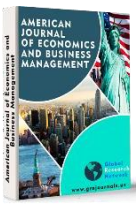

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Applying the Circular Business Model to Improve Performance Indicators of Operational Excellence / A Case Study at Daura Refinery

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Abstract:

The current study is an attempt and a contribution to the cognitive efforts related to the possibility of transferring knowledge and modern methods and applying them in the Midland Refineries Company, which was appointed by Al-Daura Refinery/ Baghdad, by addressing the variables (Circular Business Model, , performance indicators of operational excellence), as the study aims to find appropriate ways to achieve the highest Value for the outputs of production processes. The problem of the study was represented by a deficiency in the optimal handling of resources, that is, a lack of parity between the inherent value of crude oil and the current production processes to expand that value, which leads to the emergence of a high percentage of a heavy by-product (fuel oil) of limited use and low value, at the expense of light, high-demand products. The importance of the study lies in its addressing an important cognitive and applied problem in a large and vital economic sector such as the oil sector and contributing to increasing the production of light petroleum derivatives and improving their quality without the need for additional quantities of crude oil. The study adopted the applied case study approach, and used quantitative indicators represented by mathematical equations when analyzing the results. Data were collected from the official records and reports of the Daura Refinery departments, and the Karbala Refinery was also used to take some design data about the FCC unit. One of the most important results reached by the study is the production of premium, high-demand gasoline from low-demand fuel oil, while improving the overall performance of the Daura refinery without requiring additional Crude Oil. One of the most important conclusions of the study is that the Circular Business Model expand the value of crude oil in the production of high-demand products, provide protection for the environment for preserve its natural resources from depletion. One of the most important recommendations of the study is the necessity of keeping pace with modernity in operational production methods to ensure the addition of new improvements to the product and the production process.

Keywords: Circular Business Model, Fluid Catalytic Cracking, Performance Indicators.

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Introduction

The circular business model is one of the essential components in achieving a circular economy, as it limits the magnitude of the environmental crisis and the combination of social, economic and regulatory trends (high demand for goods, increased volatility of resource prices and efforts to reduce waste), and explains the shortcomings of the feasibility of linear operational business models Which depends on the logic of making, using, and destroying. In this context, the circular business model gains importance by proposing more efficient production processes in the use of resources.

The research idea addressed the circular business model in its dimensions (value proposition, value creation and delivery, and value acquisition), to improve Performance indicators of operational excellence (operational efficiency, environmental performance), in the research sample, at Daura Refinery in Baghdad, by creating new units and applying fluid catalytic cracking (FCC) technology. The research adopted the quantitative mathematical approach in implementing the applied aspect, relying on quantitative indicators of the nature of mathematical equations. The problem of the research was the inefficiency of current production processes in extracting additional value from crude oil as a resource rich in its capabilities, and the abundance of heavy waste compared to light products with high demand. The aim of the research was to develop and improve the overall performance of the refinery and contribute to strengthening the Iraqi economy by producing light petroleum derivatives with the required quality, achieving self-sufficiency and dispensing with imported products.

The study used the scenario method (before scenario) and (after scenario) when performing calculations. It represented a scenario before the calculations for the current situation of the research sample, while it represented a scenario after the calculations after choosing strategies for closing the loop, and after proposing a developmental production process to improve the current situation to a better one. The idea of the development process is based on recycling the fuel oil resulting from the crude oil refining process to transform it into the premium gasoline product targeted to be produced according to the high demand for it, and some light derivatives accompanying the process. The development process was represented by the Fluid Catalytic Cracking (FCC) unit and other units that support and complement the production process. a development process summed up by using quantities of fuel oil (by-product) from the crude oil distillation process, to be the feed material for the development process without using additional quantities of crude oil and converting it into an excellent gasoline product with high demand.

Literature Review

The problem was represented in study of (Dyremark & Gustafsson, 2021) by presence of barriers to circular business model innovation and the impact of the company's business support activities on this innovation process. This was applied through a multiple case study of ten Swedish SMEs that received direct business support for circularity and thus started a circular project. While the research aimed to understand the barriers to the circular economy in the local context, which can facilitate the development of effective support for businesses. The study identified seventeen different barriers across five categories, extending across the entire innovation process from idea to full implementation. This study concluded that training and financing are company-specific activities that can help SMEs overcome internal barriers primarily in the early stages of the process. Capacity building, addressing many of the most common barriers identified.

As for the study (Yip, 2020), there was a knowledge gap represented by the presence of many challenges and obstacles, which have not yet been completely overcome, as they have practically prevented the transition to a circular business model. Many technology manufacturing companies were targeted in different sectors, such as: the infrastructure and construction, the energy, resources and industrial, the automotive, the innovative consumer technology electronics, the health and social care, and the financial sector. With limited knowledge about what new emerging digital data technologies are and how they can support transformation and overcome these challenges and barriers. So the purpose of the thesis is to explore how the application of digital data technologies can help technology manufacturing companies towards a more circular business model.

The study concluded that digital data technologies have high potential to help technology manufacturing companies adapt their business model to the circular business model, by changing the three elements of the business model to the three elements of the circular business model; Demonstrate circular value, create and deliver circular value, and capture circular value.

The problem of the study (Muazu & Tasmin: 2020) was limited productivity, weak health and safety risk management, and low environmental performance. The study aimed to determine the role of some determinants of enterprise risk management in implementing operational excellence in the oil and gas sector, specifically seven subsidiaries of the Nigerian National Oil Company. The results indicated that the regulatory framework, employee capabilities, information technology and company characteristics can have a significant impact on implementing operational excellence in the oil and gas sector. The results prepared companies on how to improve health, safety and operational efficiency by reducing cost and waste and enhancing assets and reliability Operations and improving environmental performance.

The study (Owonte & Jaja: 2020) aims to study the degree of application of operational excellence strategy in the organizational performance of automobile marketing companies in Rivers State, Nigeria. The study population was 197 car marketing companies, from which a sample of 132 companies was drawn. The study concluded that operational excellence strategy significantly impacts the performance of automobile marketing companies in Rivers State.

Research Methodology:

The Middle Refineries Company, headquartered in Baghdad/Iraq, was chosen as a study population, while the Al-Daura Refinery (light oil derivatives division), located in Baghdad, represented the study sample due to importance of its production capacity that meets of the daily needs from oil derivatives, and its possession high technical expertise. With the refinery's need to improve production efficiency and it's quality.

1. Circular Business Model

The circular approach is a modern approach developed to enhance safety factors in production, processes and products (Steinhäuser et al., 2004). The concept of sustainable industrial development management is achieved by implementing circular materials and energy flows in the entire production chain and reducing the amount of materials and energy used in production with the intention of achieving greater efficiency (Geissdoerfer et al., 2020). Avoiding waste maximizes production from low inputs while maximizing productivity (Mawlood et al., 2022). Process improvement means an organization designs and manages its processes in order to support its policies and create additional value for its customers (Abdulredha, 2019).The concept of the circular business model or the circular economy business model in business organizations is represented by the three main components of the value logic framework which are: (value proposition, value creation and delivery system, value acquisition) as these components reflect the logic of strategic thinking about value. The essence of which is to create greater value for customers and gain the organization a greater amount of that value compared to other competitors (Richardson, 2008). Circular Business Model Represents business model strategies suitable for the transition to a circular economy based on the concepts of slowing down, closing, and narrowing resource loops (Bocken et al., 2016). Although there are several goals for organizations, such as improving quality, using modern technology, and developing products, the primary goal is to increase profit (Jawad & Al-Obaidi: 2019). The dimensions of this circular business model can be explained as follows (Richardson, 2008):

a - The Value Proposition: What will the organization offer to its customers, is there a

demand for the offered offer, and the organization's basic approach to competitive advantage.

b - The Value Creation and Delivery System: How will the organization achieve this value and provide it to its customers and what is the source of its competitive advantage.

c - Value Capture: This means how the organization achieves revenues and profits. In other words, how can the organization reduce the costs of its products or improve their quality, to meet demands in an effort to increase its sales and generate new revenues that maximize its profitability. This is one of the dimensions of the company's production system (competitive priorities) that supports the requirements of the markets with which the company wants to compete (Salman et al., 2019).

2. Performance indicators of operational excellence

Iraqi Oil institutions suffer from many problems that need to be addressed in an effort to improve performance and reach a higher level of success and excellence (Danook et al. 2023). Operational excellence is a concept that focuses on problem-solving techniques and leadership skills as the main factor for continuous development (Tariq et al., 2021). Operational excellence is viewed as an integrated management system that drives increased productivity based on industry best practices and procedures (Muazu et al., 2021). Therefore, operational excellence can be defined in simple words as organizations making improvements to achieve a competitive advantage (Sony, 2019). It requires building a vision that contributes to implementing a successful course of action that depends on the availability of basic capabilities related to efficiency (Danook & Al.Obaidy, 2022).The Performance indicators of operational excellence are:

a- Operational Efficiency

b- Environmental Performance

c- Green Productivity Index (GPI)

Operational Efficiency and Environmental Performance from ((Muazu& Gwangwazo, 2021: 92-93). The research believes that it is appropriate to develop a measure of performance indicators by introducing the green productivity index dimension as a third dimension because it helps to bridge the long-existing gap in evaluating environmental performance and also provides a small step towards a more robust quantitative approach in making environmental decisions.

Operational Efficiency is the ability to achieve the best in a distinctive way with the least possible resources and the highest possible quality (Albayatey et al., 2021). Efficient use is the achievement of goals measured by the relationship between the results achieved and the goals set (Al-Barzanji :2019). Operational efficiency is measured by the ratio of actual outputs over actual inputs (Muazu & Gwangwazo, 2021:88); (Mohsen & Al-Najjar, 2009: 29):

$$\text{Operational Efficiency} = \frac{\text{Actual Output}}{\text{Actual Input}} \quad \ldots(1)$$

Environmental Performance includes measuring *Effectiveness* and *Eco-efficiency* (Muazu & Tasmin, 2020:3861). Effectiveness means doing the right thing (Heizer et al., 2020: 26). Effectiveness usually determines the organization's policy goals or the degree to which the organization achieves its own goals. Therefore, Effectiveness - oriented organizations are concerned with production, sales, quality, creating added value, innovation, and cost reduction (Bartuševičienė & Šakalytė, 2013: 48). also Effectiveness is a criterion that demonstrates the organization's ability to achieve the goals that make it a successful organization (Karam & Dawood, 2015: 12). Effectiveness is measured by the ratio of

actual outputs to planned outputs (Al Maamouri, 2022: 57):

$$\text{Effectiveness} = \frac{(Actual\ Output)}{(Planning\ Output)} \times 100\ \% \ldots. (2)$$

Environmental Efficiency represents a management philosophy to guide and measure the development of organizations and other actors in environmental performance. Eco-efficiency measures the value of a product, a good or a service, against its environmental impact. It is also a dynamic concept that aims to gain greater value with less environmental impact, thus combining environmental and economic gains. The basic idea of eco-efficiency is to disentangle growth from environmental pressure. The mathematical formula for environmental efficiency is represented by equation (3) (ESCAP, 2009: 4):

$$\text{Eco-efficiency} = \frac{\text{Product Value}}{\text{Environmental Impact}} \ldots. (3)$$

The value of products is expressed in the profitability achieved from them.

$$\text{Profitability} = [(SP) - (PC)\ ] \times \text{production الإنتاج} \ldots (4)$$

The environmental impact is expressed in the equation (Gandhi et al., 2006: 597):

$$EI = w1SWG + w2GWG + w3WC \ldots. (5)$$

When, EI : Environmental Impact

SWG : (Solid Wastes Generation)

GWG : (Gaseous Wastes Generation)

WC : (Water Consumption)

w1 , w2 , w3 are *The corresponding weights for each (SWG, GWG,WC)*

The green productivity index is defined as the ratio of a system's productivity to its environmental impact. The Green Productivity Index helps fill a long-standing gap in assessing environmental performance and also provides a small step towards a more robust quantitative approach to environmental decision-making. The green productivity index is calculated as in the following equation (6) (Gandhi et al., 2006: 597).

$$GPI = \frac{\text{Productivity}}{\text{Environment Impact(EI)}} \ldots. (6)$$

Productivity can be calculated as in the following equation (7) (Gandhi et al., 2006: 597).

$$\text{Productivity} = \frac{\text{Selling Price(SP)}}{\text{Product Cost (PC)}} \ldots. (7)$$

Results:

Quantitative Indicators were addressed when measuring the dimensions of the study variables (circular business model, operational excellence), using a mathematical research approach to arrive at the results of the study and their interpretation. (A before scenario and an after scenario) were used, as the before scenario refers to (the current situation or the refinery's operations). The current scenario), while the after scenario refers to (the alternative situation that includes an innovative change in operations). The focus of the operations was on converting the fuel oil resulting from crude oil refining operations in the Atmospheric distillation tower into premium gasoline by assuming the creation of new operational units, which are:

1. Vacuum Distillation Unit (VDU).

2. Coking Unit (DCU) Delayed for Vacuum Residue

3. Gas Oil Hydrotreating Unit (GOHT).

4. Fluid Catalytic Cracking (FCC) unit using VGO as input to the production process.

5. Hydrotreater Unit Gasoline (GHT).

Table (1) shows the results of Dimensions of the Circular Business Model

Scenario after (Dimensions of the Circular Business Model)
1- Value Proposition: The value proposition was determined by forecasting the demand for premium gasoline, which was determined by the amount of premium gasoline imported equal to: (687378670.5) liters/year **2- Value Creation:** Value is created by closing resource loops and using the development process, its heart, the fluid catalytic cracking unit, where fuel oil is converted into vacuum gas oil and then converted into premium gasoline. **3- Value Capture**: -The increase achieved in production limits the import of premium gasoline by 43.3% of the total need. -The additional profits achieved from the development process annually are: 1630323143030.31 IQD, in addition to the Premium quality newly produced gasoline

Source: Adapted based on the research results

Table (2) shows the results of each scenario for Operational efficiency and Effectiveness

No.	Indicator	Scenario before	Scenario After
1	**Operational efficiency (%)**		
	Premium gasoline	/	**35.57**
	Ordinary gasoline	16.15	16.15
	Gas Oil	**16.17**	**20.83**
	Liquid gas	1.718	1.718
	Aviation fuel	2.3	2.3
	White oil	1.2	1.2
	Diesel oil	**0.83**	**2.04**
2	**Efficiency of resource use (%)**	38.7	79.81
3	**Effectiveness (%)**		
	Premium gasoline	Zero	**103.7**
	Ordinary gasoline	80.25	80.25
	Gas oil	96.26	**97.8**
	Liquid gas	123.03	123.03
	Aviation fuel	83.19	83.19
	White oil	26.17	26.17
	Diesel oil	39.74	62.5
4	**Overall effectiveness**	80.33	90.97

Source: Adapted based on the research results

Table (3) shows the results of each scenario for Profitability and Eco-efficiency

No.	Indicator	Scenario before	Scenario After
1	**Profitability** (IQD)		
	Premium gasoline	0	1584212157005.317
	Ordinary gasoline	105645341972.995	105645341972.995
	Gas oil	149702834135.65	194772079172.65
	Liquid gas	- 14545550919.123	- 14545550919.123
	Aviation fuel	14238019661.4	14238019661.4
	White oil	3961718607,825	3961718607,825
	Diesel oil	382637540.925	1424377447.5
	Fuel oil	97594358179.5	0
2	**Eco-efficiency** (IQD/tonne)	151712.4	655677.6

Source: Adapted based on the research results

Table (4) shows the results of each scenario for Green Prductivity Index

No.	Indicator	Scenario before	Scenario After
1	**Productivity**		
	Premium gasoline	/	**9.195**
	Ordinary gasoline	1.647	1.647
	Gas oil	**3.277**	**3.351**
	Liquid gas	0.235	0.235
	Aviation fuel	2.065	2.065
	White oil	1.656	1.656
	Diesel oil	**1.149**	**1.247**
	Fuel oil	2.484	/
2	**Total productivity**	2.11	4.9
3	**Environmental impact**	0.353	0.433
4	**Green Prductivity Index** (m^3/tonne)	5.98	11.32

Source: Adapted based on the research results

Discussion:

The results reached are shown in Tables (1), (2), (3), (4) and are classified into two categories: a before scenario and a after scenario. The before scenario concerns the results of the current operational operations, while the results of the after scenario express the results of the developmental state represented by adding new, unconventional operational units relative to the current units, the purpose of which is to exploit the fuel oil resulting from the before scenario and introduce it into production processes to produce hydrogenated vacuum gas oil first and then Then the production of light petroleum derivatives, especially the premium gasoline product, as a primarily targeted product, as the production units were designed for that. Based on this, development production operations do not require any additional quantities of crude oil. In other words, the fuel oil resulting from a previous scenario is recycled to be the input to the development process with the aim of creating and gaining more value from the same resources used and not depleting new resources.

The study focused on demonstrating the results of applying the circular business model to operational excellence performance indicators in the Doura refinery to meet the most important challenges in the industry, specifically the oil industry sector, which is represented in the use of the minimum necessary raw materials, for production and reducing product costs to achieve competition in the business market and maintain the sustainability of raw materials from depletion. This study is the beginning of the transformation in the Doura refinery to adopt the circular approach as a model for managing production and operations towards achieving a competitive advantage and reaching operational excellence. One of the most important results revealed by the study is the existence of an effective relationship between the circular business model represented by its three dimensions (value proposition, value creation and delivery, and value acquisition) with operational excellence performance indicators that are: operational efficiency, environmental performance through, and Green productivity Index.

1. Table (1) shows the dimensions of the circular business model. The value proposition is determined by forecasting the volume of demand for premium gasoline, and this is done by knowing the volume of imported premium gasoline. While the value creation dimension explains the mechanism or how value is created, which can be achieved by closing resource loops and using the development process, its heart, the fluid catalytic cracking unit, where fuel oil is converted into vacuum gas oil and then converted into premium gasoline. Value Capture explaned The additional profits achieved from the

development process annually are: 1630323143030.31 IQD, in addition to the Premium quality newly produced gasoline.

2. Table (2) shows The operational efficiency of premium gasoline production increased from (Zero) to (35.57%), while the percentage of gas oil increased from (16.17%) to (20.83%), while the percentage of diesel oil also increased from (0.83)% to (2.04%) According to these results, the efficiency of resource use increased by a large percentage from (38.37) to (79.81)%. The increase in results indicates better exploitation of crude oil. Also The effectiveness of premium gasoline increased to (103.7)% after it was (Zero) in the previous scenario. Likewise, the percentage of gas oil increased from (96.26)% to (97.8)%, while diesel oil increased from (39.74)% to (62.5)%. and in general the effectiveness of the combined products increased from (80.33)% to (90.97)%. The indication of this increase is the effectiveness of production processes that actually increased production.

3. While table (3) shows the profitability achieved for the refinery in the event of applying the development process mentioned in the research, it shows that the profitability of fuel oil is transformed to zero due to the transformation of this material into an input for the development process and its conversion into premium gasoline. This process replaced the low profitability of fuel oil with a high profitability several times. This also enhances the Value Capture dimension of the circular business model as well. The negative sign in the profitability of liquid gas indicates that this product generates a loss for the refinery, and the reason for this is that the selling price of this product is less than the cost price as a result of the state's policy of subsidizing the price because of its direct contact with the life of Iraqi society.

4. Table (4) shows Premium gasoline productivity reached (9.195) after it was (Zero) in the previous scenario with a slight increase in gas oil and diesel oil. As for the decrease in fuel oil productivity to (Zero), this means that its quantities will run out in order to adopt it as a source of fuel for the entire new development situation, and dispense with the use of new crude oil. Therefore, total productivity increased from 2.11 to 4.9. As for the increase in the environmental impact, it is considered a slight increase if we take into account the large increase in the production of premium gasoline, and this was reflected in a significant improvement in the green productivity index and an increase from 5.98 to 11.32.

Conclusion:

After arriving at the results and discussing them, we explain the following:

1. The Doura Refinery faces a real problem by not exploiting a large portion of the value contained in crude oil at the present time, as a result of the high average volume of heavy products (fuel oil with reduced crude), which reached 53.225% of the average volume of refined crude oil in the current production process.

2. The significant increase in the production of premium gasoline explains the direction in which the FCC unit was designed for the purpose of producing premium gasoline, as the design is controlled according to the type of products required.

3. The significant improvement in the operational efficiency ratios of development mode products, as well as in the efficiency of resource use, explains the success of the new development process and its suitability to achieve the goal of increasing the efficiency of use of current resources involved in the industry and eliminating the need for more raw material (crude oil).

4. The development process contributes to reducing the increase in the amount of environmental impact, despite the increase in the rate of solid waste and the rate of water consumption in the "after scenario", but this is considered a decrease in addition

to the decrease in the rate of gaseous pollutants, if we take into account the large increase achieved in production.

5. The increase in production quantities, especially the premium gasoline product, with no need to increase additional quantities of crude oil, is considered a provision of quantities of crude oil equivalent to the increase in production, and this is considered a supportive factor for the Iraqi economy, as the provision of these quantities of crude oil, amounting to (14629757.185 m^3) barrels annually, It means providing the opportunity to export these quantities of crude oil and obtain the corresponding hard currency.

6. The manifestations of positive change for the Doura refinery are represented by improving the environmental and economic dimensions of the development production process created by this study, which is reflected in the change in the Green productivity Index that expresses environmental protection and improving productivity.

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