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Sustainability in business systems as a mechanism to enhance the process of creativity and innovation in petroleum companies: British Petroleum - Royal Dutch Shell – total, during the period 2018-2022

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Abstract---This study aimed to demonstrate the impact of digital sustainability in enhancing creativity and innovation in petroleum institutions during the period 2018-2022. The study was conducted on Petroleum Company, Total Company, and Shell Company. The study was divided into two axes. The first axis touched on the theoretical framework of digital sustainability as well as The elements

of the research and development function, creativity and innovation, and the second axis was addressed in the applied study, where the study finally reached the major role that digital sustainability plays through the research and development system in supporting the process of creativity and innovation and the use of digital economy applications in the British Petroleum Company, the Total Company, and the Shell Company, and by comparing them, it became clear that the Shell Company has a relative advantage over the British Petroleum Company and the Total Company by possessing more patents every year.

Keywords---digital sustainability, research and development, technological creativity and innovation, petroleum institutions.

JEL Classification Cods : Q01.L71.M14.O31

1. Introduction

Since the advent of the Internet and the emergence of electronic and information technology at the dawn of the third millennium, societies have been changing rapidly and radically, as the increasing importance of knowledge, together with globalization and the effects of technological development in the era of the Fourth Industrial Revolution, has created a completely different world. This fourth industrial revolution, which differs from previous revolutions in its intensity, complexity and breadth by virtue of its essence, based on a new technological phenomenon called digital transformation, that is, the integration of digital technologies and their rapid penetration into the infrastructure of each company and institution, has contributed to a creative convergence, where a wide range of technologies including the Internet of Things, cloud computing, big data analytics and artificial intelligence are combined to create an ecosystem that allows mutual benefit between different types of technologies so that they benefit Each of the other contributes to its development, so businesses and communities alike have found themselves facing unprecedented opportunities and challenges.

These changes in the field of business came as a result of the process of technological creativity and innovation, where the international petroleum institutions are working to support and develop their institutions through the innovation process, which ultimately contributes to the production and development of sustainable digital economic applications that promote creativity and innovation.

1- Problematic

Through this study, we will seek to answer the following problem:

What are the ways to support the promotion of creativity and technological innovation in petroleum institutions through digital sustainability?

2- Objectives of the study

This study aims to try to know the reality of digital sustainability in petroleum institutions and the role it plays in supporting the process of creativity and

innovation in these institutions by conducting a diagnosis and evaluation of the inputs and outputs of the research and development system through the following:

- Study and evaluation of R&D activity in petroleum enterprises;
- Attempt to uncover how R&D activity promotes the use of digital economy applications for petroleum enterprises;
- The extent to which foreign institutions rely on the R&D function in the development of their activities;
- Highlight and clarify theoretical concepts related to research and development as well as the innovation process.

3- The importance of the study

This study derives its importance through the position of the subject of digital sustainability in petroleum institutions in light of a highly competitive environment dominated by great technological development, as most petroleum institutions acquire high technologies by paying attention to the subject of digital sustainability by providing research centers and specialized institutes in order to access the latest technologies.

4- Study reference

In this research, we relied on a variety of references between articles, books and forums, in addition to notes, theses and Internet sites, where the time dimension of these references ranged between ten to five years.

2. The concept of digital sustainability

The term digital sustainability refers to the great potential of digital technologies in contributing to

Achieving sustainability goals at the micro and macro levels where digitalization and sustainability intersect and are driven by the strategic objectives of digital transformation and sustainability.

There are those who defined it as the process of organizing activities that seek to achieve the SDGs through the creative deployment of technologies. (Bencsik, Palmié, Parida, Wincent, & Gassmann, 2023)

Digital sustainability should be seen as simplified solutions free of complexity, in order to facilitate their use both for organizations and individuals.

1) Digital sustainability dimensions

In order to know whether the service or product is characterized by digital sustainability or not, the following dimensions must be taken into account:

- ✧ Intergenerational equity: that is, the institution ensures, through the digital product or service, the principle of equal opportunities between the current and future generations.
- ✧ Capacity for renewal: ICTs are undergoing constant change and therefore everyone must work to ensure the continuity of innovation in digital products and services by activating the research and development system.
- ✧ Economic use of resources: It is clear that digital goods are not subject to economic competition. However, if people are excluded from accessing digital information, they need to recreate it in order to use it.

- ✎ Risk reduction: The production and use of digital goods carries many risks, such as the creation of vendor dependencies or the risk of misinterpretation.
- ✎ Environmental and economic added value: so that the digital product or service should be of added value, whether economically or environmentally, by, for example, reducing polluting emissions (Stuermer, 2014).

2) Indicators for measuring digital sustainability in institutions

Most international companies, especially those active in the field of energy, seek to provide the element of digital sustainability in its products by providing some basic indicators in the process of digital sustainability, including:

2.1. Information

Knowledge is the most advanced source of wealth, as it is the most effective tool in providing competitive advantage among companies.

2.2. Digitization

The term digitization refers to the use of technology in the conduct of all the work of the organization.

2.3. Innovation

Includes all new applications, whether in products or services.

2.4. Time

2.5. Speed of access

Speed is one of the biggest benefits of the digital economy. In the case of digital sustainability in the business world, speed starts from, the speed of access to information and sharing it with all decision-makers within the organization (Hidiroglu, 2022).

3. The concept of R&D activity

In this element, we will address the concept of R&D as a function within the enterprise. The Organization for Economic Co-operation and Development (OCDE) defines R&D as "the sum of methodological and creative work aimed at increasing knowledge, both the knowledge of the individual and the culture of the enterprise, which are used in new applications. (Zemmouri & Mardawi, 2017).

The Arab Planning Institute also defined the function of research and development as: "the process of researching different scientific knowledge and working on developing research results to be used in generating new products or applying new production methods to serve different business goals" (Abou Alsoud, 2010).

It is clear from the previous definitions that the R&D function includes a set of organized and systematic actions aimed at increasing the balance of knowledge for the individual and the institution, where this knowledge is used to issue new products or new production methods to serve the objectives of the commercial enterprise.

4. Types of scientific research

There are many types of scientific research, but we will address those types of research that the institution relies on to develop and improve a specific service or product, as there are three types of research that include each of the following research:

4.1. Basic research

It is that theoretical work that aims primarily to acquire new scientific or technical knowledge without specific practical application, and there are types of basic research, including descriptive research, and exploratory research.

4.2. Applied Research

That work is based on the acquisition of scientific and technical knowledge and directing it towards the application of a specific practical goal. The institution usually turns to applied research either to work with potential uses of basic research findings or to identify new methods or means to create practical applications.

4.3 Experimental development

It is work that relies on scientific knowledge or practical experience, which the organization resorts to for the purpose of achieving technological advancement, creating new products or improving products, systems and processes (Gallaher, Link, & Petrusa, 2005)

It is noticeable on these types that they are interconnected and sequential with each other in the process of improving or creating a specific product, each stage complements the other.

5. Objectives of the R&D activity

The objectives of the R&D function are determined in light of the general objectives of the institution and the management strategy, where the objectives and strategy of the institution are reflected in the nature and types of research and strategic planning of the research activity.

The objectives of this post can be determined through the following points:

- Value analysis and engineering to reach competitive costs to work on strengthening the competitive position of the enterprise;
- Innovation of new products to satisfy the desires of consumers;
- Increase profitability rates;
- Product development and designs;
- Development of production methods and methods to reduce cost; - development of production input alternatives;
- Continuous improvement to achieve competitive cost;
- Achieving excellence as an input to increase competitive advantage;
- Gain customer satisfaction and maintain the organization's market share (Hadjadj, 2015)

6. Measuring the activities of the R&D function

R&D activities in enterprises are measured through two important indicators: the input index and the output index.

6.1. Input indicator

The inputs of R&D activities are measured through two indicators, a financial indicator and a human resources index, the higher the percentage of these two indicators on the effectiveness of performance, and the lower the percentage of these two indicators on poor performance.

6.1.1. Percentage of total expenditure on R&D function

This ratio refers to the value of total R&D expenditures over the value of sales.

- Percentage of total expenditure on R&D function:

$$\frac{\text{Total expenditure on R\&D function}}{\text{Turnover of the institution}}$$

6.1.2. Human resources ratio

This ratio refers to the number of active employees in the R&D function over the total number of employees of the enterprise.

- Percentage of human resources:

$$\frac{\text{Number of active R\&D employees}}{\text{The total number of employees of the institution}}$$

6.2. Output Index

This indicator includes the results achieved for the R&D function, where this indicator is measured from two factors:

6.2.1. Number of patents

This factor includes the amount of patents granted to the institution during the period of its activity; the more the institution has a large number of patents, the more this depends on the quality of the research carried out and the quality of performance as well.

6.2.2 Sales value

This factor includes the value of an enterprise's sales of the new product, the greater the value, the greater the effectiveness of R&D activities (AL-Khikani, 2010).

7. Technological innovation

The U.S. National Science Foundation defined technological innovation as "the introduction or improvement of products, processes, or services to market". William defines technological innovation as "the discovery and development of products (goods, services or processes), the discovery and development of new products is the gateway to the development of new knowledge and its translation into commercial applications." (Bouznak , 2013)

8. Characteristics of technological innovation

- ↳ that it is the result of the application of agreed technological knowledge, meaning that everything new based on inaccurate information that leads to ineffective results cannot be considered technological;
- ↳ Be linked to production and productivity, that is, any innovation that does not lead to the improvement of the production process or the use of production elements or even to the provision of new products or the improvement of existing products is not technical innovation in the proper sense;
- ↳ It should not have a market presence, i.e. unlimited effectiveness and efficiency because it is considered a key factor in competition. (Hadjadj, 2015)

9. Types of technological innovation

Technological innovation is classified into product creativity, process creativity.

9.1 Product Creativity

It is the introduction of a new product (good or service) or a significant improvement in terms of its characteristics, or its intended use, often seen as the continuous technological modification of the good or improvement in the conditions of its use, the goal is usually to improve the services provided to customers and meet new needs. This type of innovation is based on the internal and external environment, the internal represented in research and development and marketing activities, while the external is represented by the users of goods, competitors and sources of new opportunities.

9.2 Creativity of the process

These methods involve changes in production organization methods in order to reduce costs for production or distribution units or improve quality (especially the development of new products that can meet special needs in terms of production and distribution), and they also involve significant changes in technologies, materials, programs and the goal in general to simplify production processes and reduce costs to improve the competitiveness of the company.

Unlike product creativity, the creativity of the production process is mainly based on the development of supplier-oriented capabilities (equipment suppliers) and the development of internal capabilities concerning the relationship between the R&D function and the production and marketing functions. (Bousslimi, 2013).

10. Conceptual Framework of Innovation

10.1. The concept of innovation

The Economic Cooperation Organization defines innovation as "the sum of the scientific, technical, commercial and financial steps necessary for the successful development and marketing of new or improved industrial products, the commercial use of new or improved methods and products, or the introduction of a method in social service" (Kebab, 2017).

The Austrian economist Josef Schumpeter defined innovation as "the result of the creation of a new method or method of production, as well as a change in all components of a product or how it is designed (Kebab, 2017).

The term innovation refers to the set of ways and methods that an organization develops in order to improve in a new product or service.

10.2. The importance of innovation for the Organization

The importance of innovation for the Organization is evident in the following points:

- ✱ Develops and accumulates personal skills in thinking and group interaction through storming teams;
- ✱ mental;
- ✱ Increases the quality of decisions made to address problems at the level of the organization or at the level of its sectors and departments, in various technical, financial, marketing and environmental fields;
- ✱ Social work;
- ✱ Improves the quality of products;
- ✱ Helps to reduce the time between the introduction of a new product and another, which contributes to the differentiation of the organization in terms of time competition;
- ✱ Helps to create and enhance the competitiveness of the organization;
- ✱ Helps to find ways to activate and increase the volume of sales;
- ✱ Helps to create and enhance a good mental image of the organization in its customers;
- ✱ In addition, the institution's introduction of innovation that no one has ever done before may allow it to have a partial and temporary monopoly of the market, depending on the degree of innovation intensity (Guenour & Ferrah , 2017).

10.3. Forms of innovation in organizations

There are three forms of innovation: managerial innovation, technical innovation, and additional innovation:

10.3.1 Administrative innovation

It means the adoption of the method of qualitative change in institutions, whether at the level of the internal or external environment, and thus administrative innovation is comprehensive in change at the level of both environments.

10.3.2. Technical innovation

It means the good or service that adds something new in the market that did not exist before and therefore is called an innovative commodity or service, technical innovation is one of the most important means that contribute to the development of organizations so that it is limited to enhancing the competitiveness of the organization in the markets.

10.3.3. Additional innovation

Defined as ancillary innovations that extend beyond the organizational environment of the organization and go beyond its core business functions (Ayad, 2017).

11. Field study

The study was carried out on three petroleum complexes, the British Petroleum complex, the Total complex, and the Shawl complex during the period 2018-2022.

Table 01: R&D expenditures and the number of patents granted to BP during the period 2018-2023

Year	R&D Expenditure	Patent and digital applications
2018	429	2500
2019	364	3900
2020	222	5000
2021	266	3800
2022	274	3100
2023	298	2500

Source: Prepared by the authors based on the annual reports of the institution.

It is noticeable from the above table that BP spends large sums on the research and development function to support the innovation of sustainable digital applications in order to keep pace with the technological developments in the energy sector as well as to improve and enhance its competitive position, where we note that the research and development function has a prominent impact in creating sustainable digital and technological innovations, if we compare between 2018 and 2022, we notice an increase in the number of innovations granted from 2500 patents in 2018 to 3100 in 2022 and this Despite the decline in R&D expenditures for the same period due to the crisis of the decline in global oil prices to record levels of \$ 44 per barrel.

Table 02: R&D expenditures and the number of patents granted to the French Total Company during the period 2018-2022

Year	R&D Expenditure	Patent and digital applications
2018	1.353	300
2019	980	200
2020	1050	200
2021	912	200
2022	986	200

Source: Prepared by the authors based on the annual reports of the institution.

It is noticeable from the table above that the number of patents granted to Total in the field of innovations and digital applications remained constant over 7 years between 250 and 300 patents, so that this did not show the impact of R&D expenditures on the innovation process. This underscores IDA's strategic direction in promoting digital sustainability in the field of energy in international markets.

Table 03: Research and development expenditures and the number of patents granted to the Shell Company during the period 2011-2018

Year	R&D Expenditure	Patent and digital applications
2018	1.222	15000
2019	1.093	12000
2020	1.014	11500
2021	922	10450
2022	986	10325

Source: Prepared by the authors based on the annual reports of the institution.

Table No. 03 shows the impact of research and development expenditures, which are considered a basic process towards innovations of new technologies or modern digital applications, on the patent during the years 2011 until 2014, where the number of patents and digital applications obtained reached about 15,000 thousand, and this is due to the large expenditures on the research and development function, which amounted in 2013 to 1.322 billion dollars, the highest percentage in 7 years, and the years 2014 declined until 2017 due to low oil prices to record levels.

From tables 01, 02 and 03 respectively, we can summarize the differences between the three institutions:

- Shell & BP's extensive R&D experience other than Total;
- The large number of R&D centers for Shell and BP, where the number for BP reached 7 centers distributed between the United States of America, Britain and Brazil, while Total has only 3 centers;
- The large size of the expenditure of the Shell Company. on the function of research and development compared to other institutions.
These differences contributed to Shell's superiority over BP and Total, reinforcing its position in the global oil market as one of the partially dominant institutions in market share.
- Despite the size of the differences in spending on research and development, all the above institutions have an international strategy in promoting creativity and innovation through their digital sustainability, and the element of sustainability comes through the adoption of these institutions for a long-term strategy through which they rely on supporting their digital products and services.

12. Some models of innovation and technological applications of institutions

12.1. For Total

○ Introduction of the first Levi Abu Dhabi exploration system

Abu Dhabi National Oil Company (ADNOC) and Total have announced their collaboration to deploy the world's first automated seismic acquisition system in Abu Dhabi. This pilot project, implemented using Total's Integrated Multimedia Exploration Technology (METIS)[®] system, uses autonomous drones and ground vehicles to drop and recover earthquake sensors without human intervention, and therefore at a lower cost. It will be deployed across the Emirate of Abu Dhabi,

contributing to onshore exploration and assessment campaigns the first in the region.

Following successful METIS® trials conducted by Total in Papua New Guinea, ADOC will implement this new pilot project to test the system's diversity and ability to scale up in a desert environment of 36 square kilometers. Seismic sensors will be shot down by six autonomous drones and will later be recovered by an unmanned ground vehicle while manually deployed manually by ground teams.

12.2. For BP

Introducing innovative technology that helps reliability of data and reduce costs using BP's US subsidiary, British 48, is changing the way it produces oil and natural gas by adopting high-tech innovations that promote safety, reliability and cost reduction. Using cutting-edge technologies such as big data analytics, augmented reality smart glasses, drones, and advanced drilling technologies, BP is making its operations smarter – and more competitive – as part of the new operating model "Smart Operations", Lower 48 uses a series of new technologies that automate many of the time-consuming routine maintenance activities performed by operators in the field. "This new approach ultimately frees up their time to work more efficiently and creatively, focusing on what's really important," says Pugh. One example is Lower 48's creation of an analytics-powered logistics system inspired by parcel delivery companies that helps operators make the most of their time at well sites. This includes an algorithm that develops dynamic pathways for workers so that they are directed to wells of highest priority, whether related to health and safety, preventive maintenance, or performance improvement reasons.

As well as investing in technology company Calista, which turns natural gas into food for fish. It is a new way to make protein feed and offers the potential to help meet growing global demand more sustainably. The technology uses no agricultural land and contains about 70 percent less water than alternative ingredients, including soy proteins and wheat.

In 2023 BP developed real-time our digital carbon and energy dashboards for all refineries to monitor energy performance and alert employees when energy use is high. In refining, we held workshops in Whiting and Gelsenkirchen to develop new energy reduction ideas.

13. Conclusion

Petroleum institutions are working to develop their innovative capacity and develop a sustainable technological digital application by activating their research and development department through the search for information and knowledge and processing them within a group of engineers and technicians specialized in the research department in order to be used in the end in the development of a certain technology or new technological innovation, but this process requires great experience in addition to allocating a large budget and structures because the great challenges facing petroleum institutions today in light of a highly competitive environment and many variables control The status of petroleum markets from the liberalization of international trade, the removal of customs restrictions and the opening of domestic markets to international markets is how to provide a certain value represented in advanced petroleum services or add new

production patterns to consumers (consumers mean national and foreign institutions that represent their countries) who have become fully aware of the quality of the products offered.

This requires them to exert great efforts, especially with regard to markets, buyers, competitors, and they must balance between their internal and external capabilities and the opportunities they face and the threats they face, and this will only be possible by following a clear path for their various activities, especially research and development activity, which has become the main pillar in petroleum institutions.

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