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AREA BASE OF COST ESTIMATION FOR BUILDING CONSTRUCTION PROJECTS USING AN ARTIFICIAL NEURAL NETWORK

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Abstract

Managers of projects monitor the project schedule and compare planning values with the actual cost into the project and how much of it is earned value. One of success methods for managing the construction projects is to find the effective cost factors and investigate the correlations between them. In order to determine the discrepancies, the Execution Phase performance measures are compared to the baseline metrics decided upon in the Planning Phase. The significance of these deviations is assessed by factoring them into the control methods at every stage. For that, the present paper developed an ANN technique for project management to monitor the cost of project based on the correlation between the project size and the project cite area within the implementation process. The contribution in this paper is to present a project planning cost mimic the real actual cost. Modifications to the project can be monitored using this method, which takes into account both the nature of the work being done and the time frame during which it is being performed. To gauge the system's efficacy, the ANN system was applied to structural concrete and building walls. The system's final output demonstrated a straightforward and reliable method of tracking and observing progress.

Keywords: PV, ANN, Project Building Area, Project Site Area

YAPAY SİNİR AĞLARI KULLANARAK BİNA İNŞAAT PROJELERİ İÇİN MALİYET TAHMİNİNİN ALAN TABANI

Özet

Proje yöneticileri proje zamanlamasını izler ve planlama değerlerini projedeki fiili maliyetle ve ne kadarının kazanılmış değerle karşılaştırır. İnşaat projelerini yönetmenin başarı yöntemlerinden biri, etkin maliyet faktörlerini bulmak ve aralarındaki ilişkileri araştırmaktır. Tutarsızlıkları belirlemek için, Yürütme Aşaması performans ölçümleri, Planlama Aşamasında kararlaştırılan temel ölçütlerle karşılaştırılır. Bu sapmaların önemi, her aşamada kontrol yöntemlerine dahil edilerek değerlendirilir. Bunun için, mevcut makale, uygulama sürecinde proje boyutu ile proje alıntı alanı arasındaki korelasyona dayalı olarak projenin maliyetini izlemek için proje yönetimi için bir YSA tekniği geliştirdi. Bu yazının katkısı, gerçek fiili maliyeti taklit eden bir proje planlama maliyeti sunmaktır. Projede yapılan değişiklikler, hem yapılan işin doğasını hem de gerçekleştirildiği zaman dilimini dikkate alan bu yöntem kullanılarak izlenebilir. Sistemin etkinliğini ölçmek için YSA sistemi yapısal betona ve bina duvarlarına uygulandı. Sistemin nihai çıktısı, ilerlemeyi izlemek ve gözlemlemek için basit ve güvenilir bir yöntem gösterdi.

Anahtar kelimeler: PV, ANN, Proje İnşaat Alanı, Proje Saha Alanı

1. Introduction

In a framed building, four major areas which eat a substantial portion of the total project price are the structural edge , architectural construction, foundations, and motorized and electrical services. It is essential to explore all possibilities to achieve economy in a piece of these areas on the design stage, since investigations have designated that about 80 apiece cent of the scheme cost is committed through the time 20 apiece cent of the

project (sketch design phase) has been finished . Further, in the present age of ever-increasing costs, the majority of the customers of building projects are insisting on projects existence designed and executed to give maximum value for money. Hence specialists are employed to effort as a team to an increasing extent throughout the design stage. As buildings become additional complex and building customers more exacting in their requirements, so he becomes necessary to recover and refine the price control tools. Price planning and cost switch are complementary (Harb 2016). During cost preparation , the commonly accepted approximate estimating methods for computing the cost of structures are the fraction estimate method, the superficial or floor part method (also recognized as the square metre method) and the approximate quantities method. A proper application of the first two approaches in practice requires, on the one pointer , an in-depth knowledge of historical cost information of completed projects and, on the other pointer , a knowledge of the effect of project parameters on the building cost. The last , though not emphasized in practice is actual important, since structures are not generally similar and rates have to be adjusted for vicissitudes in design features. Besides, past past cost information needs to be adjusted by the application of the price index which is infrequently available in the wanted form, especially in developing countries. Cutting-edge the estimated quantities method, price estimates for new structure works are often complete by assuming approximate amounts of concrete, strengthening and form work (Amusan, Dolapo, and Joshua 2017). In the absence of realistic info relating to variations in the quantities of resources with changes in dimensions of column grids, structural scheme, amount of storeys and additional design parameters, the quantities assumed tend to be very approximate then the percentage errors might be large. Anywhere more realistic estimates are required, the cause works out alternative physical schemes, and the most economical scheme reliable with the requirements is selected after the amount surveyor has calculated the quantities and costs for the various schemes. It is extremely haphazard and wasteful if physical schemes have to be worked out and prices estimated every time a new building project originates up. However, in recent years, the emphasis on investigation relating to building price techniques, especially finished mathematical modelling and the availability of microcomputers on the cost of electronic typewriters, have if openings to overcome these problems. Trimble then Jupp at Loughborough College of Technology developed price models using regression methods for various facets of building work. Gould produced a cost perfect which deals with the capital cost of boiler , ventilating and midair conditioning installations for numerous building types. Newton and Schofield et al. also produced price models related to the various aspects of structure (Palikila R. 2015).

2. Comprised In An Estimate

An estimate is much more than a simple list of scheme costs. Cost approximations detail every component of work that is obligatory to bring the scheme to life by exactness the assumptions that motivate each cost, presences and exclusions, then associated risks (Alqahtani and Whyte 2013). The estimate should comprise a breakdown of altogether costs involved in the project. There are two main categories to classify costs (Dong, Chen, and Guan 2020):

1) Direct costs:

Costs directly associated by the job (such as, project labour costs, materials, equipment)

2) Unintended costs:

Prices incurred by the business as a part of doing business (such as, utilities, office space, cover) Cost rudiments included in estimates determination vary from business to business, but the most common costs to consider for service trades include:

1. Labour: The price of human resources that are working on a project, both in terms of salary then time Materials and equipment: The price of buying and upholding any materials and gear required for a scheme
2. Facilities: The cost of using slightly working space that is not owned by the business Vendors and sub-contractors: The cost of signing third-party servicers to complete work(Ibrahim and Elshwadfy 2021).

More accurate planning: When you're able to accurately predict what errands and resources are obligatory to complete work, you'll be able to efficiently produce an effort breakdown schedule, allocate work to staff, and adhere to predictable timelines. Better profit margins: Several factors (such as unexpected events, poorly scoped work, and inflation) can cause job costs to increase throughout a occupation's life cycle, which presents a risk to completing the work inside budget and hitting success targets. Accurate approximating accounts for expected then unexpected costs and assistances protect the profit limits (Adillah Ismail et al. 2015). Improved reserve management: With better insight into the errands and timelines required to complete work, the contractor can ensure the specific skills wanted to complete each deliverable, identify resourcing holes , hire additional persons as needed, then take on new schemes with confidence. Stronger client relationships: When clients understand the 'why' behind a project's cost, they're more likely to faith the expertise and imagine changes to the price estimate as the scheme progresses, resulting in better working relationships. Better reputation then repeat business: Once projects are delivered on time and on cheap , the likely to create happy customers, win repeat business, and gain more transfers (Ahn et al. 2010). present a study showed that the internationally competitive world, by diminishing profit margins then decreasing market shares, the cost of a project is one of the major criteria in decision making at the early stages of a building design process in the construction industry. The model is developed by means of the information of 132 projects. Subsequently, an experiential method is developed to systematically improve and well -tune the presentation of the model. Eventually, the answers show that artificial neural networks (ANNs) can obtain a justly accurate cost estimate, even with small datasets. In fact, the model proposed in this paper performed healthier than those proposed in other similar works. The model developed in this study showed a 14.5% improvement in the correctness of the model, considering MAPE (Matel et al. 2019). Present a study showed that the importance of decision creation in cost estimation for building design processes opinions to a need for an estimation tool for both designers and scheme managers (Günaydin and Doğan 2004). Proposed a study showed that the success of any project undertaking is defined by improved amount and cost estimation methods that will

facilitate real cost and time switch in projects. The objective of this education is to develop an artificial neural network (ANN) model that can predict the entire structural cost of structure projects in the Philippines (Roxas and Ongpeng 2014). Showed that the construction cost prediction is important for construction companies to compete and produce in the industry. The purpose of this study is to design construction cost forecast model and compare by Regression Analysis and Provision Vector Machine considering resources cost as input limits (Salunkhe 2020). The study showed that the Neural networks were rummage-sale to approximation the cost of plane engine components, exactly shafts and cases. The neural network procedure was compared with consequences produced by the present conventional cost estimation software and linear regression approaches. This significant development over linear regression can be attributed to the neural network ability to handle complex data circles with many inputs then few data points (Weckman et al. 2010). The study showed that the Recently researchers have found the potential requests of Artificial Neural Net (ANN) in various fields in public engineering. Many efforts to apply ANN by way of a predicting tool has been fruitful. These consequences show that ANN is able to provide dependable result in term of forecasting the housing request based on previous cover demand record. Important words: Time Sequence Univariate Neural Network, low cost housing request , RMSE, MAPE (Bakhary, Yahya, and Ng 2012). The study showed that the Data-driven top down initial cost estimating models deliver a means to healthier quantify the scope of work in dollar. The research exertion applies an artificial neural network methodology, by way of well by way of a manifold regression estimation model, to compare prediction correctness of proposed estimating methods to those achieved below MDT's current practices. Four separate estimation reckonings are provided to forecast agency costs under three broad project work kinds . Together these collections of work account for more than 80 out of a hundred of the agency's construction package (Gransberg et al. 2017). has inspected risk factors in price estimation of building projects. A study was made of danger emanating from risk issues as perceived by structure contractors. It is optional by the study for not only contractors to be vigilant in extenuation of risk factors, but clients as healthy should also take this initiative as they are bound to suffer once inaccurate cost estimates are committed to a scheme (Eliufoo 2018). Showed that the Construction schemes are getting progressively multifaceted and their scales are getting sophisticated. Lengthways these lines, he is getting more difficult to finish the schemes inside planned cost bounds . The outcome demonstrations that the rate of the rank correlations was a high positive amount , which implies here is a positive joining between them on the ranking of factors worrying the accurateness of price estimation in public structure construction projects in cowboy movie Oromia (Chimdi et al. 2020).The purpose of this study is to examine appropriate key factors swaying construction project cost approximations with a view to improving construction project presentation . The research education can be used to further investigate the equal of performance and the selection criteria of building project consultants (Oke and Aigbavboa 2019). The study showed that the Selection of a cost estimation technique is generally dependent upon the level of development in engineering and project in each project. The chief capital cost estimation approaches include capacity factored, equipment factored, parametric model, semi-detailed and detailed price estimation. This object will show how to use cost esti- mation methods in dissimilar design stages of a project (Shabani 2015).The study showed that the Building industry plays an

significant role in the growth of a country. The results designate the cost controlling does that are in recurrent use and their rank in minimizing the price overruns in order to reduce over budget then overheads while securing expected profits. Finally, it is suggested that CIDA (ICTAD) should encourage contractors to use cost controlling methods , by conducting exercise programs, awareness agendas , etc. He is also suggested to make the use of some of ICTAD leaflets mandatory (Malkanthi, Premalal, and Mudalige 2017). The study showed that the Unique of the most powerful factors of why a project becomes successful is estimating the cost. Stochastic models were simulated with Monte Carlo process. The consequences helped to comparisons of three approaches with using the qualitative and measurable criteria and MCDM then finally best cost approximation approach is selected (Firoozabadi, Rouhani, and Bagheri 2013). The study showed that the impact of healthier cost estimation accuracy for a firm that offers on projects. The findings assistance us better understand the process and effect of cost estimation accuracy in the bidding environment then provide practical implications (Fry et al. 2016).

3. Artificial Neural Networks Cost Estimation

False neural networks (ANNs) can be defined as mathematical constructions and their implementations (both hardware and software), whose mode of action is based on and inspired by anxious systems observed in countryside . In other arguments , ANNs are gears of artificial intelligence which have the ability to model data relationships by no need to shoulder a priori the reckonings or formulas which quandary the variables (Arafa and Alqedra 2010). The networks come in extensive variety depending on their structures, way of processing signals, then applications. prediction, approximation, control, association, classification and pattern credit , associating data, data analysis, sign filtering, and optimization. ANNs features which make them beneficial in cost estimating problems (in particular for price estimating in construction) are as follows (Juszczyk, Leśniak, and Zima 2018):

1) Applicability in reversion problems where the relations between the dependent then many independent variables are difficult to investigate
2) Ability to gain information in the automated exercise process
3) Ability to build and store the knowledge on the foundation of the collected exercise patterns (real-life examples)
4) Ability of knowledge simplification ; predictions can be made for the information which have not remained presented to the ANNs during a training procedure .

4. Results

The largest obstacles standing in front of a cost estimate, particularly in early stage, are lack of preliminary information and larger uncertainties as a result of engineering solutions. Quantity calculation done if the planning process is mature so that the job description, but in the early planning may not be based on the calculation of the quantity. Selection of detailed price estimation methods require more detailed guidelines and a relatively long time in order to obtain an accurate estimation. In the present paper, the effective factors which cause a trouble in cost estimation

of construction projects specified with project size/ gross floor area, project complexity of design and construction, construction method/ techniques /technology, project duration, number of project team members and quality of construction required. In order to specify the main effective factor, the relative importance index (RII) is used to find out the higher score of these factors a shown in figure 1.

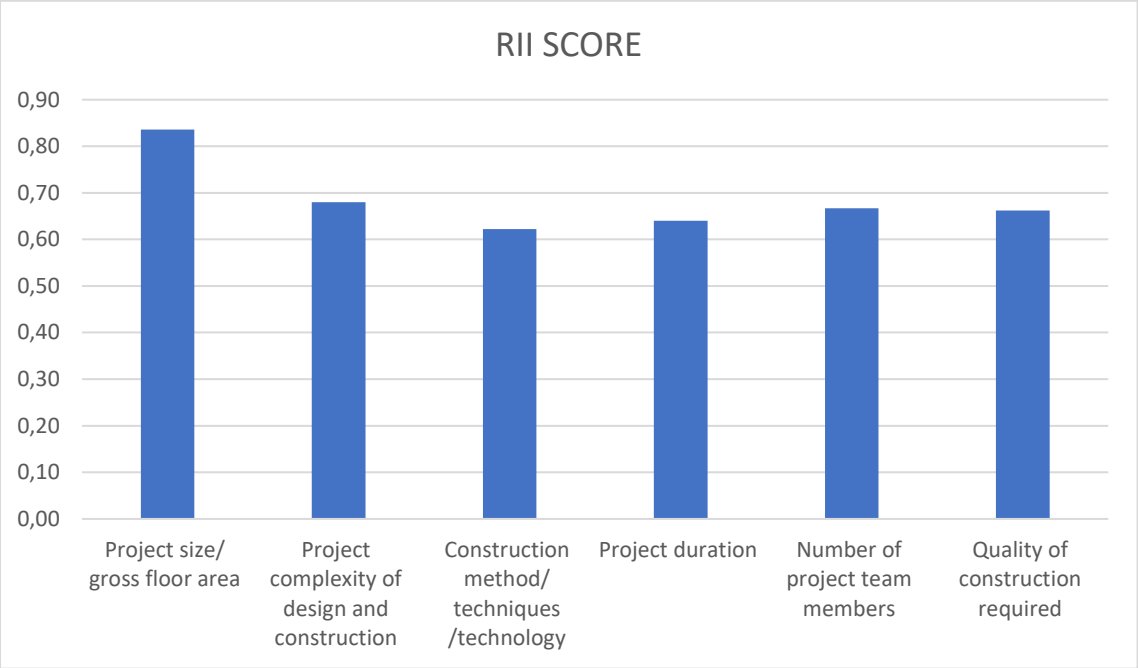

Figure 1. RII results of the effective parameters

Due to these findings, the performance evaluation prioritized the cost and specification of construction factor influence. A relative index analysis was utilized to rank and analyze criteria. Relative significance index analysis is used to discover most key criteria and rank Likert scale indicators. The next step in the present work is to evaluate the RII finding in the project cost estimation. The project budget covers all payments and expenses during the project's life cycle. Project managers will calculate and evaluate the project's success based on the estimated budget. The concern is whether the estimated project will provide an accurate evaluation. This method uses real costs to calculate cost-varying budget variances. This makes it easy to track a project's budget over time. Iraqi project managers, academics, and industry professionals (quantity surveyors, architects, and engineers) with construction project management and evaluation skills were assembled. According to professional comments and survey results, effective building criteria might affect a construction project using the calculations below.

	$y = 0.6517x2 - 0.6706x + 0.2156$	(1)

where y is the percentage of differences in cost depends on the effect of x which represent the building area/site area. This formula is founded from tracking the variations in the costs of different areas of building projects and cites. The results observed a dynamic relative variations of costs as shown in figure 2.

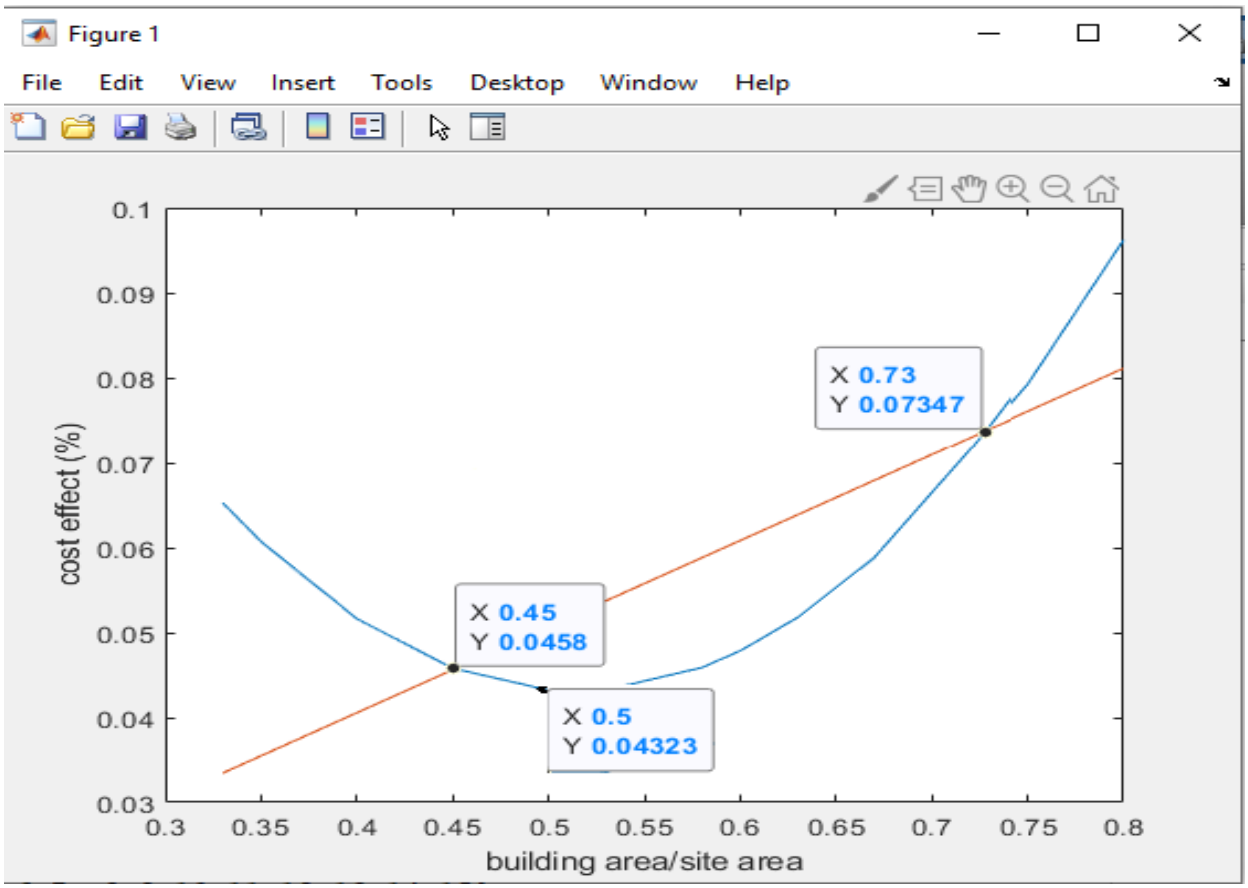

Figure 2. Cost effect variations

As shown in the figure, the correlation regression intersection points specify the boundary conditions of building area to site area index and the optimum point an (x=0.5 and y=0.0432). this results are the core of ANN training process. It is used in ANN-based method for tracking project cost and time. From this perspective, the technique tracks project cost and time. The present technique monitors project revisions based on work types. To test the ANN system, it employs the project's concrete and walls. Change management is unique. In order to test the present system, the input representation is selected as a building with cite area 600 m2 and building area is 350m2 which represent the optimum selection results of point (x=0.5 and y=0.0432). using Revit software provide the researcher the area of walls and roofs as shown in table 1.

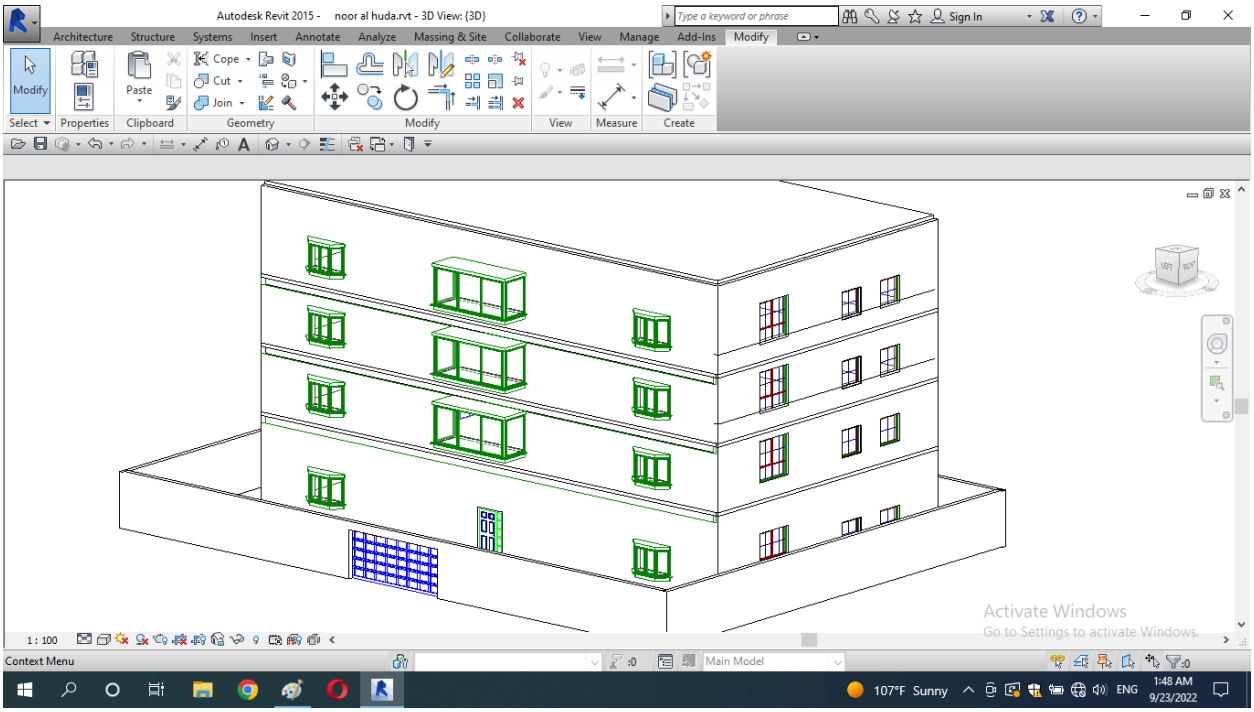

Figure 3. The Revit result of the used case study.

Table 1. The Revit walls and roofs quantities

	Quantity (m2)
Walls area	2081.82
Roofs area	7369.32

The ANN system will monitor the brick-by-brick construction of the walls in this phase. Using the data shown in the Figures below (schedule data) and the output data (output data). By employing the ANN approach, it is possible to uncover the acceptable degree of deviation from cost and schedule goals. An actual construction project was used to collect data for this study's performance evaluation. It's important to look at actual data to see if the cost indexes are acting normally. These charts are an example of an analytical method that provides important information for distinguishing between managed deviations (which are permitted) and uncontrolled deviations (which are not acceptable). This information assists the project manager in making decisions on how to keep the project on track by spotting difficulties with project progress and taking corrective action at the right moments.

It can be observed that there is a less payment in actual values than the planned values. This result can present a real indicator to the project manager about this item of tender.

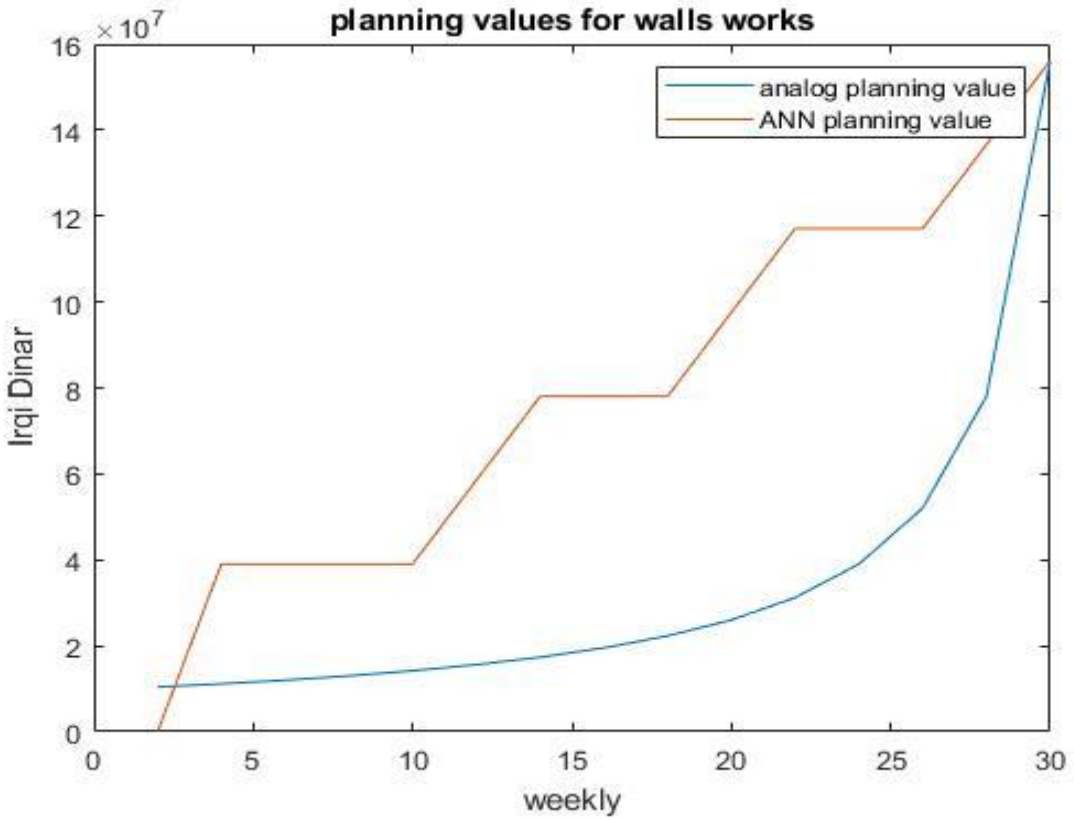

Figure 4. A Comparison between walls analog cost estimation planning values and ANN results

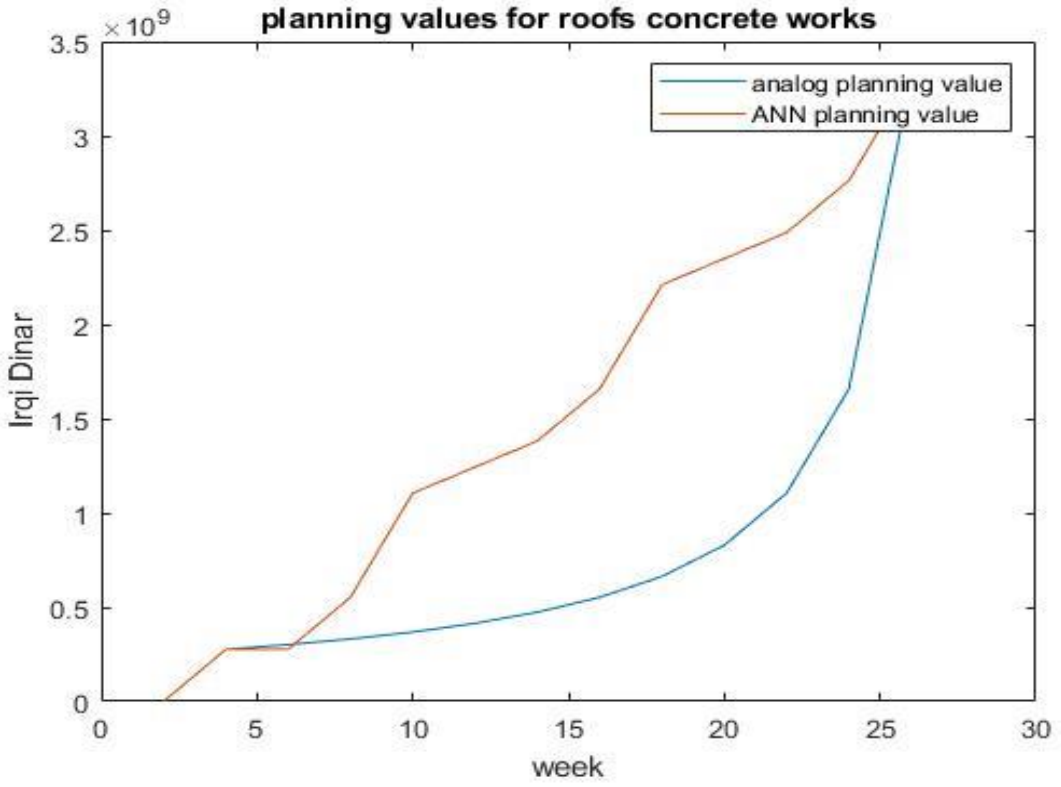

Figure 5. A Comparison between roofs analog cost estimation planning values and ANN results.

The results observed a real planning results of project payment which is very useful in project budget planning.

5. Conclusion

The project team and project management must reduce costs properly. There are several ways to accomplish this. The project manager oversees the project's objectives and expenses. If a project manager fails in this regard, project management is ineffective. This is because it determines the company's profitability. In traditional cost control strategies, a budget is applied during project planning. The budget includes all project payments and expenses. The project managers are responsible for all budget-based computations and performance evaluations. The question is whether the estimated project offers a suitable evaluation. This research created an innovative approach for tracking a project's cost and duration depending on its area and cite. The current strategy tracks project changes based on construction type. Real project concrete and walls are used to test the ANN system. Change management is unique. Change cost mechanisms must be in place to account for future project changes. This study employs cost estimate to determine cost-varying. This makes tracking budget spending across a project's stages straightforward. Actual expenditures must be compared to each time period's budgeted targets. Depending on the length of the project, weekly, monthly, or annual goals may be set.

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