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Nanotechnology and Its Role in Reducing Costs: Case Study in Iraq

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Nanotechnology is a collective definition that represents each technology and science application that operates within a Nano scale and indicates the scientific basics and new characteristics that may be found and mastered when operating in this range. This research aims to determine the relationship between nanotechnology and reducing costs. In this research, the data was collected through questionnaires in an industrial company in Baghdad. The total number of participants was 70, taken from the managers of randomly selected industrial companies. The results showed that the level of nanotechnology in term of relative important is high, with the mean of 3.9088 and standard deviation is 1.08492, and also the level of reducing costs in term of relative importance is high with the mean 4.0338 and standard deviation is 1.1456.

Key words: *Nanotechnology, cost reduction, technology, cost elements, target cost.*

Introduction

At the beginning of the 21st century, people witnessed a new phenomenon that is recognised as nanotechnology in various parts of their lives. In this regard, Nanotechnology is a collective definition indicating every form of technology and science that operates on a Nano-scale and indicates the scientific basics (Helland, 2004). It also means any technology on a Nano-scale that has applications in the real world. Nanotechnology includes the production and application of physical and chemical systems at scales ranging from individual molecules to submicron dimensions.

Nanotechnology is one of the most significant modern concepts when economic units enter into production. It also provides products with aspects that are superior to those produced in a traditional costing manner. Due to the scientific progress and technological developments that have led to increased competition, companies need to apply concepts that assist introducing nanotechnology in the production processes and bring in the benefits. Therefore, the

implementation of nanotechnology impacts the production process in all its stages. It also influences the economic indices such as a decrease in the production costs and the employment rate.

Nanotechnology is one of the newest technologies that attract considerable investment by governments and private industry worldwide. This research focuses on nanotechnology and its impact in reducing costs, especially at Iraqi industrial enterprises.

Problem Statement

The problem of this research can be discussed as the problem that the traditional cost management systems are unable to cope with developments in the new environment. Furthermore, according to the increased production costs in general and the specific direct costs , in addition to the non-delivery of products of high quality, all of these could cause issues in confirming project costs and quality. Therefore, it is important to implement new technology to cope with developments in the new environment, such as nanotechnology.

Research Objectives

The main objective of this study is to realise the impact and the direct role of nanotechnology in reducing projects costs.

The aims of the study are as follows:

1. To configure out the concepts of nanotechnology and reducing costs.
2. To determine if there are any significant effects of Nanotechnology on reducing costs.

Research Questions

The main questions that this study seeks to answer are as follow:

1. What is the relationship between Nanotechnology and reducing costs?
2. What are the main concepts of Nanotechnology and reducing costs?
3. Is there a statistically significant effect of Nanotechnology on reducing costs?

General Background of Nanotechnology

Nanotechnology is a relatively recent developing trend that has gained a huge interest in recent scientific research. Nanotechnology allows the manipulation of individual molecules by utilising suitable methods and techniques resulting in another proportionally smaller set on the desired scale (Yadav, 2014). The term “nanotechnology” was created by the Japanese

scientist, (Taniguchi, ARAKAWA, & KOBAYASHI, 1974), but it was not utilised until 1981, when (Drexler, 1981) published his first research on the nanotechnology. Nowadays, the domain of nanotechnology is rapidly developed and obtaining heavy investments in the advanced countries and several developing countries in the world involving China and India (Chattopadhyay, 2009).

The term "Nano" originates from the Greek term "Nanos," which means dwarf or extremely small. The nanotechnology is defined by different means that are often exchangeable. The nanotechnology can be defined as the science including designing, installation, description, and application of materials that are described by at least one dimension in the nanometer range 1 nm = 10^{-9} m. In nanotechnology, two kinds of perspectives, bottom-up and top-down are utilised. In the "bottom-up" approach, Nano-scale materials are formed by the collapse of larger materials chemically or physically. While in the "top-down" approach, Nano-scale objects are gathered atom-by-atom or molecule-by-molecule. The nanotechnology contains the production and application of physical and chemical systems at scales ranging from individual molecules to submicron dimensions. It is also interesting to note the integration of the resulting nanostructures within a larger system (Poole Jr & Owens, 2003).

Use of Nano-Technology in Industry

There are several uses of nanotechnology in various industrial sectors. This section includes a summary of some uses of nanotechnology in industry:

Construction

Nanotechnology has arisen to make construction cheaper, faster, safer and more prosperous. Automation of nanotechnology in construction may enable the establishment of structures from advanced houses to huge skyscrapers rapidly, and at a very low price. Use of nanotechnology in construction includes the development of new definitions and understanding of the hydration of cement granular through using of nano-size ingredients like alumina and silica and other nano-particles. The industries also examine the tools of manufacturing nano-cement. Furthermore, cement with nano-size molecules may be manufactured and processed - it may open up a big number of opportunities in the domains of electronic applications, ceramics and high strength composites. In the nano-sized materials, the proportion of molecules on the surface increases relative to those inside and this causes novel characteristics. One of the applications of nanotechnology in construction is steel. In this regard, steel has been a largely available material and has a primary role in construction. Using nanotechnology in steel assists in enhancing the characteristics of steel. The fatigue causes the structural failure of steel because of cyclic loading like bridges or towers. The

present steel designs are dependent on decreasing in the service life, organised inspection regimes and allowable stress. This has an important influence on the life-cycle costs of structures and borders the efficiency use of sources. Extra copper of nano-molecules decreases the surface unevenness of steel, which then limits the number of stress risers and hence fatigue cracking. Advancements in this technology utilising nano-particles would cause increased safety, fewer requirements for organised inspection regimes and more effective materials free from fatigue issues for construction (Iraj Ahmadi, 2014).

Aerospace

Lighter and more powerful materials can be of immense value when utilised by aircraft industries, leading to an increased performance. Spacecraft may also find this useful when weight is a primary factor. Nanotechnology would assist with decreasing the size of equipment by reducing fuelconsumption needed to render the aircraft airborne. Hang gliders can be capable of halving their weight while raising their strength and toughness during using nanotechnology materials. Nanotechnology is decreasing the mass of super capacitors that may increasingly be utilised to give power to assisting electrical motors for launching hang gliders off flatland to thermal-chasing altitudes (Iraj Ahmadi, 2014).

Agriculture

Applications of nanotechnology have the potential to replace the whole agriculture sector and food manufacture series from production to protection, waste treatment, packaging, processing, and transportation. Nano science definitions and nanotechnology applications have the potential to redesign the production cycle, rebuild the processing and conservation processes and redefine the food habits of the people. Moving agriculture within greenhouses may recover most of the water utilised by dehumidifying the exhaust air and treating and re-utiliing runoff. Furthermore, greenhouse agriculture requires less labour and far less land area than open domain agriculture, and offers greater separation from weather conditions involving seasonal variations and droughts. Greenhouses, with or without thermal insulation, would be extremely low cost to build by nanotechnology. A wide-scale move to greenhouse agriculture would decrease water utilisation, land utilisation, and weather-correlated food shortages (Iraj Ahmadi, 2014).

Environment

Nanotechnology, if utilised correctly, is able to decelerate environmental degradation. The elements that utilise environmental degradation involves vehicular emissions, greenhouse gases, de-forestation, and excessive water utilisation. Since nanotechnology may produce many various materials by utilising simple abundantly available material like carbon and hydrogen, it has the potential to significantly decrease mining operations. This may cause

soil conservation, and energy conservation. Manufacturing techniques that pollute may also be changed by nanotechnology products, progressively. Generally, low cost manufacturing enables enhancement to be deployed at very low costs. Enhancements in storage of solar energy with nanotechnology are probably to decrease CO^2 emissions, ash, soot, and hydrocarbon (Iraj Ahmadi, 2014).

Enhanced Medicine

Molecular nanotechnology may influence the practice of medicine in several methods. Medicine is highly complicated, therefore it may take some time for the full interests to be achieved, but several interests may immediately occur completely . The equipment of medicine may become low cost and more powerful. Research and diagnosis may be far more effective and enable fast responses to modern diseases like engineered diseases. Small, low cost, many sensors, computers, and other implantable devices can enable continuous health controlling and semi-automated treatment. Many new types of treatment will become possible. As the practice of medicine becomes cheaper and less uncertain, it may become available to more people (Iraj Ahmadi, 2014).

Economic Significance of Nanotechnology

Nanotechnology is leading a new industrial technology that is reshaping the economies of the various countries of the globe, such as bringing labor markets and developing international commerce, the correlations of the countries of the globe, and undoubtedly the various social and economic changes. Nanotechnology also is based on restructuring the atomic structure and decreases atoms to bring new materials, which called nano-material that will bring a clear influence on the countries of the globe, especially the countries, which still rely on a few essential commodities and labour revenues and export revenues. The application of nanotechnology is related to the manufacturing of goods that are taken into account as the core of the concern of nanotechnology - related to patents that will cause the exchange of industrial products with natural products, which will influence the economies of several countries of the globe and the export of these commodities and materials. Nanotechnology is efficient in the development of the economies of the globe when it is adapted to the community, local and organisational context if it was selected and designed through the development of sound strategies to integrate the absorption, acquisition and diffusion of knowledge, despite the various costs of entering the globe of nanotechnology from one country to another (Benelmekki, 2015).

The Concept of Cost Reduction

Cost reduction is described as achieving the lowest level of costs compared to the previous level, like the utilisation of instruments and equipment that perform the same processes at

lower costs or maximise production amounts with the same value of costs, access to materials and products at lower costs than before, and making a change and modifying work policies, practices and to decrease waste of time or decrease overtime costs (Arnold, 2008). This process is the highest priority for companies due to its effect on the revenues and profits of the company and to ensure its growth and continuity. The purpose of this process is to follow a series of policies and practices derived from the company's reality, environment and nature. Especially those in the accountability position (Goetsch & Davis, 2006). The strategies and methods that decrease the cost, which is utilised by the company difference in cost, the most protruding ones are speed in delivery, specific wasting of time, effort and money, stability of business, activities and functions, implement the work properly and free of errors and deviations, efficiency and effectiveness in work and strength and robustness of organisation and accuracy, and use the equipment with the highest tolerances, quality, ease of utilisation, repair and maintenance (Erekat, 2015).

The cost reduction process is subjected to two inputs: the traditional approach and the modern approach. The traditional approach is a standard control system purposed at identifying the causes of standard deviations (Rahamna, 2011). While the modern approach, which came in response to the raising awareness of the clients of the products offered by companies, and the desire to offer their requirements and meet their needs and satisfy their desires to get products of high quality and suitable qualities and low cost at the same time, where companies resorted to adopting a different of methods that will check this response. This approach is seen as a method of reducing costs as one of the methods that cause lower costs of products without compromising their essential qualities to reach client satisfaction and to meet their demands (Horngren, 2016), which purposes to decrease the prices of labour activities and costs products without any change in their quality, properties and functions (Rajakhan, 2002). To achieve this purpose, companies have utilised many systems; most popular are target cost and activity-based costs.

Target Cost

The cost system is taken into account as a cost-management approach designed mainly to decrease product costs through the pre-production phase, without compromising its quality and maintaining its functional potential. During this procedure data and information that enables the decision to begin or stop the production process are being produced. The cost-goal role is to decrease costs by refuting the cost-to-molecules target and abandoning unnecessary parts (Ali, 2019).

Activity-Based Costs

The basic approach to activity-based costing consists of unique features compared to traditional costing methods which also make the implementation steps different than the existing ones. The main difference with the traditional approach is that activity-based costing is the main focus of activities when traditional costing approaches mainly focus on the product itself. The shift of focus from products to activities has changed the understanding of the costs as well. With an activity-based view, it is possible to assign indirect costs on business activities and distribute them on products by using an appropriate activity driver which increases the accuracy of product cost information drastically. Furthermore, cost objects consume activities, which consume sources; hence source expenses are traced to activities by source cost drivers, and activities costs then are traced to cost objects during activity cost drivers. A cost object might be anything for a cost/revenue assessment. For example, a product is a classical cost object. Activities are anything you do in an organisation, for example, a manufacturing company, in which assembling, handling, welding, etc., are all activities. A source is something you need in order to perform activities such as labour, electricity, buildings, machines, etc (Tamur, 2013).

Nanotechnology and Its Relationship to Reducing Costs

The integration of new nano-materials in production as a result of the employ of cost systems leads to enhanced technological performance in production due to the introduction of these new nano materials, requiring monitored conditions and correct controls to be established and conserved in industrial processes. Using the new nano-materials in production will contribute to having enhanced control and to reaping interests gained from the utilisation of nano-materials in industrial processes, to increasing the durability of these industrial processes, and enhancing and assessing the production line performance in concepts of productivity and cost effectiveness; to enhance the functionality and performance of product installation inside industrial companies (Ali, 2019).

Methodology

The primary purpose of the research is to determine the relationship between nanotechnology and reducing costs. In general, there are many tools to collect data like questionnaire surveys, interviews and others. These tools depend on two approaches, include quantitative and qualitative approaches and kinds of data.

In this research, the data was collected through a questionnaire that was distributed to randomly selected mangers in several industrial companies in Baghdad. Furthermore, the questionnaire was divided into three sections: section one about general information and demographic data like age, scientific qualification and years of experience. Section two

included some items that related to nanotechnology to determine relative importance; while, section three contained some items that related to reducing costs to determine relative importance. Furthermore, the Likert scale was used to measure the opinions of the managers who answered the questionnaire. The Likert scale includes 5 points (1 = not at all important, 2 = low important, 3 = neutral, 4 = important, 5 = very important).

Results

Reliability

The reliability for the questionnaire was tested through Cronbach's Alpha. Its value reached to 0.811 which reflects an acceptable value.

Demographic of Participants

To determine the properties of samples, the frequency and percentages of the demographic variables were determined for the sample of this research. The total number of the participants in the questionnaire was 70. Table (1) shows that the age group (25-30) is the lowest category (18.6% of participants), while the age group (35-40) is the highest category (41.4 of participants), and the age group (25-30) is 40% of participants.

Table 1: Distribution of sample participants by age variable

Variable	Categories	Frequency	Percent
Age	25-30	13	18.6
	30-35	28	40.0
	35-40	29	41.4
	Total	70	100.0

Table (2) shows the participants' experience, the majority 40% of participants have 5 to 10 years, about 35.7% of participants have 10 to 15 years, about 12.9% of participants have more than 15 years, and 11.4% of participants have less than 5 years.

Table 2: Distribution of sample participants by years of experience variable

Variable	Categories	Frequency	Percent
Years of Experience	< 5 years	8	11.4
	5-10 years	28	40.0
	10-15 years	25	35.7
	>15 years	9	12.9
	Total	70	100.0

Table (3) shows the scientific qualifications of participants. It is clear that the majority of participants are holders of the Bachelor's degree, accounting for 60% of sample.

Table 3: Distribution of sample participants by Scientific Qualification variable

Variable	Categories	Frequency	Percent
Scientific Qualification	BA	42	60.0
	Post Graduate	28	40.0
	Total	70	100.0

Table (4) clarifies the career status of participants, and reflects that about 35.7% of participants are executive managers, while about 32.9% of participants are general managers and about 31.4% of participants are heads of departments.

Table 4: Distribution of sample participants by career status variable

Variable	Categories	Frequency	Percent
Career Status	Head of the department	22	31.4
	General Manager	23	32.9
	Executive Manger	25	35.7
	Total	70	100.0

Table (5) demonstrates the specialisations of participants, as the largest percentage, reaching (40%) of the sample is for an accountants specialisation.

Table 5: Distribution of sample participants by specialisation variable

Variable	Categories	Frequency	Percent
Specialisation	Accounting	28	40.0
	Business Administration	23	32.9
	Economies	19	27.1
	Total	70	100.0

Analysis of the Responses of the Sample Participants

In this research, the relative importance is determined according to the five-measure of the Likert-scale for each item; where the number of levels includes low, medium, high. The low level indicates when the arithmetic mean ranges between 1 to 2.5, the medium level when the arithmetic mean ranges between 2.5 to 3.5 and the high level when the arithmetic mean is more than 3.5 and reaches 5.

First: Nanotechnology, Which Includes Two Paragraphs: Forming Supporting Companies and Corporate Re-engineering.

Table (6) shows the mean, standard deviations and the relative importance of forming supporting companies, as the mean for items range from 3.7714 to 4.0429 and standard deviations for items range from .87062 to 1.27737. Furthermore, the company's management comprises of a team of scientists who are given broad powers in strategy administration, transforming new nanotechnologies inside developing projects is considered as the most important item in this field and it is ranked first.

Table 6: Mean, standard deviations and the relative importance of forming supporting companies items

No.	Item	N	Mean	Standard Deviation	Relative Importance	Rank
1	The company has strategies and plans purposed at establishing some of research centres for nanotechnology in Iraq.	70	3.9000	.87062	High	3
2	The company has common interests with other companies to adopt the ideas of manufacturing research and development correlated processes in the domain of nanotechnology and technology.	70	3.7714	.96566	High	6
3	The company collaborates with incubator companies, industrial groups and researchcentres to transfer nanotechnology.	70	3.8714	1.17857	High	4
4	The company seeks to create partnerships with multiple organisations that deal with innovation and assist start-up companies to transform research findings within nanotechnologies.	70	3.9857	.99990	High	2

5	The company has a website that enables companies and institutions, universities which desire using nanotechnology	70	3.8143	1.27737	High	5
6	The company's management comprises of a team of scientists who are given broad powers in strategy administration, transforming new nanotechnologies inside developing projects	70	4.0429	1.17258	High	1

Table (7) shows the mean, standard deviations and the relative importance of the cooperate re-engineering. The mean for items range from 3.5429 to 4.1571 and standard deviations for items range from .92683to 1.16399. Furthermore, the company is replacing new concepts in nanotechnology and training its workers to reach global competitiveness, which is considered as the most important item in this field and it is ranked first.

Table 7: Mean, standard deviations and the relative importance of the corporate Re-engineering items

No.	Item	N	Mean	Standard Deviation	Relative Importance	Rank
1	The company puts its long-term purposes and strategies precisely and clearly	70	3.5429	1.16328	High	5
2	The company has a new vision purposed at radically replacing its activities and business	70	4.0000	1.04950	High	3
3	The company sights nanotechnology as a primary hub	70	3.8143	1.15837	High	4
4	The company designs modern management processes to match with nanotechnology directions	70	4.0857	1.16399	High	2
5	The company is replacing new concepts in nanotechnology and training its workers to reach global competitiveness	70	4.1571	.92683	High	1

Table (8) clarifies that the general measurement of corporate reengineering is high, and the general mean is 3.92. Furthermore, the general measurement of forming supporting companies is high, and the general mean is 3.8976. The table also shows that the corporate re-engineering is more important than forming supporting companies. Finally, the level of nanotechnology in term of relative importance is high, with the mean at 3.9088 and standard deviation at 1.08492.

Table 8: Mean, standard deviations and the relative importance of Nanotechnology

No.	Item	N	Mean	Standard Deviation	Relative Importance	Rank
1	Forming supporting companies	70	3.8976	1.07745	High	2
2	Corporate re-engineering	70	3.92	1.09239	High	1
3	Nanotechnology	70	3.9088	1.08492	High	

Second: Reducing costs

Table (9) shows that the mean, standard deviations and the relative importance of reducing costs, the mean for items range from 3.44 to 4.17 and standard deviations for items range from 1.07 to 1.222. Furthermore, the company's making management adopts all ways and strategies to decrease the costs of its activities and operations is considered as the most important item in this field and it is ranked first. Finally, the level of reducing costs in term of relative importance is high, the mean is 4.0338and standard deviation is 1.1456.

Table 9: Mean, standard deviations and the relative importance of reducing costs items

No.	Item	N	Mean	Standard Deviation	Relative Importance	Rank
1	The company's management adopts all ways and strategies to decrease the costs of its activities and operations	70	4.1714	1.07638	High	1
2	The company's cost system is effective in concepts of real-time costing of products	70	4.1429	1.19523	High	2
3	The company's costing system is capable of measuring the actual performance of the components of the product and the production process	70	4.0571	1.22635	High	6

4	The company's management concerns on reducing its costs while maintaining the quality of its products	70	4.0714	1.12058	High	5
5	The company's administration takes all efficient ways and means to limit the production of defective and contravening products	70	4.0714	1.19566	High	4
6	The company's management adopts all ways and strategies to enhance value-added processes and to decrease the volume of non-value-added processes	70	3.9714	1.10298	High	7
7	The administration of the company considered the sights and recommendations of experts focused on the application of reducing costs.	70	4.1429	1.18304	High	2
8	The company contracts programs and training workshops for different administrative levels to increase the level of productivity and decrease errors and deviations in the job to achieve manufacturing leadership	70	4.0571	1.07522	High	6
9	The company's management conducts a review of the prices of activities, products and operations	70	4.1429	1.10710	High	2
10	The company's administration concerns on evaluating and controlling the performance of the projected plans and comparing their actual costs with what is planned for the pilot	70	4.1000	1.13124	High	3
11	Reducing costs is one of the company's strategic purposes	70	3.4429	1.18732	Medium	8
	General Measurement	70	4.0338	1.1456		

Nanotechnology and its Relationship to Reducing Costs

To determine the relationship between nanotechnology and reducing costs as well as to determine if there are any significant effects of nanotechnology on reducing costs, the regression analysis test was adopted. Table (10) shows that r is equal 0.595 and this value is more than 0.5, which means there is a relationship between nanotechnology and reducing costs. Nanotechnology is effective in reducing costs, but it is not as important as the p-value is higher than 0.05.

Table 10: Regression analysis to determine the effect of nanotechnology on reducing costs

Summary Form		ANOVA		Dependent Variable
r	R square	F	Sig.	Reducing Costs
0.595	0.354	4.93	0.053	

Conclusion

The basic conclusions that this study resulted with can be summarised as follows;

1. The general measurement of corporate re-engineering is high, and the general mean is 3.92.
2. The general measurement of forming supporting companies is high, and the general mean is 3.8976.
3. The corporate re-engineering is more important than forming supporting companies.
4. The level of nanotechnology in term of relative importance is high with the mean at 3.9088 and standard deviation is 1.08492.
5. The level of reducing costs in terms of relative importance is high with the mean at 4.0338 and standard deviation is 1.1456.

Recommendation

This study recommended the following;

1. Industrial companies should adopt all strategies and methods that could aid in decreasing the costs of their activities and operations.
2. Industrial companies should use the new concept of nanotechnology and training its workers to reach global competitiveness.
3. Researchers should conduct several further relevant studies according to the importance of this study topic in recent industrial markets.

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