (ton)	81,754
5	jet fuel	22,651
6	gasoline	2,989,683

2- Determine the direct economic costs

The oil refinery produces intermediate products that are inputs for other stages, so its cost should also be determined.

Table (2) Direct Economic Costs

Products	Output quantity (m3)	Direct economic costs
light naphtha	564,321	24,878,989,633
hydrogenated naphtha	1,236,825	54,527,416,527
kerosene	787,447	34,715,878,459
Gas oil	1,640,509	72,324,494,548
fuel oil	4,726,640	208,381,508,563
liquid gas 1	123,345	5,437,865,157
medium liquid gas 2	23,494	157,585,713
final liquid gas	146,839	4,411,569,459
hydrogen	197,686	1,325,956,542
jet fuel	22,651	998,585,434
Heavy naphtha	195,290	8,609,668,446
Reformit	727,210	4,877,689,039
Gasoline	2,989,683	112,306,117,035
Total	13,381,940	532,953,324,553

3- **Determining green activities**: Operation-determination activities are the essential step in the activity-based costing system (ABC), and the green activity-based costing technique is an extension of the (ABC) system; after the researcher was briefed on the company's operations and activities through field visits, meeting with engineers and workers, and studying the organizational structure, green activities were identified, corresponding to the stages of the production process, for easy understanding of (GABC) technology. Therefore, direct and indirect environmental costs are called green activities with an environmental and economic dimension. Those activities implicitly "are economic activities and environmental activities because they will be charged with part of the indirect economic and environmental costs. Therefore, they are called green activities with an environmental and economic dimension.

Accordingly, the researchers classified the activities of the green company for the light oils department only into the following activities:

A- Separation activity: It is the first activity of the production process in which the crude oil received from the Basra Oil Company is separated at air temperature into heavy and light oil products through distillation towers according to a certain pressure and temperature that is gradually raised by heat exchangers to reach a temperature of 372.

B- Cracking activity: This activity converts light-weight materials into heavy-weight and high-value materials by cracking the material particles with physical processes through the refining tower under pressure, and water steam permeates those particles.

C- Treatment activity (liquid gas improvement): The third activity involves chemical processes by adding chemicals to products that contain sulfur and nitrogen atoms and mixtures of minerals, where carbon compounds are formed to easily separate them and thrown out to air, such as compound H_2O, and improving products according to the required specifications.

D- Blending activity: It is the last activity of the oil refining process, in which other intermediate products are mixed with some refined materials and chemicals to produce a product with certain specifications related to chemical and physical properties and octane number.

4- Determine the indirect environmental and economic costs.

Table (3) indirect environmental costs:

Type of cost	Indirect environmental costs
The cost of wastage of the raw material	6,966,864,884
The cost of emitted gases	18,997,435,820
The cost of waste in chemicals	152,786,750
The cost of the environmental department	776,901,748
The costs of the basins department (industrial water)	1,464,428,764
Total	28,358,417,966

Table (4) Indirect Economic Costs:

Type of cost	Indirect Economic Costs
Energy	17,400,849,595
Maintenance	1,733,472,987
systems and control	2,761,302,302
Electricity maintenance	5,282,829,454
rotating equipment	1,338,275,636
general equipment	13,751,589,916
Engineering services	348,858,975
laboratories	5,713,259,967
Engineering inspection	657,524,461
production services	21,284,154,264
Materials	9,823,386,000
Total	72,439,129,733

5- Determine the cost drivers and activity drivers.

The driver	Quantity driver	Separation activity	Cracking activity	Treatment activity	Blending activity
Percentages of energy and water utilization	56%	31%	20%	5%	0%
maintenance hours	12,552	2,712	3,648	6,192	0
Actual hours for systems and control	157,300	87,500	32,500	26,500	10,800

Actual electrical maintenance hours	374,097	175,518	150,634	13,118	34,827
Actual hours of rotating equipment	303,274	173,910	58,804	10,945	59,615
Actual hours for general equipment	249,072	127,173	94,398	14,532	12,969
Actual hours for engineering services	51,150	13,000	26,250	0	11,900
The number of samples in laboratories	54,211	37,237	6,867	3,536	6,571
Actual hours engineering inspection	21,150	9,450	6,950	4,750	0
Production quantities for each stage	13,381,940	9,297,028	948,390	146,839	2,989,683

Concerning the second allocation stage, the activity cost driver was determined based on the quantity of output (production quantities).

Table (6) drive activity for intermediate and final products:

Cost driver **Activity**	**Separation**	**Cracking**	**Treatment**	**Blending**
Products		production quantity		
light naphtha	564,321			
hydrogenated naphtha	1,236,825			
kerosene	787,447			
Gas oil	1,640,509			
fuel oil	4,726,640			
liquid gas 1	123,345			
medium liquid gas 2		23,494		
final liquid gas			146,839	
hydrogen		197,686		
jet fuel	22,651			
Heavy naphtha	195,290			
Reformit		727,210		
Gasoline				2,989,683
Total	9,297,028	948,390	146,839	2,989,683

6- Allocation indirect costs to green activities.

Environmental costs have been allocated to green activities based on production quantities (Table 6) for each activity due to the difficulty of obtaining another allocation basis due to the oil refinery's lack of the necessary measures to determine the quantity of impact of these pollutants. The calculation method is as follows:

Separation activity = (total environmental indirect costs/total production quantities) × the production quantity of separation activity

= (28,358,417,966/13,381,940) × 9,297,028 m^3 = 19,701,852,731 for each m^3

Likewise, for the rest of the activities...

Table (7) Allocation of indirect environmental costs to green activities:

Green Activity	**Type of cost**	**indirect environmental costs**
Separation		19,701,852,731
Cracking		2,009,785,707
Treatment		311,175,515
Blending		6,335,604,014
Total		28,358,417,966

As for the allocation of indirect economic costs, it was based on the cost drivers according to Table (5), and the calculation method for the separation activity is as follows:

- Energy and water = total energy and water costs × ratio benefit from the separation activity.

= 17,400,849,595 × 31 % = 5,394,263,374 ID

- Maintenance = (total maintenance costs/total maintenance hours) × maintenance hours of the separation activity

= (1,733,472,987 / 12,552) × 2712 h = 374,536,228 ID/h

- Systems and control = (total costs of systems and control/total actual hours) × actual hours of the separation activity

= (2,761,302,302/ 157,300) × 87,500 h = 1,536,007,320 ID/h

- Electricity maintenance = (total electricity maintenance costs / total actual hours) x Actual hours of the separation activity

= (5,282,829,454/ 374,097) × 175,518 h = 2,478,586,196 ID/h

- Rotating equipment = (total costs of rotating equipment/total actual hours) × actual hours for the separation activity

= (1,338,275,636/ 303,274) × 173,910 h = 767,423,240 ID/h

- General equipment = (total costs of general equipment/total actual hours) × actual hours for the separation activity

= (13,751,589,916/ 249,072) × 127,173 h = 7,021,387,166 ID/h

- Engineering services = (total costs of engineering services/total actual hours) x actual hours for the separation activity

= (348,858,975/ 51,150) × 13,000 h = 88,664,060 ID/h

- Laboratories = (total laboratories costs / total number of samples) × number of samples for the separation activity

= (5,713,259,967/ 54,211) × 37,237 sample = 3,924,381,793 ID/ sample

- Engineering inspection = (total engineering inspection costs / total engineering inspection hours) × engineering inspection hours for the separation activity

= (657,524,461/ 21,150) × 9,450 h = 293,787,525 ID/ h

- Production services = (total costs of production services/total quantity of production) × production quantity of the separation activity

= (21,284,154,264/ 13,381,940) × 9,297,028 m^3 = 14,787,047,476 ID/ m^3

- Materials = (total cost of the materials section / total quantity of production) × the quantity of production of the separation activity

= (9,823,386,000/ 13,381,940) × 9,297,028 m^3 = 6,824,742,639 ID/m^3

And so on for the rest of the accounts...

Table (8) Allocation of indirect economic costs to green activities

Type of cost	costs	Separation	Cracking	Treatment	Blending
energy	17,400,849,595	5,394,263,374	3,480,169,919	870,042,480	0.000
maintenance	1,733,472,987	374,536,228	503,800,944	855,135,814	0.000
systems and control	2,761,302,302	1,536,007,320	570,517,004	465,190,788	189,587,189
Electricity maintenance	5,282,829,454	2,478,586,196	2,127,185,548	185,246,492	491,811,218
rotating equipment	1,338,275,636	767,423,240	259,487,989	48,297,668	263,066,738
general equipment	13,751,589,916	7,021,387,166	5,211,836,677	802,330,670	716,035,402
Engineering services	348,858,975	88,664,060	179,033,198	0.000	81,161,717
laboratories	5,713,259,967	3,924,381,793	723,708,402	372,656,606	692,513,166
Engineering inspection	657,524,461	293,787,525	216,065,958	147,670,978	0.000
production services	21,284,154,264	14,787,047,476	1,508,426,495	233,549,970	4,755,130,323
Materials	9,823,386,000	6,824,742,639	696,191,896	107,791,528	2,194,659,936
Total	**72,439,129,733**	**49,987,933,807**	**16,139,193,800**	**4,190,529,765**	**11,473,266,447**

7- Calculating the costs of green activities.

Collecting the costs of green activities according to Tables (7 and 8)

Table (9) costs of green activities

Activity	indirect environmental costs	indirect economic costs	Total
Separation	19,701,852,731	49,987,933,807	63,192,679,750
Cracking	2,009,785,707	16,139,193,800	17,486,209,739
Treatment	311,175,515	4,190,529,765	4,399,088,507
Blending	6,335,604,014	11,473,266,447	15,719,569,704
Total	28,358,417,966	72,439,129,733	100,797,547,699

8- Allocation costs of green activities to products.

In this step of the second allocation stage, the quantity of production is adopted as an activity driver because it is the reason for the consumption of products from activities. The activities' share of economic costs was allocated separately from environmental costs to determine the ration of each intermediate and final product of environmental costs based on Tables (6 and 9).

The method of calculating the costs of the products of the separation activity from the green activities (economic costs):

The economic loading rate of the separation activity = the total costs of the separation activity / the total quantity of production of the separation activity

= 43,490,827,019/ 9,297,028 m^3 = 4,678 ID/m^3

- ❖ Light naphtha ration= economic loading rate of separation activity × light naphtha production quantity

= 4,678 × 564,321 = 2,639,852,151 ID

- ❖ Hydrogenated naphtha ration= economic loading rate of separation activity × hydrogenated naphtha production quantity

= 4,678 × 1,236,825 = 5,785,778,279 ID

- ❖ Heavy naphtha ration= economic loading rate of separation activity × hydrogenated naphtha production quantity

= 4,678 × 195,290 = 913,552,042 ID

- ❖ kerosene ration= economic loading rate of separation activity x white oil production quantity

= 4,678 × 787,447 = 3,683,621,714 ID

- ❖ Gas oil ration=economic loading rate of the separation activity × gas oil production quantity

= 4,678 × 1,640,509 = 7,674,185,140 ID

- ❖ Fuel oil ration= economic loading rate of separation activity × fuel oil production quantity

= 4,678 × 4,726,640 = 22,110,880,780 ID

- ❖ Medial liquid gas1 ration= economic loading rate of separation activity × medial liquid gas1 production quantity

= 4,678 × 123,345 = 576,999,317 ID

- ❖ Jet fuel ration= economic loading rate of separation activity × jet fuel production quantity

= 4,678 × 22,651 = 105,957,595 ID

Table (10) Allocation of costs of green activities to products (Economic)

Activity	Separation	Cracking	Treatment	Blending	Total
produ Rate	4,678	16,319	27,839	3,139	
light naphtha	2,639,852,151				2,639,852,151
hydrogenated naphtha	5,785,778,279				5,785,778,279
kerosene	3,683,621,714				3,683,621,714
Gas oil	7,674,185,140				7,674,185,140
fuel oil	22,110,880,780				22,110,880,780
medium liquid gas	576,999,317	383,394,849			960,394,166
final liquid gas			4,087,912,992		4,087,912,992
hydrogen		3,225,958,112			3,225,958,112
jet fuel	105,957,595				105,957,595
Heavy naphtha	913,552,042				913,552,042
Reformit		11,867,071,072			11,867,071,072
gasoline				9,383,965,690	9,383,965,690

Method for calculating the costs of products of separation activity from green activities (environmental costs):

Because the cost guided was chosen in the first and second phases of production quantitys, the environmental loading rate is the same for all activities as follows:

Environmental loading rate for separation activity = total cost of activity / total quantity of activity

= 19,185,286,755/ 9,297,028 = 2,119 ID/m^3

❖ Light naphtha product rate= environmental loading rate ×light naphtha production quantity

= 2,119 × 564,321 = 1,195,883,865 ID

❖ Hydrogenated naphtha ration= environmental loading rate of separation activity × hydrogenated naphtha production quantity

= 2,119 × 1,236,825 = 2,621,025,154 ID

❖ Heavy naphtha ration= environmental loading rate of separation activity × hydrogenated naphtha production quantity

= 2,119 × 195,290 = 413,849,748 ID

❖ kerosene ration= environmental loading rate of separation activity × white oil production quantity

= 2,119 × 787,447 = 1,668,723,671 ID

❖ Gas oil ration= environmental loading rate of the separation activity × gas oil production quantity

= 2,119 × 1,640,509 = 3,476,495,524 ID

❖ Fuel oil ration= environmental loading rate of separation activity × fuel oil production quantity

= 2,119 × 4,726,640 = 10,016,487,309 ID

❖ Medial liquid gas1 ration= environmental loading rate of separation activity × medial liquid gas1 production quantity

= 2,119 × 123,345 = 261,387,432 ID

❖ Jet fuel ration= environmental loading rate of separation activity x jet fuel production quantity

= 2,119 × 22,651 = 48,000,028 ID

Table (11) Allocation of costs of green activities to products (environmental):

Activity	Separation	Cracking	Treatment	Blending	Total
products Rate	2,119				
light naphtha	1,195,883,865				1,195,883,865
hydrogenated naphtha	2,621,025,154				2,621,025,154
kerosene	1,668,723,671				1,668,723,671

Activity	Separation	Cracking	Treatment	Blending	Total
products Rate	2,119				
Gas oil	3,476,495,524				3,476,495,524
fuel oil	10,016,487,309				10,016,487,309
medium liquid gas	261,387,432	49,788,083			311,175,515
final liquid gas			311,175,515		311,175,515
Hydrogen		418,926,523			418,926,523
jet fuel	48,000,028				48,000,028
Heavy naphtha	413,849,748				413,849,748
Reformit		1,541,071,101			1,541,071,101
Gasoline				6,335,604,014	6,335,604,014

9- Collect direct and indirect costs of products.

The last step is collecting all costs in Tables (2, 10 and 11).

Table (12) Total product costs

	light naphtha	**hydrogenated naphtha**	**kerosene**	**Gas oil**	**fuel oil**	**medium liquid gas 1**	**medium liquid gas 2**	**final liquid gas**	**Hydrogen**	**jet fuel**	**Heavy naphtha**	**Reformit**	**Gasoline**
Output quantity	564,321	564,321	564,321	564,321	564,321	564,321	564,321	564,321	564,321	564,321	564,321	564,321	564,321
D.ECO .Cost	24,878,989,633	24,878,989,633	24,878,989,633	24,878,989,633	24,878,989,633	24,878,989,633	24,878,989,633	24,878,989,633	24,878,989,633	24,878,989,633	24,878,989,633	24,878,989,633	24,878,989,633
Ind.ECO. Cost	2,639,852,151	2,639,852,151	2,639,852,151	2,639,852,151	2,639,852,151	2,639,852,151	2,639,852,151	2,639,852,151	2,639,852,151	2,639,852,151	2,639,852,151	2,639,852,151	2,639,852,151
Ind.ENV. Cost	1,195,883,865	1,195,883,865	1,195,883,865	1,195,883,865	1,195,883,865	1,195,883,865	1,195,883,86[illegible]	1,195,883,865	1,195,883,865	1,195,883,865	1,195,883,865	1,195,883,865	1,195,883,865
Total cost	28,714,725,649	62,934,219,961	40,068,223,844	83,475,175,211	240,508,876,652	6,276,251,905	[illegible]	8,810,657,966	4,970,841,177	1,152,543,057	9,937,070,235	18,285,831,212	128,025,686,738
Cost [illegible]	50,884	50,884	50,884	50,884	50,884	50,884	[illegible]	107,770	25,145	50,884	50,884	25,145	42,823
light naphtha													27,522,978,69[illegible]
hydrogenated naphtha													30,479,330

	light naphtha	hydrogenated naphtha	kerosene	Gas oil	fuel oil	medium liquid gas 1	medium liquid gas 2	final liquid gas	Hydrogen	jet fuel	Heavy naphtha	Reformit	Gasoline
Heavy naphtha													103,243,007
Reformit													18,285,831,212
medium liquid gas1								6,276,251,905					
medium liquid gas2								590,768,645					
Total cost			40,068,223,844	83,475,175,211	240,508,876,652			15,677,678,517		1,152,543,057			173,968,218,981
Per m³ cost			50,884	50,884	50,884			191,766 ton		50,884			58,190

Conclusion

• The application of GABC technology helped to more accurately allocate indirect costs, including environmental ones, and thus determine the cost of the product fairer, as well as the impact of this technology on reducing costs in the short term, as observed when comparing the cost of products according to GABC technology and the traditional system applied as in Table (12):

Table (12) Comparing the cost of products between GABC technology and the traditional system applied in the refinery

Products	GABC Cost	TCS cost	Reduction amount
kerosene	50,884	74,397	23,514
Gas oil	50,884	59,912	9,029
fuel oil	50,884	26,584	-24,300
liquid gas (ton)	191,766	514,377	322,611
jet fuel	50,884	75,422	24,538
gasoline	58,190	102,054	43,864

- the percentage of environmental impact of green activities is 28%.

Environmental impact ratio of green activities = environmental costs of green activities / total costs of green activities x 100%

= 28,358,417,966/ 100,797,547,699 × 100% = 28%

• The environmental costs amounted to (28,358,417,966 dinars) and were hidden within the indirect costs, which necessitates managements to take these costs seriously to work to reduce them as much as possible to reduce pollution emitted from the refinery.

• GABC technology helps to reduce costs in the long term as well by reducing gas emissions through the establishment of filters to condense these gases and benefit from butane and propane gas, the two main components for the formation of liquid natural gas, which is one of the essential resources for the production process, and thus the cost of purchasing natural gas from outside the refinery will decrease, in addition to reducing the percentage of gases polluted to the air.

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