



## DEVELOPMENT OF INDICATORS FOR ESTIMATING THE COST OF WAREHOUSE BUILDINGS PROJECTS

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### ABSTRACT

The initial cost projections for any proposed project are an important pillar in determining the necessary budget to finance the project. The preliminary cost estimate requires that the surveyor have experience in project implementation. In addition to previous data on similar projects

implemented and documented in a way that can be used in the formulation of initial cost estimates, and the lack of such data in the Iraqi contractors to the weakness of the available expertise, which is limited to the establishment of some small industrial workshops and buildings. The study deals with the study and analysis of a sample consisting of (50) storehouses during the period from( 2003 with different specifications and sizes, as well as the reasons for differences in the cost of building implementation - 1994) The warehouse buildings were carried out before and after the implementation year of the establishment. The storage buildings were classified according to their size. According to selections proposed by the researcher based on available data and on-site surveys of some buildings storehouse.

**KEYWORDS:** estimation, civil engineering.

### INTRODUCTION

Each construction project requires a preliminary cost estimate based on preliminary and simple information such as the project goals documented by the employer as well as initial designs. The employer prepares preliminary estimates of the cost of implementing a proposed warehouse building for the purpose of preparing an initial budget for the implementation of THE project and the decision on the optimal cost in case of experience with the owner work

in the implementation of warehouse buildings In the absence of previous experience, the employer resort to contracting contractors with experience in the construction of this type of facilities in a manner turnkey, in the case of being large storage facilities. Iraqi companies went to acquire expertise in the construction of warehouse buildings, which prompted. Many contracting companies to enter into this area starting from the preparation of designs and calculation of costs implementation, and preparing the initial costs of the proposed origin is considered one of the main problems facing Masahi Quantities for lack of cost indicators for warehouse buildings for use in preparation preliminary cost estimates, this problem was mainly with companies implementing such projects. The research includes theoretical and practical aspects, where the theoretical aspect deals with a review the literature that dealt with the methods currently adopted in the preliminary cost estimates for construction projects. As for the practical side, the study of a sample of (50) warehouse buildings executed during the period from 2003). Implementation cost data for these projects were adopted and adopted in the derivation of indicators – 1994 proposed costs. Mathematical equations were also developed to apply these indicators guess the cost of execution. The proposed indicators are accurate in estimating the initial costs of warehouse buildings in addition to ease application and comprehensiveness of all store buildings.

## 2- The theoretical side

Young<sup>[1]</sup> has defined the term guess is the decision about the amount of time, cost and resources required to implement each part of the work according to accepted standards of achievement and performance. Several scientific sources have dealt with the basic methods of estimation based on simple information about the shape, size, and type of service<sup>[2,3,4]</sup> to some approximate methods in estimating the initial costs:

1. Method of surface area.
2. The volumetric method.
3. Method of content floors.
4. Server method.
5. Method of structural elements.

Many scientific sources have indicated the need for indicators and criteria to study cost variables productivity and time. These indicators are characterized by scientificity, realism, clarity and consistency. Numerous methods in developing indicators were referred to by the National Center for Administrative Planning<sup>[5,6,7,8,9,10]</sup> was interested in developing

definitions of cost indicators as adopted while<sup>[6]</sup> relay on a formula for determining the error ratio between the estimated cost and the real cost

$$E = \{(Ce \setminus Ca) - 1\} * 100$$

Where:

E: error percentage

Ce: the estimated cost

Ca: The real cost

The National Center for Administrative Planning defined the cost indicators as "a kind of cost type predetermined, involving a set of scientific and technical facts, reached through the technical study and experiments are the result of efforts and thinking of management, engineers and accountants combined and a modern definition of cost indicators indicated.<sup>[6]</sup>

Is a non-dimensional figures that give the cost in a time relative to a given year as a basis without entering into a detailed calculation of the cost and used to compare the difference between costs or prices for a fixed quantity of goods and services, ie cost indicators reflect the change in price levels between two periods of time.

### **3 Practical Side**

#### **3.1 Field survey**

Through the field study of a number of warehouse buildings implemented by the company Faw Engineering General, and Ramadan Mubarak Company, and see the cost data for a number of store buildings were selected (50) building implemented during the period (1994-2003). The measurement and dispersion measures for the sample of the research sample were calculated and analyzed. It was found that some store buildings are a large warehouse and storerooms added to a pre-existing warehouse group for expansion purposes or for purposes of diversity in materials and thus dealing with these buildings as an independent storage structure within the sample of the research.

#### **3.2 Characteristics of the research sample**

The sample included multi-structural building structures, construction methods, and materials Construction, there are general characteristics and special recipes for this sample as follows:

1. It is a one-storey building used to store equipment, industrial materials or storage materials.

2- The storage structure of the research sample is that it is different size stores, large and small.

Classification was adopted on the basis of specific definitions of warehouse buildings.

3 - The common construction methods in the implementation of the warehouse buildings included in the sample are as follows:

A) Reinforced concrete structure (bridges or columns)

B - Basis or floors are reinforced concrete.

C - Carrier walls and cutters or aluminum blocks for internal cutting.

(D) The roof either from the reinforced concrete or from the metal structure covered with metal sheets.

The historical data obtained from the research sample included the following details:

First, the total cost of each warehouse building previously implemented.

Second: The year of construction of each former warehouse building.

The sizes of store buildings differ depending on some of the requirements reached through Data analysis of the number of warehouse buildings as follows:

### **1- Number of building units**

Some stores are a single building unit that includes all departments such as warehouse, administration, Services, and even queries). However, some stores are a set of scattered construction units, each unit performs a specific purpose and this increases the requirements of roads and squares that connect building units and this increases the size of store buildings.

### **2. Spaces and height**

Some of the warehouse buildings reach to 22000 m<sup>2</sup> As a total of construction units converging, there are stores estimated area of 12000 m<sup>2</sup> as a wide shed with an average height 10 m<sup>2</sup> .The increase in area and height increases the number of internal concrete columns or requirements ferries also increase the number of bridge bridges, increasing the need for even bridge cranes forklifts Increasing height affects the determination of the type of construction material required for the construction of the building and to remove the sections of bridges and concrete or steel concrete pillars.

### 3. Construction methods

The style of construction of warehouse buildings varies depending on the size of the warehouse, size and type of machinery transport, load, size, weight and notes of construction methods that reinforced concrete is used in implementation of foundations and floors in addition to the walls as a concrete structure cut by the block or covered with metal panels, and the roof is executed from reinforced concrete, such as cutting my site or concrete parts in advance casting as a common technique in the implementation of the ceilings of the storage facilities (research sample) or concrete bridges armed with metal panels, based on the importance of reinforced concrete as a main building material used in the construction of warehouse facilities have been based on the difference in the prices of their implementation Within ten years (1994-2003) in the process of deriving the proposed cost indicators for warehouse buildings.

### 4. The total cost of the store

The total cost of a store The cost is a financial indicator that gives an image of the size of the store, regardless of type the special equipment required under the contract of the contract, which increases the cost, the higher the cost of the store, the greater the strength, such as the increase in the number of building units and increase the area and height, and vice versa, taking the year of construction of old stores study axis in mind on 1994 Different from construction costs on 1995 and 1996. Thus, it is clear from the above mentioned that the smaller the number of building units and the less the area and the height the store takes a classification (small size), taking the construction period in the account, increasing the period means that the increase complexities during the implementation phase are many and this increases the indirect cost and thus the total cost despite the small size of the store the warehouse buildings as in the table (1) Which shows the limitations that have been relied upon in the classification mode.

**Table 1: Size Limits of Stocking Establishments (Research Sample).**

	Volume	Area m <sup>2</sup>	Number of establishments	Cost limits for establishments (1994-2003) Million	Cost limits for establishments after (2003) Million
1	Very big	> 10000	More than 4	(2000-100)	More than 2000
2	big	10000-6000	(4-3)	(1700-100)	More than 1700
3	middle	2000-6000	(3-2)	(1200-70)	More than 1200
4	small	2000-1000	2	(850-40)	More than 850
5	Very small	<1000	1	(450-10)	More than 450

**Table 2: Classification of the cost of storage facilities (research sample) on a volume basis.**

Year	The cost of implementing the warehouse facilities (million dinars) for each size				
	Very big	big	middle	small	Very small
1994	120	100	72	45	15
1995	145	120	87	60	29
1996	180	140	104	63	30
1997	250	204	146	72	44
1998	295	222	127	108	47
1999	420	300	197	140	48
2000	690	884	612	480	180
2001	1680	1080	780	420	248
2002	2200	1990	1380	900	480
2003	2135	1710	1200	840	420

### 3.3 Effect of project paragraphs on total cost

The construction of any engineering project requires the completion of the following paragraphs:

1. Civil works (construction works and finishes).
2. Electrical works.
3. Mechanical works.
4. Health work.
5. Laboratory work.

The cost analysis of the warehouse establishments showed that the cost of civil works to the total cost of the store is between (35%-78%) the most common percentage is 60%, and the lower percentages of the structural paragraphs, i.e. less than 50%. This is due to the presence of some special equipment and equipment required of the contractor to process them, which increases the total cost of the inventory and thus reduce the cost of civil works. The above cost ratios show the importance of reinforced concrete as a major structural

material affecting the cost of civil works in particular, which justify the researcher to develop indicators of the difference in the prices of the implementation of the reinforced concrete helped to derive cost indicators for the warehouse establishments used in estimating the initial costs and relying on them to follow up and control the site costs. as for electrical work in a small-sized store accounted for proportion 15% of the total cost, which is an approach to a large-scale store where the electrical works constituted a percentage 16.38 % . Note that electrical services are an important factor in the store and may enter these services in the cooling of the store, whatever the size of the store, for example, "store food is small but needs to large electrical equipment increased the cost of electrical work to the total cost compared to the store is large in size but its need for electrical services is less, so the researcher did not rely on the services electrical in deriving indicators. the impact of the mechanical work of some of the warehouse establishments is also noticed in the store small but contains mechanical equipment and equipment formed by its cost ratio 61.7% of the total cost, but this does not apply to the large warehouse where the proportion of the cost of mechanical works 17.6 % of the total cost despite being large. While health works are a cost ratio ranging from 1-5% of the total cost.

### **3.4 Design requirements affecting the cost of warehouse facilities**

Through the study of data and analysis of the costs of storage buildings (research sample) that the cost of enterprises the warehouse is affected by a number of design requirements as follows:

1. The cost of the warehouse origin increases with the increase of the area of the sections that make up the origin to increase requirements of foundations, floors, number of external and internal columns and number of bridges.
2. The organization and coordination of the sections of the warehouse helps to ease movement and handling during stages this leads to reduced transport and handling costs for materials and easy movement of machinery and equipment .Thus speeding up the achievement and reducing the cost.
3. There is a kind of flooring that needs special additives for corrosion resistance and cracking requirements
4. High loads and shocks where some storage facilities need metal floors this increases the cost of warehouse origin.
5. The type of external and internal walls is determined depending on the type of machines used in storage and on the type of material stored in addition to the weather conditions

surrounding the store in the area of temperature and humidity, there are reinforced concrete walls, some of which are from blocks or from the higher the durability and resistance to the walls, the more expensive it will be store origin.

6. The lighting inside and outside the store is necessary and to reduce the cost is resort to lighting natural depend on increasing the number of openings and windows in walls and ceilings so as to minimize requirements for industrial lighting, which require sockets, cables and electrical wires with prices increase the cost of origin.
7. Multi-storey store facilities are less expensive than warehouse buildings with a floor one that occupies more space for the spread of its structural units on a large area and this increases the road and electrical, mechanical and health services requirements.
8. The cost of warehouse facilities increases with the increased need for separate administrative buildings construction within the warehouse building to reduce the need to construct additional construction units as administrative buildings.
9. Some storage facilities need special labs, which are important for storage cost of origin for the need of laboratories to the electrical, mechanical and health services in addition to industrial safety requirements that specify the type of doors, floors, escape ports and stairs and others.
10. The style of roofing varies from the origin of my store to another depending on the area of origin and its height and the type of bridge cranes used in addition to other requirements, if the ceiling of reinforced concrete and the placement of my site is becoming more expensive as it requires site control and treatments in particular, if the concrete ceiling is precast, this reduces the cost for easy implementation the ceilings covered with metal panels are easy and quick to implement except for high prices the chassis may increase your cost.
11. Some warehousing facilities need special structures and equipment necessary to operate the origin my store has special lighting assemblies, inspection equipment and electrical requirements against the explosion and other devices that increase the cost of the warehouse origin, which the contractor study possibility of processing and installation to avoid risk. It is clear from the above that the design requirements increase their impact on the cost with increasing size and the cost of its implementation increases with the increase in the prices of resources (materials, workers and equipment) necessary for their implementation.



### 3.5 Derivation of cost indicators to estimate the initial cost of warehouse facilities

The researcher was able to derive cost indicators to estimate the initial costs of the warehouse facilities depending on the following data:

1. Theoretical study of the commonly used indicators in the field of structural management which included definition of indicators, types, uses and methods of calculation.
2. Study and analyze data for the research sample that resulted in obtaining information.

Next:

- a. The cost of construction of storage facilities (the research sample) and the factors affecting them.
- b. Identify important paragraphs within civil works.
- c. Determining the percentage of the cost of service works, finishes and special equipment.
- d. The difference in the cost of construction of the warehouse facilities within a period of ten years.
- e. The difference in the prices of the implementation of reinforced concrete and its impact on the cost of warehouse origin.
- f. Classification of storage facilities to different sizes, depending on the definitions determined by the researcher in the classification in table 1.

Costing measures were established for the storage facilities of the research sample based on the comparison of the cost of each source within the research sample with the cost of the warehouse establishments executed during the period (1994-2003).

Measures were found to show the difference in the prices of the implementation of reinforced concrete for these installations as in the table 4. Figures are vertical to the right of the proposed cost scale tables years of implementation the warehouse establishments required to find their cost measures and the horizontal years represent years implementation of warehouse facilities that have been relied upon as a source for finding cost measures, and for finding cost measure for a very large store done on 2000 Compared to a similar public store done in 1994 the cost measure is 6.62.

### 3.6 Derivation of indicators to calculate the initial cost of the proposed storage facilities based on suggested cost metrics

Indicators were calculated to calculate the initial cost of the proposed storage facilities based on the cost measures referred to in the tables 1, 2, 3 and 4 under the following steps:

Determination of the base year number of the cost of the warehouse establishments (the research sample) and the prices of the concrete implementation and referred as (A) as follows:

1. A year 1994 is defined as the base year for the cost of warehouse facilities executed for the period from 1994-1998
2. The year 1999 was defined as the base year for the cost of warehouse facilities implemented for the period 1999-2003.
3. The base years above were determined on the basis of the significant increase in the cost of construction of warehouse facilities during 1998 and onwards and the construction costs for 1994-1998 were slightly different and rising "on a regular basis.
4. The number of the year in which the origin is similar to the proposed origin is indicated by (b).
5. In the absence of historical data on the previously issued stock of the store the proposal shall be based on any other warehouse origin that is similar in size and area in addition to the method and type of construction mentioned in Table 1
6. The number of the year in which the proposed stock origin is indicated shall be indicated by (c).
7. Selection of the appropriate cost scale for the previously issued warehouse establishment "(similar to the proposed origin) and cost of origin in the base year from the above cost measurement tables prepared.

$$K_1 = C_b/C_a \dots \dots \dots (1)$$

Where:

**K<sub>1</sub>**: Cost scale for each previously exported industrial origin "(in the sample).

**C<sub>b</sub>**: Cost of industrial origin previously executed "of the sample of the research.

**C<sub>a</sub>**: Cost of similar industrial origin previously implemented in the base year.

8. Selection of the measure of change in the prices of the implementation of reinforced concrete  $k_2$  Depending on the price of the implementation of the reinforced concrete per cubic meter of the previously implemented construction (similar to the proposal) and the price of the execution of the reinforced concrete per cubic meter of the base year starting from Table 4.

Which is set up by applying the following equation:

$$K_2 = \frac{\text{The price of concrete for the previously completed construction}}{\text{Price of reinforced concrete in the base year}} \dots\dots(2)$$

Assume that the proposed origin will be constructed during 2004, for example the prices of the implementation of reinforced concrete prevailing in 2004 are compared with the prices of the implementation of reinforced concrete in the base year.

#### 4- Evaluation of proposed standards, indicators and equations on an applied basis and a calendar questionnaire

To evaluate the proposed benchmarks and indicators to calculate the initial costs of the warehouse facilities,

Two methods are:

1. Practical application of the proposed standards and indicators on the facilities previously implemented and others implemented during the year 2003.
2. The calendar questionnaire, which included a number of engineers in Al-Faw Engineering Company, specialized in the construction of warehouse facilities through the two methods above, the researcher has been able to evaluate the cost indicators and derived measures and its importance, accuracy and ease of use by the beneficiary (Al Faw Engineering General) the researcher selected two sources: the origin of the medium size achievement similar to that of another establishment completed in 1998, and a large size of 50% similar to that of another establishment in 2000. The initial cost of each of the above was calculated based on the proposed cost indicators and derived measures, as in table 3 Which shows the expected costs, real costs and measurements of medium-sized warehouse buildings and the results of initial cost calculations were approximated by 77% of the contractual estimated cost calculated by the executing contractor.

**Table 3: Practical application of cost indicators for medium-sized warehouse buildings.**

Expected Cost	Real cost	Cost index	Base year	Year of construction Of the proposed structure
87,12	87	1,21	1994	1995
156,6	104	2,17	1994	1996
193,6	146	2,69	1994	1997
142,5	127	1,98	1994	1998
216	197	3	1994	1999
737,3	612	3,74	1999	2000
945,6	780	4,84	1999	2001
1908,9	1380	9,69	1999	2002
1506,6	1200	7,64	1999	2003

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