

The Prospective of Artificial Neural Network (ANN's) Model Application to Ameliorate Management of Post Disaster Engineering Projects

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ABSTRACT

We have found that it is important to conduct this study now, especially under COVID-19 or post disaster, or any other disasters whether they were natural or man-made, to recover from those disasters, crises and to mitigate those risks from societies as much as possible. Society and paralyzes its movement as occur with COVID-19 and focus on project risk management of all kinds digitally and remotely to mitigate crises and control the economy of countries from collapse. We should use the Artificial intelligence in the absence of a solution of problems facing all projects in all countries and work together on self-development first and then the development of information technology IT, continuous updating of what is happening in the world of developments and that crises generate innovation "the need is the cause of invention". This study deals with the use of Artificial Neural Networks (ANN's) to find a solution to problems and delays facing projects or in the absence of a physical or mathematical solution. The ANN model was used to build a model as a way to find a solution to the delay problems in projects, discusses the reconstruction strategies and delays in time and cost caused by different delay factors in some selected projects in Baghdad (as a case study). Selected projects crew and laborers were the main part to data collection through a survey and questionnaire forms filled by them.

INTRODUCTION

Projects in Iraq or any other country are suffering from different factors of delay, those factors vary in their importance also due to many reasons, some of those reasons are in common in different countries, and some are related to a certain country or situation of that country. Thus, the method of collecting data should be built due to the area these data are collected from delays in engineering projects are the challenges often faced in the course of implementation, where delay is a common problem in building industry all over the world that affects development of the construction industry particularly and of the overall economy of countries generally. To improve performance of project it is important to study the problems of delay that affect the success of project.

The Iran-Iraq war of 1980 had damaged many construction projects and buildings, bridges, infrastructure etc. Nevertheless, Iraqi engineers reconstructed that in a shortage of time and economic cost because Iraqi economy status last years was very good compared to these current years followed with right planning and achieving in construction projects management. In contemporary times, the city has often faced severe infrastructural damage, most recently due to the 2003 invasion, and the subsequent Iraq civil war that lasted until December 2011. In recent years, the city of Baghdad has been frequently subjected to insurgency attacks, the matter that led to destroy more of the infrastructure in the country. Thus, some projects were started to build what was destroyed up or to establish a new projects to contribute in improving life in Iraq.

Avoiding wars from occurring is the best way to prevent war-related disasters in the first place. Perceptibly, it is too late to prevent what occurred during the war between Iran and Iraq that led to an outbreak of hostilities later. Similar situations are likely to arise in the future of this country (Iraq) especially after the collapse of the prior regime in 2003 and what followed of the wakened armed conflicts that delayed construction industry in all fields in Iraq.

To understand reconstruction after disasters we must build the subversion resulted later, and rebuild the infrastructure in a process of urbanization under post war/disaster conditions. Therefore, it is a definition in a scale minus, because it takes in consideration the rebuilding process of the destruction of the physical infrastructure only, and neglects the rest of the urban fabric components. Which form the physical structure of a society, where the physical infrastructure is, in fact, a reflection of life cultural, social and economic history, technology, climate, and human activity.

It has been known that reconstruction strategies after the disaster is a group of processes and policies that are placed to cope with disasters and prepare them before those to occur (Laframboise and Loko 2012) and meet the pressing needs during a disaster and the reconstruction of what was damaged by whether on a short or long-term level. So that these policies are inclusive of all aspects of life which intending the rebuilding processes during or post disasters within other social, economic, cultural aspects, and these policies are different in nature from those that are placed in situations and normal conditions. Moreover, it means meeting the needs of the abnormal and unstable conditions and considered disaster management as public project management and defined 10 Critical Success Factors (CFS) that must be taken into consideration in disaster management as follow, effective institutional arrangement, clear responsible governmental unit and authority line will speed up decision making in recovery. On a national level, specific governmental department and responsible unit must have fully authorization to manage disasters, coordination and collaboration and has developed key considerations in pots-disaster reconstruction, was based on Disaster Emergency Committee (DEC) member agencies' experience during post-

tsunami reconstruction in Aceh. He arranged reconstruction process into three sections: Planning, design and construction. The humanitarian disaster occurred after the 2003 in Iraq was a product of the war and all sabotage and violence actions related to this war were literally practiced in Iraq in different levels of the society. Moreover, led to clog the construction industry in Iraq for different reasons that delay or hinder the whole process causing cost and time overrun when projects implemented under these circumstances ^[1-3].

In their study, they examined the causes of time delays and cost overruns in thirty post-disaster reconstruction projects in Iraq. Although the factors of delays have been studied in many countries and contexts, there are few data available from countries in light of the conditions that characterize Iraq during the past ten to fifteen years of wars and crises that have not been witnessed by humans before. The case study approach was used, with thirty building projects of various types and sizes selected for the Baghdad case study. Project data were collected for surveys that were used to build statistical relationships between time delay rates, cost and delay factors in post-disaster projects. The most important delay factors identified were contractor failures, redo designs and change orders, security issues, selection of low-price bids, weather factors, and owner failures. Some of them may be in line with findings from similar studies in other countries and regions, but some are unique and are only found in samples of projects for the case study Iraq, such as security issues and the selection of low-price bids. While many studies have examined the factors causing delays and cost overruns, this study provides unique insights into the factors that need to be considered when implementing emergency and post-disaster reconstruction projects in areas affected by war and terrorism ^[4].

Thus, the purpose of this study came to invent models under ANN's approach to consolidate projects that face problems in implementation by knowing the effective factors of delay before they occur, and to estimate the actual cost and time necessary for project and avoiding the overrun in both terms of cost and time under severe conditions of post disasters projects.

In their study, the content analysis to identify 38 recurring cost overrun factors and 11 major causes in oil and gas construction projects. The factors that cause cost overruns have been categorized based on their common root causes. The Delphi method was used to verify this classification. Evidence from 12 construction projects in the oil and gas sector that experienced cost overruns was used to verify the results of this study. The results of this study may help workers in the project sectors to mitigate the risks of cost overruns in oil and gas projects and achieve their budget targets and not exceed them and focused in their study on developing a distinctive plan for emergency reconstruction projects and helping community leaders and planners educate the public about how informed decisions and choices affect the process of rebuilding and achieving a safer and more sustainable society, economic recovery; emergency planning recovery. In discussions and deliberations within communities and about post-disaster reconstruction policy, participants have many other interests to balance against concerns about natural hazards like earthquakes; floods or war. These emotional debates elicit an often fervent desire to perpetuate historical and unsafe development patterns and construction techniques versus a desire to use disasters as opportunities to rethink these patterns and practices and move away from unconscious decisions of the past. Intelligently balancing competing interests has always been at the heart of planning ^[5].

They devised a program to predict delays in construction projects and before the project reaches the stage of cash shortage and stoppage, to mitigate Hazard and to give a new method of risk management to make change in traditional stylish Risk assessment by using a real data form Iraq Case study by using artificial intelligence networks through the questionnaires on which the program was built and which were distributed in projects and data collection through a distributed data collection survey conducted by the author. Mathematical data analysis was

used to build a model to predict the change in time and cost of projects before construction began. Artificial neural network analysis was chosen as a mathematical approach. The most important factors identified that led to schedule delays and cost increases were contractor failures, re-designs of blueprints and change orders, security aspects, underbidding bids, weather factors, and owner failures. In their study, the researchers confirmed that using the ANN model for such a problem is an effective way to model this complex phenomenon and found that the use of the artificial neural network model is an important option for problems that projects may face and is expected to be an effective method for modeling this complex phenomenon in post-disaster emergency reconstruction projects.

MATERIALS AND METHODS

We assumed that delay in cost and time has difficulties to be predicted and solved, thus ANN's was chosen to reach a solution for them. Due to the development in the information technology and computer sciences recently, this branch of knowledge artificial neural networks "ANN's" has grown rapidly to find solutions for complicated data analysis which is based on large sample size to find solutions for problems by modelling them using high computer languages and sophisticated algorithms. The easiest way to represent ANN's principle is that they are simulating the human brain in solving problems in a primitive way. Definitely many processes occur inside the brain cells "neurons" to solve a problem then a solution comes out for them without knowing how that solution was made up. Signals between neurons are transferred through links where the strength of these links interpret how strong the relationship between neurons are in the ANN analysis, where Figure 1 represents the layers of processes that happens in treating data under this approach [6].

Figure 1. ANN's work steps.



Answers of these questionnaires are representing the main data that has been processed to reveal solution for delay in time and cost. Therefore practicing these models, will definitely contribute in finding suitable solutions to avoid delay in projects and estimating them before they occur especially after these causes of delays being repeated in different projects while the projects themselves are described as unrepeated projects. Each project is somehow different from another one. Moreover, that will optimistically help the constructional foundations to assess the current status before starting a project. Results have been discussed to explain how delay factors are acting then raising all reasons causing them and showing which factor was the most effective and which one was the least. Also, ANN's and regression models were tested to estimate delay in cost and time and showing the ability of using these models to estimate the needed time of implementation and the adequate cost that should be considered in the budget of the project with the required quality. The model should consider the quality in determining the expected delay in cost, where the later should be determined due to some standard specifications

following the Iraqi standard specification (ISS) that is originally derived from the American Society for Testing and Materials (ASTM) [7].

Artificial Neural Network analysis (ANN's)

The definition of intelligent neural networks in an artificial endeavor ANN's is to find the solution in the absence of problem solution. Neural networks are a computational tactic used in construction and other different research disciplines, which is built on a large compilation of data represented as neural units (artificial neurons), somehow imitating the way an organic brain answers questions of research and solving a problem with large clusters of biological neurons connected by axons.

Artificial Neural Networks (ANN's) have been used as a method to find a solution for complicated problems or no solution problems. As in this study, ANN's based built model was used as a method to find a solution for a complicated problem which is forecasting delay in construction projects under two different circumstances [8].

We assumed that delay in cost and time has difficulties to be solved, thus ANN's was chosen to reach a solution for them. Artificial Neural Networks (ANN's) have been used as a method to find a solution for complicated problems or no solution problems. As in this study, ANN's based built model was used as a method to find a solution for a complicated problem which is forecasting delay in construction projects under two different circumstances. Conventional conditions in Baghdad as a case study which is suffering from stress of many kinds of conflicts and the other one is under emergency conditions especially after the war against terror that forced people to depart and move to other areas.

As to the previous definition of the ANN's, the model was built in this study is composed of three layers, input layer, hidden layer, and output layer. The first layer "Input" represented by input factors identified by the user (delay factors) to predict the third layer (Output) of an efficiency multiplier (Time and Cost) based where those multiplier is then used to adjust an average time and cost gradient (ΔT and ΔC) of implementation for use on a specific project. The model used in this research is the Artificial Neural Network (ANN) approach. To review the concepts of these models, we find that they simulate the learning behavior of the human brain.

To illustrate this, we first need to imagine the basic neurobiological structure of the brain consisting of an estimated 1011 (100 billion) neurons, neurons connected by electrical signals that are ephemeral pulses of electrical current in a cell wall or membrane. Synapses are those inner neural connections, which are refereed by electrochemical joints as they are located on branches of the cell called dendrites. Normally each neuron gets thousands of connections from other neurons, and therefore it constantly accepts a huge amount of internal signals that eventually reach the cell body. They are also combined together in a certain way to develop a weighted signal for the input and when the resulting signal exceeds some threshold value, a voltage pulse will be fired or generated by the neuron in response. This signal is then transmitted to other neurons via branching fibers of neurons called the axon [9,10].

However, since biological neural networks are then formed, artificial neural networks are modeled as a set of elementary computational entities represented by nodes, organized in a corresponding technique. The nature of the brain is designed to contain nearly as many neurons while artificial neural networks have much fewer nodes than the neurons in the brain. In addition, ganglia function much simpler than the neurons they represent. However, this will not prevent artificial neural networks from detecting brain-related properties that include learning and memory at different scale and amplitude. The node is the main component of the artificial neural network and compared Artificial Neural Network (ANN) with Adaptive Neural Fuzzy Inference System (ANFIS) models in a distribution system with non-deterministic inputs to reduce cost from the classical recharge model, finding that using ANN reduced cost

by 34% while saving 36% of the cost using the ANFIS model, along with the newer model was able to modify the values of input and output variables and parameters for a more robust solution.

Further development of this ANN model for construction project management is possible in some different fields such as manufacturing and design. Similar ANN models have been successfully developed, for example the garment industry and developed three cost prediction models in order to determine an accurate cost for road maintenance. These models were developed in the province of New Brunswick based on historical data during the period 1965–1994. Based on the models and the management review, it was concluded that maintenance funding needed to be increased by 25% and developed a parametric cost-estimating model for highway projects by using a neural network approach to manage construction cost data. They introduced two alternative techniques to train network's weights: simplex optimization (Excel's inherent solver function), and GAs (genetic algorithms). Multiple linear regression models for preliminary cost estimating of road construction activities as a function of project's physical characteristics such as terrain conditions, ground conditions and soil drill ability were developed.

The multiple linear regression models for preliminary cost estimating to be used by Alabama Highway Department (AHD) for long range cost forecasting. The total project cost per mile is the function of a list of probable predictors comprising line items, such as quantities of work items per mile.

Thus, another model was built using statistical approach (SPSS 2010) where liner regression was tested for the collected data in two models, the first one to reveal the relationship between the actual and the planned time, and the second one was for the actual and planned cost.

These two models "equations" represent a liner regression of the form:

$$Y = a \pm bX$$

Where: Y: the estimated time or cost (dependent variable)

X: delay factors (explanatory variable)

a: intercept (value of Y where X=0)

b: the slope of the line

Correlation coefficients were also calculated to figure the strength of association of the observed data for X and Y.

Data included in these models were for the projects in the conventional and emergency status, where we put in out consideration that ANN's analysis wouldn't fit in emergency status because these projects are not suffering from delays because every step in conducting them was studied and implemented they way it should be, but their data were used in finding the regression relationship of predicting cost and time of implementation.

Projects in Iraq or any other country are suffering from different factors of delay, those factors vary in their importance also due to many reasons, some of those reasons are in common in different countries, and some are related to a certain country or situation of that country.

RESULTS

Delay factors in relation to questionnaire results

The suggested delay factors of this study were pre-reviewed and some factors were selected to be those ones that affect construction project implementation and management. Beside the reviews survey, field samples were represented by questionnaire and have also suggested that the main delay factors are occurring frequently in the environment of this case study (Baghdad city, Iraq).

As Iraq went through war circumstances and still passing through consequences of war action, as sectarianism violence, religious extremism, political affiliations, etc. all that led Iraq to go through emergency status, and all constructions projects occurred in that time would be considered as emergency status projects.

More than 90% of bridges in Anbar province, Iraq (for example) were totally destroyed. Few temporary bridges were built to replace them and those new built bridges are one side local made and materials, where they are just an emergency-built bridges, the money is granted by donors countries so they have to be rebuilt to their original status and all that need giant projects to rebuild them.

Residential units and foundations are also destroyed where the whole infrastructure of the big cities of this province were totally destroyed by terrorist group to prevent Iraqi army and liberation forces to liberate these areas from their authority. The matter that looks very difficult to rebuild and reconstruct unless all efforts, funds and supports are gathered for these destroyed areas.

Here we can mention what happened to Iraq in early centuries when the Mongolian army invaded Baghdad 1258 AD and destroyed it. Although what is happening NOWADAYS is even worse than what happened in that era.

Three emergency bridges were assigned in Ramadi transportation state of roads and bridges in the ministry of construction and housing. Mentioning Al-qasim, Abo-Faraj, Omar bin Abdulaziz, alternative bridges as emergency construction project. They were rebuilt by using a loan from the international bank of 4.300.000 million \$ in one year of implementation and through the field visit, al Qasim bridge has been conducted and being used for public transportation after liberating these area from the authority of terrorists groups.

Costs relationships

We investigated the regression model between the planned costs (CO) with the actual cost (C act.) for 28 of the implemental projects. This shows that these two costs (CO, C act.) are very correlated to each other ($R^2=0.96$). We applied this equation as a feedback to determine the actual cost of the 28 projects included in forming this equation. It gave very close values to actual cost values. We also applied this equation to another two projects cost, that were not included in forming this equation, and it also gave a very close predicts to the values of the actual cost. That means this equation could be valid to predict the actual cost of any project if we know the planned cost that was originally put while bidding.

The theory could be used by both sectors, the governmental and the private. Where in most contracts, the process of bidding is to accept low prices, therefore there will be some consequences resulted from low prices bidding that reflected by fraud and quality manipulations when the contractor may show while carrying out and here it could give the key to determine actual cost of any project.

Times relationships

We also investigated the regression of the contract time and the actual time of implementation as a trial to predict the actual time when the contract time is fixed. There was a high correlation between both durations of implementation ($R^2=0.92$).

It gave a close value of the predicated time of implementation to the actual time besides we also tested this equation for some projects that not included in forming the equation itself, and it gave a close estimates to the actual time of implementation. This equation then could be used to determine the actual time of projects implementation when the planned time is fixed in the contract itself.

The difference between the predicted time that is almost equal to the actual time, and the contract time (planned) is caused due to the delays factors that were studied in earlier paragraph. Analysis of variance showed that there was no significant deference between the planned cost (CO) and the actual cost (C act.), where most contractors

were committed to their prices they submitted to conduct the work, with some variation or extra cost in spite of the non-significance of it. While there was a highly significant differences between the contract times (T₀) and the actual time (T_{act}) ($p < 0.01$) which confirms that most contractors are not committed to the time of implementation due to factors of delays suggested in this study, the matter that lead the beneficiary to apply penalties of time shifting. These empty cells were not use in building model equation but they gave a close values as a feedback.

ANN's and statistical model building

A glance at results will show how delay factors were playing on the cost and time delay. Hence, the statistical methodology has given results to arrange delay factors in a way as factors were studied to be affecting cost and time delay. If we look at the model that was built for this study, we can see that delay factors can affect cost and time delays directly.

This models can be used in engineering projects to predict delay ratio and additional cost before the deadline of project in time and before approaching to the financial shortage. In this case, there will be two plans to put in consideration before starting the project itself. The first is to shift the cost of the project to approach the cost predicted by this model and in that case there will be no or less shortage in cost, also adjusting the time specified for the project and in this case, therefore, time delay could be eliminated. The second plan is to over control the factors causing delay as possible as the implementer could do, and here both cost and time shortages will be decreased too. This model can be used by both, the beneficiary (owner) and the implementers (contractor). Where contractors can use it to predict the additional cost and time that should be put in consideration when the bid would be assigned to him. Here he will put all possibilities in the plan before bidding, and he can also negotiate with the beneficiary for better results. This model is mainly built for the beneficiary before even assign the bid to any contractor and listing conditions of the contracts that includes estimating the right cost and time line for successful project at the end.

DISCUSSION

Advantages of the current study

This study showed by revealing some facts:

1. It gives a summary of the stages of project management and reflects an impression of the implementation processes that the project may go through.
2. The model that was built according to our field research study may touch the reality of construction projects, find practical solutions, and reveal the reasons for the delay.

We should Making future Studies to focus on the delay factor that were found in this study in more details to make sure all the reasons that participate in making these factors as a delay factor controlling time and cost in construction projects. So we can study some other factor that were included in this study as an external factor, while the future works should focus on each of external factor as a main factor such as power shortage and the infrastructure of this country (Iraq), Training and developing the technical engineering team of the beneficiaries following real and well prepared programs where these teams should be tested and evaluated by higher committees to decide if they are technically and practically qualified enough, Rehabilitating contractors on different level because contractors are considered as the implementer and the real cause of delay in time and cost, by holding workshops and lectures to educate them in the field of bidding and implementing better contracts, Supporting and improving construction tests laboratories on a national level and opening more branches in different areas and provinces. Also, encouraging private sectors to open their own laboratories, as well as provoking the use of the in situ laboratories that depended by governmental institutes and directorates to avoid bias and

fraud of sampling that might occur while translocating samples to different places for tests, Statistical analysis has also given a precise estimates of delay in time and cost therefore the model built under this methodology could also be used to forecast delay in time and cost, Testing more factors and upgrading the model according to the time of conducting and the nature of construction projects, Getting rid of administrative corruption spread in every joint in the country starting from school level and ending to all services facilities, social, health, residential, Building human being before raising constructions. Where the latest happen to be better and easier when white and honest hands stand for it, in addition, to allocate the proper person to the proper workspace, depending the scheduled plans in engineering projects managements in reconstruction practically as deeds more than words. The necessity of reviewing channels that all projects pass through to screen them to keep quality control of time and cost because time is considered as money in the market and keeping the planned time is a goal for this study. Wasting time is wasting of general incomes of the any country, Developing capabilities of the team, finding new legislations and rules to fit the current situations to keep the continuous evaluation and preparing programs to announce contracts in organized categories as the old categories are considered as unsuitable to the planned cost and time of implementation, training and qualifying the engineers and the teams of the project and strength the manager of projects in all governmental institutions. In addition, training should cover the constants offices in the private sectors to make sure to each to the quality. Finding solutions for the external factors such as the power and water shortages that control most activities of life. Where Baghdad and the whole country is suffering from the power shortage that causes most other kinds of shortages as an external factors since more than 15 years. Power shortage was one of the most important external factors causing delay. Thus, power plants should be considered as one of the first projects to take care of, starting with ending investment contracts with bad reputation firms and hauling contracts to a good reputation firms. For emergency status projects, there should be a proper disaster management whether they were natural or manmade disasters especially in the last years as many earthquakes hit. Therefore, all construction project must contain disasters precautions as one of the necessary requirement and putting considerations for worse conditions might Iraq (case study) go through.

CONCLUSION

We can say that our study revealed some facts, as it provides a summary of the stages of project management and reflects an impression of the implementation processes that you may go through. The model that was built according to the research field study may touch the reality of construction projects, find practical solutions, and reveal the causes of delay. We aim with the model created using the model to represent the project before starting it from the first preparation stage, such as the feasibility study and preliminary designs to help decision makers control delays in time. Focus on working with the iron triangle foundation of time, cost and quality which is the first step and reference for any project that begins.

We stress the need to rehabilitate and re-evaluate owners and contractors to ensure financial efficiency and specialization in project implementation and to withdraw the hand of any part that fails to exceed the restrictions and qualifications reported by the Ministry of Planning, Housing and Construction. The Ministry of Planning should also review all the rules, laws and legislations dealing with implementation to prevent the increase in high-rise funds for construction projects that will be implemented by unqualified companies, along with following the procedures of direct invitation and inviting well-known citizens. And global companies to compete. Therefore, it is necessary to focus on the qualification of contractors at various levels, because the contractors are the implementers and the real reason for the delay in time and cost, through holding workshops and lectures to educate them in the field of bidding and the implementation of better contracts. Building test laboratories are also

supported and improved. Also, encouraging the private sector to open its own laboratories, activating rules and legislation that guarantee the rights of engineers and project managers and giving them confidence to support their decisions. In addition to allowing watchdog and integrity sponsors to investigate instances of any inconvenience. Furthermore, reporting and reporting cases of corruption and fraud in construction project work. And follow accurate steps towards choosing the appropriate designs and plans for the project before starting implementation. Preparing accurate and complete Bills of Quantities (BOQ) to avoid falling into the corner of delay. And the enactment of a new law obligating executing companies not to sell contracts to more than one subcontractor. Depending on the low-price bids, if only these bids cover the real cost of the construction project to avoid any foreseeable delays during the implementation of the project.

Considering the skills and qualifications of an Executive Engineer with more than five years of experience to be referred and registered as an Affiliate Engineer supervising the meticulous implementation of projects. In addition to testing more factors and upgrading the model according to the implementation time and the nature of construction projects. One of the main external factors causing the delay was the lack of energy. Thus, power plants should be considered one of the first projects to be taken care of, starting with the termination of investment contracts with reputable companies and the withdrawal of contracts to reputable companies.

Getting rid of the administrative corruption that is prevalent in every joint in the country, starting from the school level and ending with all service, social, health and residential facilities. Establish an international council to oversee Iraqi reconstruction projects in which reputable countries that have fought and fight against administrative corruption in governmental and non-governmental organizations participate. Where Norway found to be one of the world's least corrupt.

The use of Artificial intelligence (ANN) to predict and identify appropriate solutions to the problem of delays in construction projects is extremely important for all countries to reduce and mitigate crises and properly manage risks and move in the right direction. Therefore, we must focus on managing risks accurately and employing technologies and information technology in the field of disaster management and mitigation as much as possible. Work must be done to develop remote project management and digital management. As for our study, it is possible to go to how to build mathematical models and artificial intelligence to solve a specific problem that may face any project in all aspects of life. The use of the model that was created according to ANN networks in this study is a way to avoid delays in time, not to increase the cost and to maintain the balance of the project until completion. Circumstances may differ or be similar from one country to another.

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