Unit Price and Cost Estimation Equations through Items Percentage of Construction Works in a Desert Area

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ABSTRACT

This research will cover different aspects of estimating process of construction work in a desert area. The inherent difficulties which accompany the cost estimating of the construction works in desert environment in a developing country, will stem from the limited information available, resources scarcity, low level of skilled workers, the prevailing severe weather conditions and many others, which definitely don't provide a fair, reliable and accurate estimation. This study tries to present unit price to estimate the cost in preliminary phase of a project. Estimations are supported by developing mathematical equations based on the historical data of maintenance, new construction of managerial and school projects. Meanwhile, the research has determined the percentage of project items, in such a remote environment. Estimation equations suitable for remote areas have been formulated. Moreover, a procedure for unite price calculation is concluded.

Key words : unit price, cost estimating, desert, items percentage

تخمين كلف الفقرات الانشائية ونسبها ومعادلاتها في المناطق الصحراوية

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الخلاصة

يغطي هذه البحث أوجه تقدير المختلفة لأعمال الانشاء في المناطق الصحراوية. يرافق تقدير كلفة الاعمال الانشائية في البيئة الصحراوية للبلدان النامية العديد من الصعوبات التي تنبع من محدودية المعلومات المتاحة وندرة الموارد، وانخفاض مستوى العمال الماهرين وسوء الاحوال الجوية وغيرها التي لا توفر بصورة جيدة تخمين عادل وموثوق ودقيق. حاول البحث تحديد أسعار الوحدات لتقدير التكاليف في المرحلة الأولية للمشروع . عملية التخمين دعمت بواسطة معادلات رياضية مطورة تستند على البيانات التاريخية للصيانة وإنشاءات جديدة لمشاريع ادارية ومدارس ولأربعة انواع من المشاريع. وفي الوقت نفسه، حدد البحث النسبة المئوية لفقرات فقرات المشروع، في مثل هذه البيئة النائية. حيث تم اشتقاق المعادلات الملائمة لعملية التخمين ، فضلا عن تحديد الاسعار لأغراض التخمين عى اساس الوحدة.

الكلمات الرئيسية: سعر الوحدة، تخمين الكلفه، المناطق الصحراويه، نسب الفقرات.

1. INTRODUCTION

Today's construction projects management faces many challenges due to the increased complexity and diversity of projects executive techniques, the need for huge verification of construction materials requires, updating of equipment and automation, computerization technique and management information systems. The need for continuous control on project costs to satisfy client's targets, gives rise to search for new concepts in estimating costs of construction items accompanying the completion of the design stage. The cost estimating before the design completion is called "Approximate cost" or "rough cost" which is less accurate than cost estimating after the detailed design. **Dutta, 2005**.

The successful estimating process essentially depends upon estimator's experience, and acquaintance with achieving an accurate cost estimate; which surly is not so much different from actual cost later, **Buchan, et al., 2006**. There is no denying the historical cost of previous projects or records will be used throughout the decision making phase that is related to feasibility to proceed adopting the execution of construction project or not. It becomes urgent to make the right decision because it gives the client an idea or indicators of cost level to make him capable of studying and examine carefully the financial situation. Meanwhile such an estimate will help in achieving the balance sheet especially for governmental projects, where some decisions are essential and urgent after completing the design; therefore the estimation of a project cost must be calculated effectively and efficiently, **Callahan, et al., 2007**. However, although the successful estimating process depends substantially upon estimator's experience, and familiarity with market, also the use of more real predication of material prices and production rates to get rather an accurate cost estimate, will make the estimation of cost not much different from actual cost later. Therefore the historical data of costs of previous project is represented as backbone of successful estimation of cost in addition to normal estimating techniques. **Mubarak S., 2010.**

2. RESEARCH OBJECTIVES

This research aims to prepare a practical approach to estimating the cost of projects in the desert area by submitting a price indexes and estimating equations supported by percentage of items to make the executive priority.

3. RESEARCH HYPOTHESIS

Research hypothesis focuses on the problems that are encountered in the construction projects of desert area in cost limitation especially in the first stages of the construction project work. This problem becomes clear when the execution begins, most of the problems appear when planning and execution interfere with each other. The resulting weakness in the project cost limitation is the result of price iteration, the emergency conditions and the materials ensuring. By ensuring the optimal limitation of cost of the project, the planner can optimally control the project activities costs.

3. RESEARCH METHODOLOGY

The research mythology will consist of the following steps:

1- Literature survey to review the familiar cost estimation types. The ratio of construction items and the suitable mathematical tool are used to represent the project cost behavior in construction units.

2- Data collection aims to collect historical data on activity costs of two types of buildings (construction of managerial building and school building), and periodic reports, invoice of payments, BOQ and tables of quantity surveying for maintenance activities.
3- Finding the optimum relationships by using mathematical regression model in (Excel package) between cost and construction units and finding the percentage of construction items and developing equations of cost estimating.
4- Displaying and discussing the results and drawing the final conclusions and recommendations.

4. COST ESTIMATION TYPES

The cost estimating for construction project starts in the preliminary phase or in feasibility study, to define the required financial requirements. The result of the estimation may differ according to the estimating techniques and to relevant information available, in construction field where there are different types of cost estimation as shown in **Table 1**.

The first type of estimation gives rough estimate, depending on unit basis used in preliminary study and is prepared by using various methods for different structures and works, as shown in **Table 2**. The plinth area or superficial area method is deduced from the cost of the similar building having similar specification, characteristics and construction techniques but at same height of each floor. In a locality the plinth area rate is computed by using historical data on several buildings. In the same context the cube rate can be estimated after checking the cubic volume of building to consider, where the height of building is a crucial factor, it's more flexible than plinth area and it will be used for different sizes of building with different design.

The approximate quantity method depends on expected length of walls by using running meter rate multiplying the total length of walls, while the detailed estimate needs a completed and detailed design with specification accompanying a completed quantity account.

Dagostino, et, al., 2011, referred to three others types of estimating approaches for approximate estimating which are as follows:

1- Assembly Estimating: in this estimation the projects are treated as a group of assemblies like residential, electrical , gypsum-board partitions wall, etc. These groups can be estimated either manually or by computer software which will make the estimate more quickly by such a breakdown of project.

2- Parametric Estimates: the equations that are concluded from the statistical process will be used by depending on one of the parameters in estimating the anticipated cost.

3- Model Estimating: the computer models will be used here when the estimator is asked questions and has to answer them such as length, width, height, floor thickness, depth of footing, fire sprinklers, etc.

5. DATA COLLECTION AND ANALYSIS

In this research the approximate estimate considers (unit basis, plinth area, cube rate). The case studies data came from new construction and maintenance

projects. The data on two types of projects (construction of managerial building and school),were obtained from projects office in Ghadame's Province in the great Arab desert 625 km south west of the capital Tripoli. A similar technique was used to study the maintenance **Table 3**. The second part of this study "the percentage of construction items" depends on final payment certificate of the project considered to define the ratio of cost of each items to total cost of project.

In this study, equations are derived by using Regression method (Excel package) to find out relations related to units and to explain cost behavior and finally, these equations were tested through correlation as shown in **Table 4** .

The raw data of this project is too large to be included in this research; therefore the researcher put the final information.

The units used for construction of managerial buildings in this study are area (square meter) and volume (cubic meter), these two units were used in maintenance also. For these types of building of school construction, the units used in maintenance were area (square meter), volume (cubic meter), number of students in each school and number of classes also.

6. THE RESULT AND DISCUSSION

The result of estimating of new construction works, are reasonable with low standard deviation **Tables 3** shows also the equations which have high correlation, and are more realistic than unit cost as shown in **Table 4**, where the following equations are related to new construction of managerial building :

$$y_{cms}=500.818x_s-1343.92 \quad (1)$$

$$y_{cmc}=73.51x_c+22049.53 \quad (2)$$

Even the equations that are related to new construction of schools are:

$$y_{css}=908.96x_s+13402.27 \quad (3)$$

$$y_{csc}=197.6x_c+13409.77 \quad (4)$$

$$y_{cst}=2423.9x_{st}+204519.2 \quad (5)$$

$$y_{csl}=43630.26x_{cl}+204519.2 \quad (6)$$

But the results of maintenance work have proved to be less realistic because of the inaccurate input raw data with clear variation in value of same work among the different projects which have the same basis .The maintenance work gives disappointing results, **Table 3** and **Table 4**,. It seems this result can never be used, therefore the maintenance data or cost does not reflect realistic cost. It is believed that, the main reason for great difference in maintenance cost lies in the manner of preparing bill of quantity which is usually done in office rather than on site, and the estimators were junior engineers having little experiences. For example, some items which don't cost very much are priced highly; items need a lower cost than fixed in the estimating sheets or in (BOQ).

For items cost percentage, the concrete work and finishing represent the higher percentage in construction work of the two types studied –managerial building and schools ,while for maintenance work, the electric work is greatest with ratio (%44)

for schools, while in office building, the greatest ratio was in finishing work, **Table 5** and the **Figs.1, 2, 3,** and **4** represent the illustration of item percentage of school and managerial building in case of either new construction or maintenance.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

1.The price of work for area, volume and units can be used as a basis for estimating and decision making stage, for managerial buildings and schools, while the students units and classes do also give accurate results.
2. The historical data of maintenance work is non-systematic indeterminate and reveals there are unsuitable relations with the factors or bases of approximate estimate.
3. Most of new construction equations that are concluded by regression are suitable for use to estimate the cost.
3. The final payment certificate of construction work is more realistic than that of maintenance work as a consequence of nature of work and the maintenance equation that is concluded is less suitable to use.
4. In this research, several projects are neglected because of lack of information and they are not documented which lead to inaccurate estimating.

6.2 Recommendations

1. The researcher suggests the price of approximate estimate in this research be used for estimating new project and update for each period be made.
2. The consulting offices should play a part in predicting costs using their estimating methods, pre-estimate procedure and experience methods.
3. Information about accounts and data cost of project must be documented and filed.
4. The annual maintenance must be estimated carefully by specialist committee based on database or by suggesting model for analysis of such fuzzy information.

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NOMENCLATURE:

x_s = estimated area m^2

x_c = estimated volume m^3

x_{st} = estimated number of students

x_{cl} = estimated number of classes

y_{cm} = estimated cost of managerial building based square meter

y_{cmc} = estimated cost of managerial building based cubic meter

y_{css} = estimated cost of school building based square meter

y_{csc} = estimated cost of school building based cubic meter

y_{cst} = estimated cost of school building based student number

y_{csl} = estimated cost of school building based classes number

Table 1. Types of cost estimating. [Researcher]

1- Approximate estimate	Estimate per unit basis
	Plinth area estimate for building.
	Cube rate estimate for building.
	Approximate quantity method
	Item rate estimate.
	Revised estimate.
	Supplementary estimate.
	Maintenance estimate.
2- Detailed estimate	*When the drawings , planning & specification & bill of quantities are ready*

Table 2. Units basis used to cost estimating, **Dutta, 2005.**

No.	Type of project		Unit of estimating
1	Buildings	School	Student or class room
		Hostel	Student
		Hospital	Bed
		Theater, cinema & halls	Seat
		Residential building	Tenement
		Dormitory	Barrack
2	Road and highways		Kilometer ,area
3	Irrigation channels		Kilometer depending on capacity of channel
4	Bridges and culverts		Running meter
5	Sewerage project and waters supply project		Population served or area covered
6	Overhead water tank		Capacity per cubic meter

Table 3. The unit prices per each unit basis.

Type of work	Type of structure	Cost estimated $ Per			
		Square meter	Cubic meter	Student	Class
construction	Managerial building	554.1 ±104.62	134.95 ±40		
	School	932.6 ±12.2	202.74 ±2.6	3962.5 ± (210.7)	71325.57 ± (3793.2)
maintenance	Managerial building	196.87 ±189.5	39.66 ±25.5		
	School	46.98 ±16.4	11.39 ±4.73	139.08 (101.04) ±	2347.78 ± (1136)

* By multiplying the above values by the related unit basis to get the estimating cost.

Table 4. The equation of cost estimating per unit.

Type of work	Type of structure	Equation concluded per unit (x)			
		Square meter	Cubic meter	Students	Classes
Construction	Managerial building	Y=500.818X-1343.92 R=0.987	Y=73.51X+22049.53 R=0.975		
	Schools	Y=908.96X+13402.27 R=0.983	Y=197.6X+13409.77 R=0.983	Y=2423.9X+204519.2 R=0.983	Y=43630.26X+204519.2 R=0.983
Maintenance	Managerial building	Y=126.535X+25037.03 R=0.469	Y=12.05X+54861.29 R=0.199		
	Schools	Y=31.93X+8440.676 R=0.193	Y=12.11X-1673 R=0.193	Y=20.41X+21218.6 R=0.193	Y=583.04X+19251.7 R=0.193

* The above equations are extracted by using regression tool after analysis of the raw data.

Table 5. The items ratio per total value of project (%).

Type of work	Maintenance		Construction	
Type of structures	Schools	Managerial building	Schools	Managerial building
Leveling and utilities		0.105	0.87	0.19
Clearing demolition	o.171	0.513		0.26
Excavation		5.07	1.66	1.26
Filling		0.243	2.0	1.37
Concrete		6.54	36.3	25.31
Masonry	0.231	2.88	7.045	13.34
Finishing	15.695	21.28	16.465	20.77
Roofing and flooring	5.171	9.109	7.485	6.13
Metal	8.252	14.649	4.125	5.86
Damp proof		1.51	4.585	3.77
Wood	5.66	7.51	4.287	6.75
Sanitary	20.107	12.85	6.015	5.44
Electric	44.09	11.87	5.737	4.67
Water tank		4.57		3.75
Final cleaning	0.612	1.21		0.48
others			2.365	1.01

* Some items were unavailable and are not considered in the original BoQ

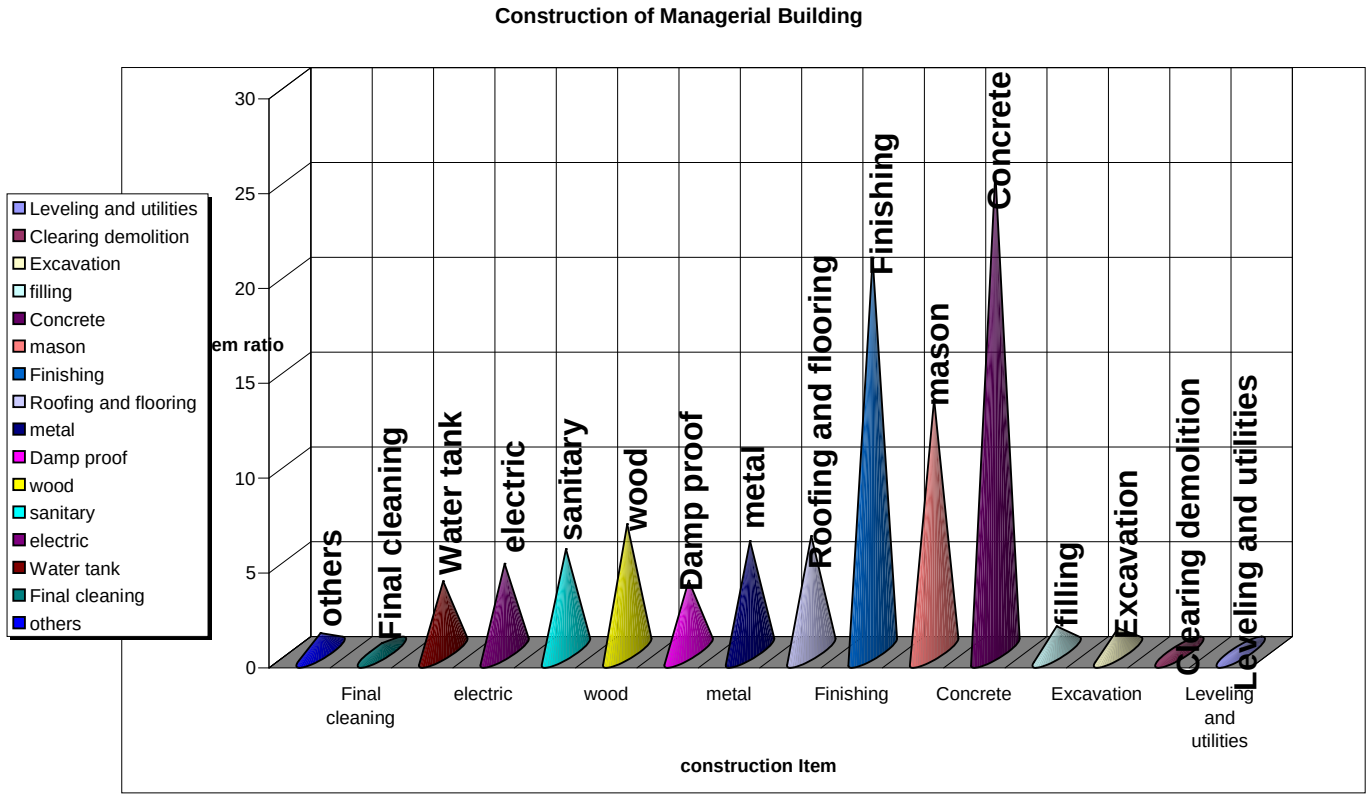

Figure1. Item Percentage of construction managerial building.

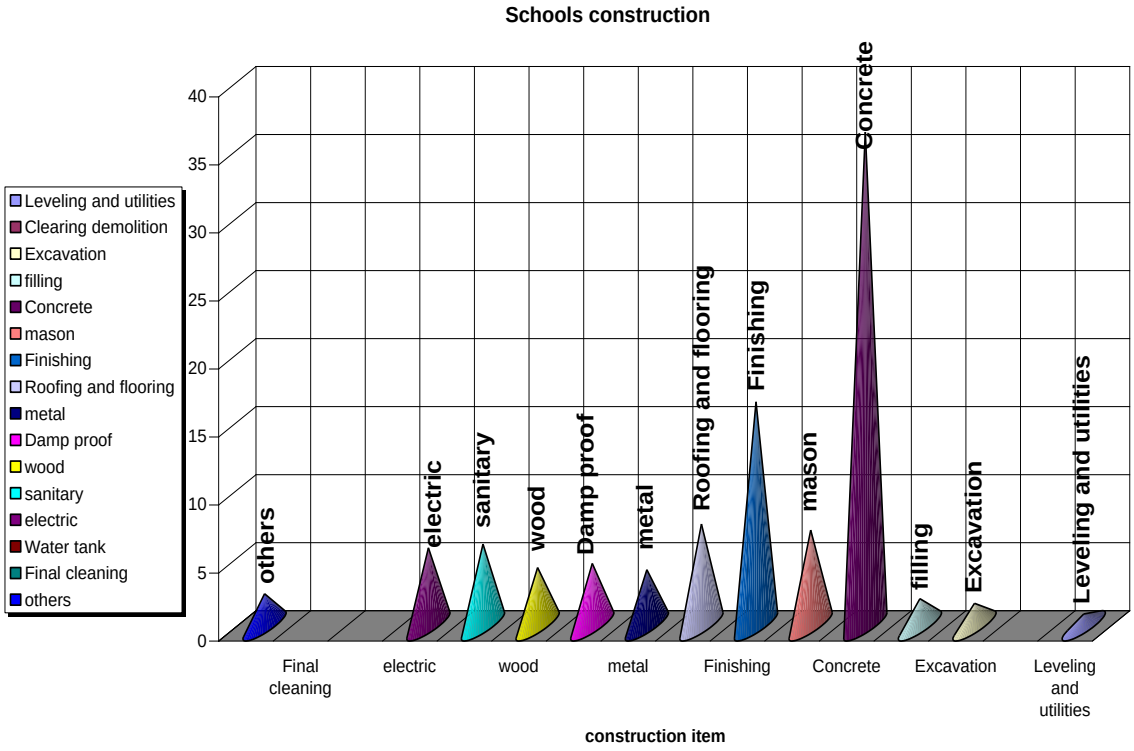

Figure 2. Item percentage of school construction.

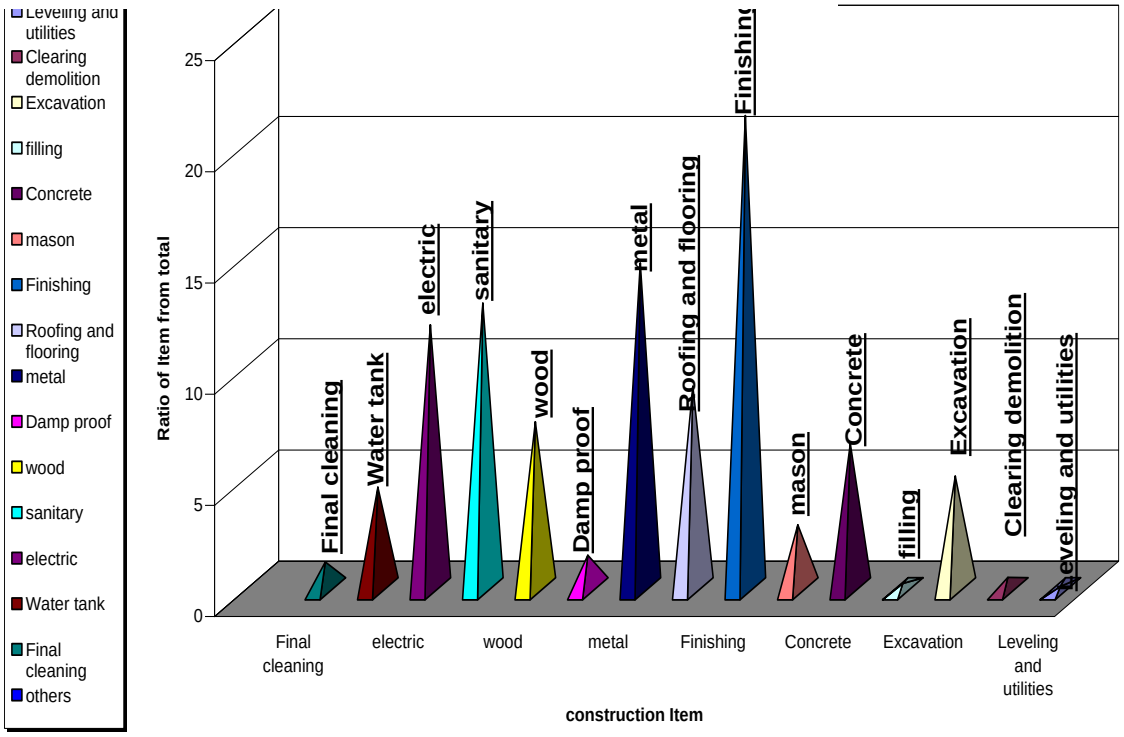

Figure 3. Item percentage of maintenance of managerial building.

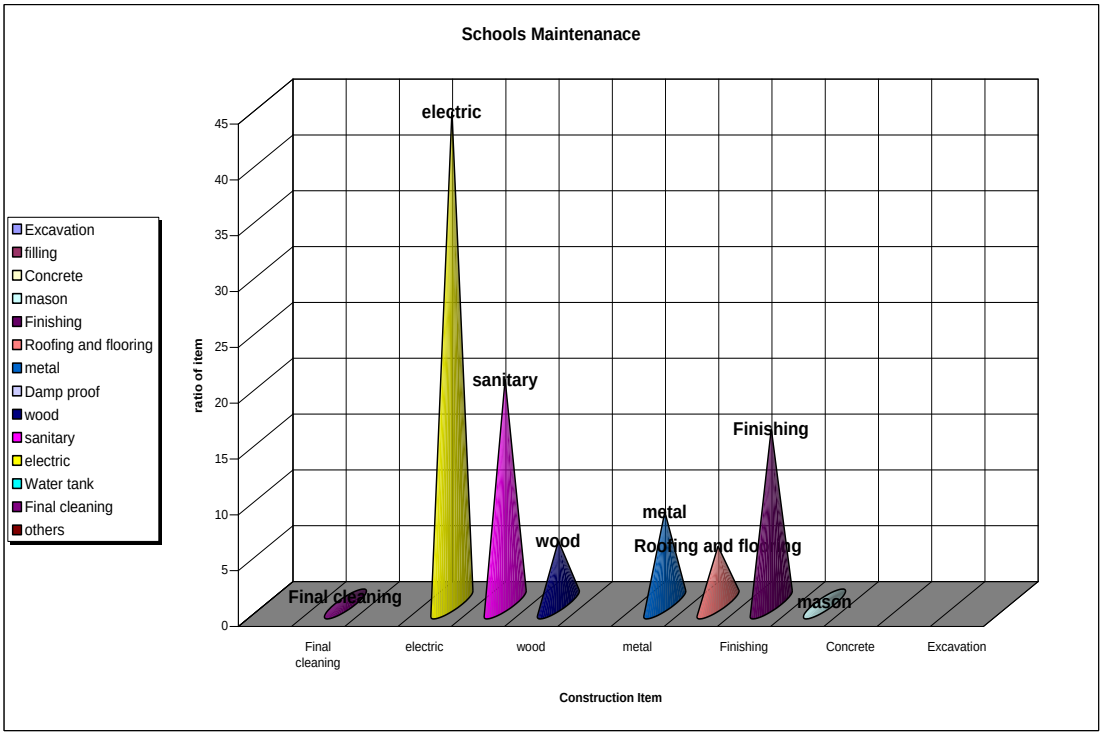

Figure 4. Item percentage schools maintenance.