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The Cost of Technology Transfer in Construction Companies (In Iraq)

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ABSTRACT

The construction sector is considered an important and influential pivot in the national economy of any country. Nations are working to develop this sector, receiving modern and developed techniques. So, this sector can be a carrier or a receiver of modern technologies. The cost of technology transfer between the international companies that sponsor this sector is a matter of great importance, especially since different factors affect the need for this advanced technology. The cost of technology transfer in construction is related to multiple factors presented by Knowledge, equipment, plant, hardware and software. The lack of distinguishing and evaluating the direct and indirect costs in the construction sector during technology transfer may lead to infractions in the company's budget. This manuscript aims to investigate the direct and indirect costs of transferring technology and the major factors constrained by this process. This work adopted a theoretical study and investigated the opinions of experts and engineers (by questionnaire) working in different construction sites. This Manuscript showed that the largest weight of the cost for both modern equipment and counsulant/designers is a direct cost and indirect cost, respectively, for transferring technology in the construction sector.

Keywords: Construction, Technology Transfer, Direct Cost, Indirect Cost.

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تكلفة نقل التكنولوجيا في الشركات الإنشائية (في العراق)

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قسم هندسة الموارد المائية، كلية الهندسة، بغداد، العراق

الخلاصة

يعد قطاع البناء أحد المحاور المهمة والمؤثرة في الاقتصاد الوطني لأي دولة. وتعمل الدول على تطوير هذا القطاع وتحسينه من خلال قبول وأستقبال التقنيات الحديثة والمتطورة. لذا؛ ويمكن لهذا القطاع أن يكون ناقلاً أو مستقبلاً للتقنيات الحديثة حسب الحاجة الفعلية لذلك. وتشكل تكلفة نقل التكنولوجيا بين الشركات العالمية الراعية لهذا القطاع أهمية كبيرة، خاصة وأن هناك عوامل مختلفة تؤثر على الحاجة إلى هذه التكنولوجيا المتقدمة. ترتبط تكلفة نقل التكنولوجيا في البناء بعوامل متعددة تتمثل في المعرفة والمعدات والمصانع والأجهزة والبرمجيات. إن عدم التمييز والتقييم بين التكاليف المباشرة وغير المباشرة في قطاع البناء أثناء نقل التكنولوجيا قد يؤدي إلى الإخلال بموازنة الشركة. تهدف هذه المخطوطة إلى دراسة التكاليف المباشرة وغير المباشرة في نقل التكنولوجيا، والعوامل الرئيسية التي تعيق هذه العملية. اعتمدت هذه المخطوطة على الدراسات النظرية واستقصاء آراء الخبراء والمهندسين (عن طريق الاستبيان) الذين يعملون في مواقع البناء المختلفة. أظهرت هذه المخطوطة أن الوزن الأكبر للتكلفة لكل من المعدات الحديثة والمستشارين/المصممين هو التكلفة المباشرة، والتكلفة غير المباشرة على التوالي لنقل التكنولوجيا في قطاع البناء.

الكلمات المفتاحية: الأنشاء، نقل التكنولوجيا، التكلفة المباشرة، التكلفة غير المباشرة.

1. INTRODUCTION

The total cost of construction in normal circumstances is expected to be the sum of the following expenses: Materials, Labor, Site Overheads, Equipment/Plant, Head office Cost, and Profit, but in many parts of the world, particularly in Nigeria, there are other costs to be allowed for **(Eshofonie, 2008).** The success in time performance depends on the choice of construction method management of construction resources **(Meeampol and Ogunlan, 2006; Al-Ageeli and Al-Zobaee, 2016)** have considered that one of the reasons for the failure of projects in Iraq is the increase in cost, in addition to the presence of several factors that contribute to the project's failure, such as the poor financial efficiency of the employer, the contractor's low budget, and the lack of good resources, and among these resources is the presence of inferior equipment. All of these factors contribute to projects faltering.

Cost determination is a fundamental process for every project. It can be defined as calculating the quantities of materials, labor and equipment expected to be used to complete the construction project within specific specifications and calculating the project cost based on that **(Altaie and Saco, 2009).** It's important to identify all factors that will contribute to the project cost, examine the factors' importance and develop a cost-predictive model **(Ganiyu and Zubairu, 2010)**

The selection and use of equipment in any project should be an integral part of the overall project plan. The modernity and number of equipment required on any project depends on the nature and size of the project and greatly affects the overall construction cost**. (Memon, Rahman et al., 2011)**

Although the construction industry appears to be a traditional industry with repetitive aspects, the implementation method is almost the same in one country. For various types of projects **(Nyström, 2019),** the practical experience has proven the need to update the techniques adopted in its implementation, and that is the desire of the parties involved in obtaining the required quality, which is implemented with the latest, easiest and simplest methods, obtaining the final product in the fastest time and at the lowest cost. Developing countries have engaged in international technology transfer (ITT) to narrow the technology gaps between them and developed countries. These efforts take many forms. Projects are widely used as short-term means of transferring technology across borders and between companies. International development projects have been used for some time. Long by development agencies and multilateral and bilateral agencies to provide infrastructure needs and transfer technology to developing countries. Therefore, contracts are usually awarded to foreign companies on the condition that they transfer new technology to local companies **(Oti-Sarpong and Leiringer, 2021).**

It is an interesting finding, considering that Technology Transfer in any industry is a strategic and managerial decision to improve competitive advantage and, thus, profits, **(Eden et al., 1997; Love and Irani, 2001).**

2. BUDGET OF PROJECT

The budget estimates can be defined by the project system and structures, flowcharts, diagrams, equipment specifications, major equipment and material price information from vendors, special site considerations, labor availability and management, current material and labor escalation trends, and regulatory requirements. **(Potts and Ankrah, 2014).**

The Actual Cost (AC), also known as the Actual Cost of Work Performed (ACWP), is the actual cost incurred to accomplish the activity in a specific time frame. Everything budgeted in Planned Value (PV) and Earned Value (EV) should match the actual cost (e.g., all labor, materials, construction equipment, and indirect costs) **(Potts and Ankrah 2008).** Cost needs to be managed; this involves managing the consumption of all resources, including people and material, not just money. **(Turner, 2009)** The estimating cost process involves estimating the costs of each activity in the project **(Chou, 2011).** Costs include human and physical resources **(FME, 2014).**

3. DIRECT AND INDIRECT COSTS

The traditional performance metrics regarding time, cost, and quality are related to project management success. **(Radujković and Sjekavica, 2017).** Technology in construction is defined as the combination of materials and equipment resources, construction-applied resources, construction processes, and project requirements and constraints. Materials and equipment, construction-applied resources (like information and skills), and construction equipment are all examples of construction resources.

Some expenses are easily recognized in relation to a specific item or product, such as labor or material costs; these prices are referred to as direct costs. **(Warsame, 2006)**

The direct costs can be consistently linked to work on a specific project (labor, materials, and other direct expenditures). **(the Adaptation, 2006)**
The sum of the direct costs represents the total cost of any project. These are represented by the costs of manpower, materials, equipment...etc. That has an important role in production, while the indirect costs are generally represented by the expenses of supervision, administration, and consulting **(Azeez and AlSaffar 2014).**
The tangible expenses related to machinery, suppliers, and subcontractors. The true cost of the equipment, subcontracts, etc. are some examples, are also known as direct costs.
While the indirect costs are connected to additional necessities required to finish the work, these fees may include design, pre-operating costs, construction and construction management, general expenses and conditions, and permissions **(Timothy Blackburn, 2020).**
A project's indirect and maintenance expenses and its direct costs of operations will be impacted by the use of alternative construction materials **(Kazaz et al., 2016).** Regarding other equipment costs, such as on-site transportation, dismantling, installation and off-site transportation, it should separate these costs from operating expenses and add them to the project's indirect costs **(Al-Dairi, 2011).** The other classification of direct and indirect costs is as follows **(Husain et al., 2018).**
Direct costs: These are the costs that can be charged to the specific activities of the project and include (urban land costs, road construction costs, technical services costs, and housing unit construction costs)
Indirect costs: These cannot be attributed to the project's specific activities (professional costs - consulting fees, cost planning design, insurance, design modifications, and engineering management costs).

4. COST OF TRANSFERRING EQUIPMENT AND PLANT

Micro, small, and medium-sized enterprises (SMEs) require a constant flow of new technology. Still, they cannot develop their technologies or knowledge due to their size and numerous resource constraints, including a lack of skilled labor. As a result, they turn to technology transfer (TT) as an economic strategy **(Khabiri et al., 2012).** As a result, consideration must be given to the availability of skilled employees needed for project execution, which cannot be provided internally regarding technology and know-how needs **(Sunke, 2008).**
Other challenges that may face cost analysts are the impact of technological changes on the rate of changing or updating building components and equipment and making long-term cost forecasts on minimal information **(Boussabaine, 2013).**

5. PIVOTS AND CHARACTERISTICS FOR TECHNOLOGY TRANSFER IN CONSTRUCTION

The components of Technology Transfer include three types: the hardware represented by equipment, plant, capital goods, product design, etc. The other two components are know-how and know-why **(Rezouki and Muhsin 2015).**
To understand Technology Transfer in construction, it should study the major barriers preventing construction organizations from investing in information technology, including uncertainty about defining and measuring the benefits associated with the construction

applications. The difficulties in determining the benefits associated with improving the availability of information and decision-making prevent the effective analysis of IT costs/benefits. **(FLANAGAN and MARSH, 2000)**

a- Technology transfer is used in three different contexts. They are the building, consulting, and related industries. **(Bakar, 2004)**

b- Many developing countries depend on developed countries regarding materials, technology, plants, equipment, and human skills**. (Mselle, 2014)**

c- Decisions regarding the purchase of technology **(Strom, 2017)**

i. What resources are at your disposal to support the purchase, adoption, and upkeep of technology?

ii. In general, how does your agency pick what technology to acquire? Who makes the decisions in that process?

iii. Does your organization have any employees or a team in charge of purchasing and/or implementing technology?

6. DATA COLLECTION AND INFORMATION (DISCUSSION OF RESULTS)

To figure out the degree and the impact of the cost on the technology transfer, this research aims to study this influence on the transferred technology and the factors that affected this process. A questionnaire was prepared and distributed to personnel with good skills and knowledge who were transferring technology in one way or another.

A total of (105) questionnaires were distributed, and received (97) questionnaires and excluded (16) of them related to a lack of responses and seemed not satisfactory. So, the vailed questionnaires were (81). The information and Data were collected from personnel and experts with multiple years of experience. **Fig. 1** below shows the percentages of cumulative years of experience for each respondent. Information was collected about the tasks and responsibilities entrusted to any respondents to know their jobs. The assessment of the cost of technology transfer by specialists or experts working in the construction sector can be related to the nature of work that each of them performs, and it can be different and varied for each job. The total cost of technology transfer may be combined for each stage of the construction project implementation.

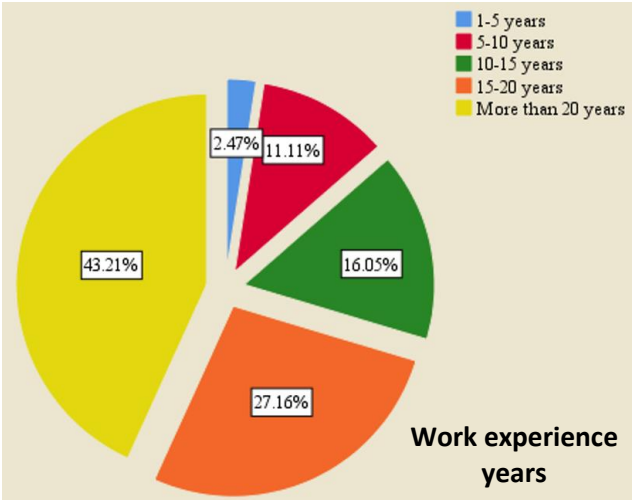

Figure 1. Numbers of experiences years for the respondents

Table 1 shows the tasks, duties, and functions the respondents perform in the organization to which they belong. The job that the person performs and can assign the technology transfer process as a technical, administrative or financial evaluation.

Table 1. The Field of Work Experience

		Frequency	Percent	Valid %	Cumulative %
Valid	Implementation of projects	2	2.5	2.5	2.5
	Quality - Assessing the Quality of Work Execution	3	3.7	3.7	6.2
	Checking - Tests and Follow-up	4	4.9	4.9	11.1
	Preparing contracting documents and making contracts	6	7.4	7.4	18.5
	Estimation and Specifications - in Projects	7	8.6	8.6	27.2
	Supervising the Implementation of Projects	13	16.0	16.0	43.2
	Supervision and Implementation of Projects	20	24.7	24.7	67.9
	Providing Consultants and Designs	26	32.1	32.1	100.0
	Total	81	100.0	100.0	

Funding plays a significant role in supporting the transfer of modern technology, and it has ratios ranging (76) between a very strong effect role and an influential role. This refers to no modern technology without cost, while only 5 responses trend to the medium degree of effect. **Fig. 2** reflects these results.

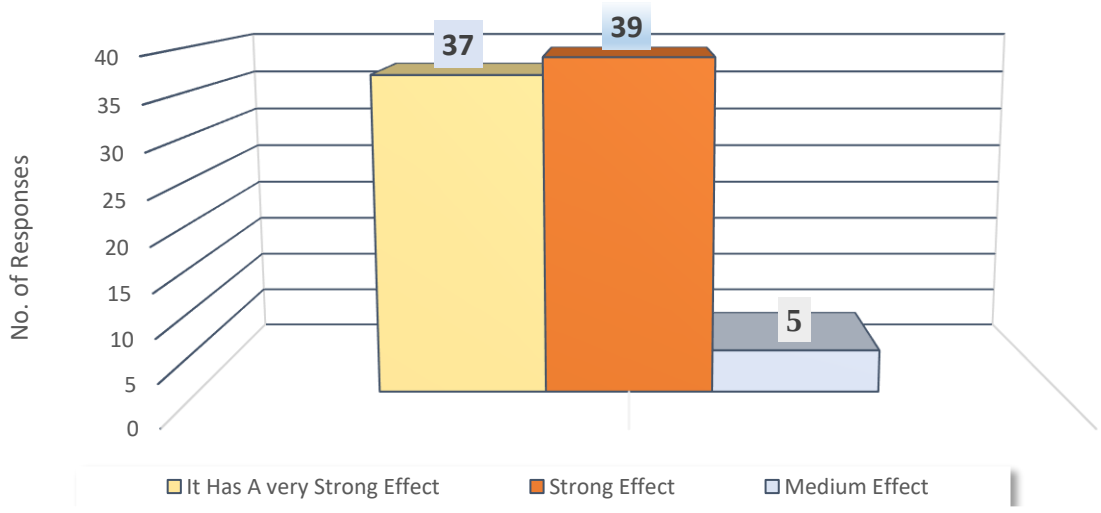

Figure 2. Impact degree of availability funds on the acquisition of modern technology transfer

Table 2 shows the level of support for the transfer of modern technology to Iraq. 39.50 of the respondents indicated that the transfer of modern technology has not yet taken place. The same percentage of respondents confirmed that the financial allocation was behind this failure and was not at the required level. This percentage demonstrates the importance of financial allocations in supporting the transfer of modern technology. There are other reasons behind the lacking or weakness for transferring modern technology transfer.

Table 2. Level of Supporting the Technology Transfer

Description of supporting the transferring the technology	Responses %
Technology has not been effectively transferred to the construction sector	39.50
Financial allocations for importing modern technologies are insufficient / or there is nothing in the financial disciplines that is directed toward importing technology	39.50
Imported technology needs abnormal capabilities and is not available to carry out the transfer of the technology	8.64
The lack of clarity in the classification between the acquisition of modern technology and the technology available in the construction market	6.17
The approved techniques are advanced and modern, and there is no need to import foreign technologies	6.17

6.1 Effect of Components of Direct Cost in the Construction Sector on Technology Transfer

The questionnaire presented some types of these costs to verify their impact on the total cost of technology transfer. The responses in **Table 3** below showed that the cost of preparing the site on which the project will be built in all its details got the highest percentage, as the cost of starting the project and obtaining the appropriate site. Preparing the rest of the logistical support requirements for establishing the project is important through this stage.

Table 3. Types of Direct Cost Related to Technology Transfer

No.	Description of Direct Cost Types	Ratio %
1	Cost of constructing the physical structure/site of the project	45.67
2	The cost of raw materials and/or manufactured materials included in the project activities' completion.	24.69
3	The cost of the machinery and equipment used to complete the project activity (s)	14.81
4	The cost of manpower/operators and craftsmen in the project	4.93
5	The cost of the work and wages of periodic/sudden maintenance (repairs) for the breakdown and stopping of machines	4.93
6	The cost of the works supporting the completion of the project activity(s)	2.46
7	The cost of periodic/sudden maintenance (spare parts) for the breakdown and downtime of project machines	2.46

The beginning of the project, often gives a futuristic picture of the success of the project. The maintenance cost has got a low percentage, because the construction project may be needs this process few years after its completion. The need for foreign expertise will be necessary at the beginning of the implemented project.

6.2 The Indirect Cost

Indirect costs have a significant role in the overall costs of technology transfer. **Table 4.** shows the percentages of indirect cost, and the research indicated (10) types of indirect cost during the implementation of the project, as it was found that the salaries and wages of consultants and designers were more than the other types of indirect costs .
The second indirect cost category is represented by the cost of Wages/cost of transporting modern machinery/equipment and technologies from the country of origin to the desired location.
The other types of indirect costs are listed in the same table and sorted in descending order according to the percentage ratios by respondents.

Table 4. Types of indirect cost affecting technology transfer

No.	Description of Direct Cost Types	Ratio %
1	Wages/salaries of consultants - designers	34.56
2	Wages/cost of transporting modern machinery/equipment and technologies from the country of origin to the desired location	13.58
3	Logistic support expenses (communication - fuel - electricity - water)	11.11
4	Fees, taxes and interest for the works carried out	8.64
5	Wages/salaries of administrators (administration, accounting and legal)	7.4
6	Logistics support expenses (office equipment - furniture)	7.4
7	Other administrative services expenses	6.17
8	Fees/costs of negotiation and contracting between the parties to the transfer of technology	4.9
9	Fees/cost of technology transfer Delegating/travelling experts and getting acquainted with the techniques and modern methods adopted in carrying out the works	3.7
10	Fees/cost of technology transfer Delegating/travelling experts and getting acquainted with the techniques and modern methods adopted in carrying out the works	2.46
11	Average	7.481481
12	Standard Deviation	7.994649
13	T-TEST	2.230659

6.3 The Accuracy of the Direct / Indirect Cost Estimation Process for the Project Activity

To check the accuracy level for calculating the direct/indirect cost amount for each project activity. **Fig. 3** indicates that the level of very accurate with a ratio equivalent to 27.16 %,

and the level of accuracy is 55.55%; these rates refer to the importance of distinguishing between the direct and indirect costs and the necessity for calculating them. The above ratios although explain the importance of the accuracy, but the level of high accuracy is less than of the required range, and it should be has high percentage ratio.

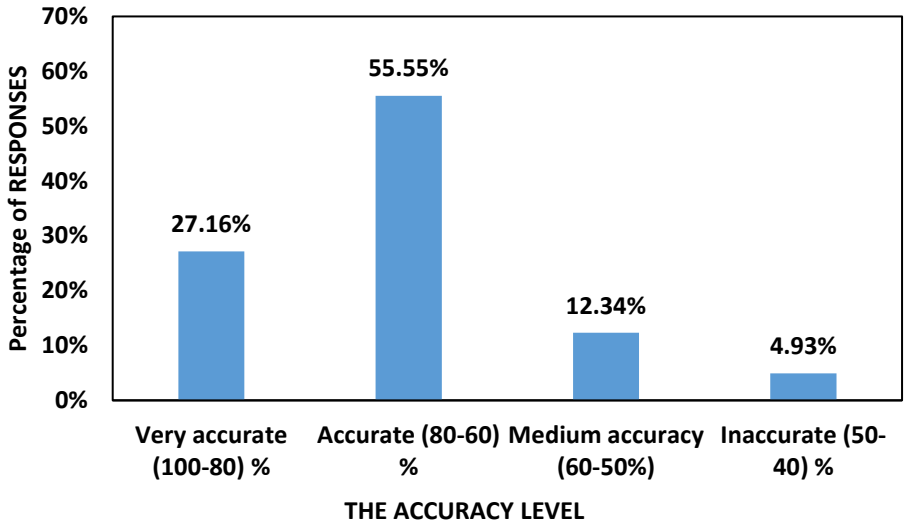

Figure 3. The level of accuracy for calculations of the direct and indirect cost

6.4 The Percentage Degree or Weight of the Direct Cost in Technology Transfer

This question focuses on the weight of the direct cost and the percentage ratio for this cost. **Fig. 4** shows that 51 of 81 respondents describe the weight of direct cost as more than 70% of technology transfer cost.

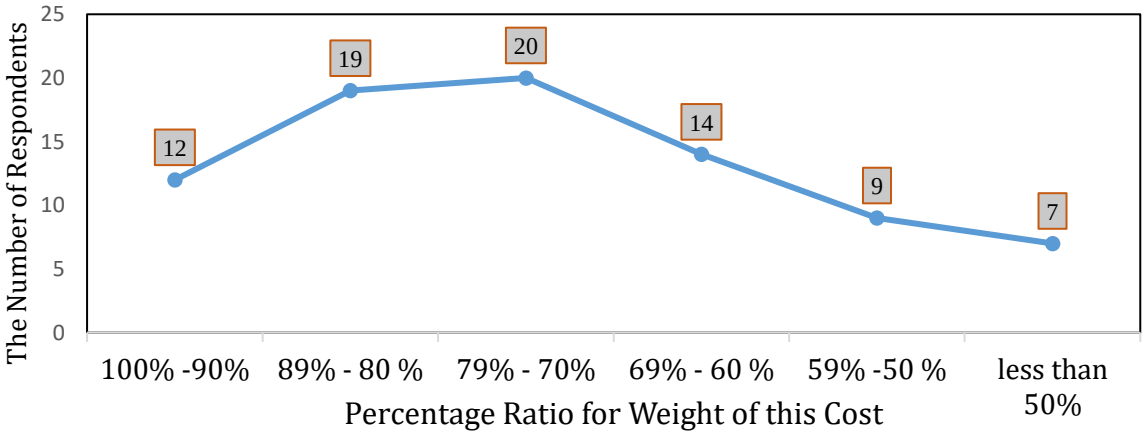

Figure 4. The percentage ratio of weights of the direct cost

6.5 The Percentage Degree or Weight of the Indirect Cost in Technology Transfer

Although the indirect cost has a significant weight and is important for technology transfer, the respondents, as shown in **Fig. 5** described that the indirect cost has a weight less than the direct cost

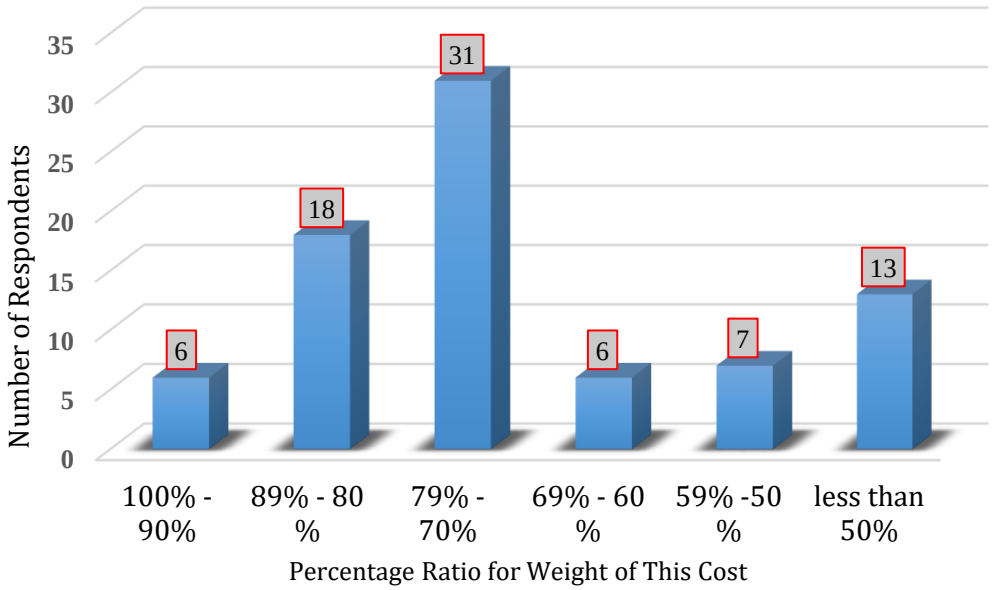

Figure 5. The Percentage Ratio of Weights of the Indirect Cost

6.6 The Technology Transfer

Fig. 6 shows that respondents have agreed with a high percentage (93%), that investment projects are an important means for transferring expertise and modern technology between multinational companies.

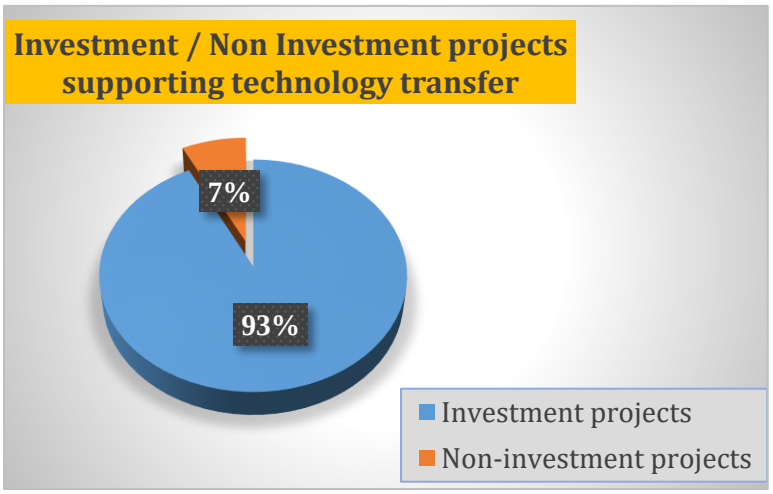

Figure 6. The Nature of projects in which technology transfer can occur

The cost of the investment projects may be more than others, but technical and economic benefits will appear after the completion of these projects.

6.7 The Expected Costs (Direct Costs)

The expected costs that appear in the technology transfer are many. **Table 5** shows that the most important direct cost included in the technology transfer process is the cost of the machinery and equipment, which has a percentage rate of 42%. This machinery will be used in the implementation of the project.

Table 5. Types of direct cost appeared during the technology transferring

Types of direct cost	Responses %
The cost of the (imported) machinery and equipment that will be used in the implementation	41.97
The high cost of raw materials and manufactured materials (imported)	23.45
The cost of the implementation technology, which may not be known to the implementers or technicians in the country importing the technology	18.51
The cost of the manpower that will carry out the implementation process may be related to those imported materials, devices and machines	9.87
The cost of transporting those materials and manufactured materials from the origin to the importing country	6.17

6.8 The Proposals and Procedures for Supporting the Technology Transfer

To encourage the technology transfer and development process, the responses, according to percentages, are shown in **Table 6.**

Table 6. Procedures for Supporting the Technology Transfer

The suggested Procedures for supporting the technology transfer	Responses %
Conducting economic and technical studies to compare the types of modern technology available for the project to be established	28.39
Establishing investment projects, especially (industrial or service), whose cost can be recovered within a not-long time	25.92
Involving competencies and practical cadres with high experience in negotiating and contracting to obtain advanced technology	19.75
Involve competencies and practical cadres with high experience in supervising and executing projects to reduce the time and cost spent to complete them	13.58
Conducting research, scientific tests and investigations to test imported technology and its applicability, and to choose the most suitable one	11.11
Holding training courses and workshops that deal with modern technology and methods of acquiring and transferring it	1.23
Average	4.432099
Standard Deviation	0.155059
T-TEST	54.10136

7. CONCLUSIONS

This work, although it is done in Iraq, and the responses of companies' personnel were collected because many of them were working in multinational companies, so it provides some (non-private) conclusions according to the field study. On the other hand, the conclusions of this paper can be applied to countries that have the same political situations or circumstances:

i- The technology transfers to be successful need continually fund and have to determine enough special budget during and till to complete the technology transfer process. The cost of imported technology should be classified accurately into direct and indirect costs. (76%) of respondents have ensured that the funding has a strong effect on the acquisition of modern Technology Transfer to the construction sector.

ii- The amount of direct cost is often more than the indirect cost. The need to the represented items of the direct cost (preparing or establishing the work site, equipment, plant, labor, materials, and others), is the major reason beyond of cost increase.

iii- According to this study, the direct cost ratio was concentrated in the cost of imported machinery to implement the project and related to the negotiation procedures, contracts or conditions considerations between parties, inspection and test requirements, and the cost of transporting equipment from the manufacturer state to the receiver country.

iv-This paper concentrates on the Wages /salaries of consultants-designers and refers to having a significant weight than others. It has the second priority of indirect cost, which is a normal state of indirect cost because their wages/salaries fall under the imported skill and knowledge cost.

8. ACKNOWLEDGMENT

This work is a partial attempt to improve the technology transfer and support it by focusing on their different costs, especially in the construction sector in Iraq. Thanks to respondents in various construction organizations (both public and private) for supporting this work through ideas and opinions.

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