RESEARCH ARTICLE

DEVELOPING AN ANN MODEL TO SUGGESTS THE OPTIMUM TYPOLOGY FOR EFFECTIVELY MANAGING CONSTRUCTION PROJECTS.

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Abstract
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This paper aims to identify and analyze the factors that really affect the project success into the construction market in addition; the paper aims to develop an ANN-based model that helps construction firms in assessing/predicting their ongoing projects' outcome. Actually, this will improve the construction industry current overall performance and increases its ability to overcome the national market competitiveness and also, enhance the company's international reputation. The suggested ANN model is designed to be used for public building projects. It could be used to assess the success of these projects' type in terms of a degree of variation in project time - frame. The model is developed for the identification of all project typology attributes for construction projects in Egypt and Gulf Area.

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Introduction:-
Project Typology is a characterization from the known attributes of a project. The characterization will provide a more comprehensive understanding of the project that should result in developing an appropriate execution approach and the assignment of organizational resources. In different terms, project typology summarizes what is known about the attributes of a project that classifies the project in its category with other similar projects. For instance, when characterizing a project as large/small project. In such case the project size will become the profiling attribute. In other example, when characterizing a project as domestic/global, the project location becomes the profiling characteristic …..Etc. [1]

Projects management is not only about conducting a plan and executing it. Modern project management encompasses managing five primary areas including: the project's external and internal environments; its life cycle; integration / interfacing /configuration through reliable information; control processes; and performing effective communication process. Therefore, developing a project profile allows a systematic approach of developing a project execution plan that helps to right select of the project manager with compatible experience and skills. [2]

In order to correctly profile a project, a simple system must be used which have to include enough attributes for the purpose of capturing the most of all important projects' characteristics. [1]

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The Darnall-Preston Complexity Index (DPCI™) achieves this objective by grouping eleven attributes into four broad categories: internal, external, technological complexity, and environmental attributes. The DPCI is one model for understanding and profiling projects. This index assesses the complexity level of the project's key components and produces a unique project profile. This profile indicates the project complexity level, and provides a benchmark to compare projects based on their complexity level, which leads to gathering the project's characteristics that have to be addressed into the project execution plan. The DPCI provides project stakeholders with information regarding experience, knowledge, skills, and abilities needed by the project manager. The DPCI also has implications for the composition, organization, and skills needed by the project leadership team. [3]

The DPCI provides information and a context for developing the project execution plan and for assessing the success probability. [1]

The Darnall-Preston Complexity Index (DPCI™) is designed to develop a project profile that reflects different project aspects that will influence the project leading and executing approach. The DPCI is built on four categories of attributes:
1. External as: environmental attributes which has great existence at the project staring dates, such as size, duration, and available resources.
2. Internal as: clarity of the project objectives, clarity of the project scope, the organizational complexity, and the stakeholder agreement.
3. Technological as: newness of the technology and the team member's familiarity with the technology.
4. Environmental as: legal, cultural, political, and ecological conditions and regulations.
5. The DPCI was developed based on four assumptions:
6. All projects are unique.
7. Projects have common characteristics.
8. These characteristics can be grouped together to create a project profile.
9. There is an optimum execution approach for each project profile and therefore an optimum set of skills and experience for the project manager and execution team. [4]

Aim and research objectives:-
The aim of this study is to identify the most important factors affecting project success in terms of compliance with project agreed time-frame. The developed ANN model proposes a new approach for the public sector construction projects' typology that managers can use to facilitate making the right decisions about their projects that guarantees its success. The categorization of project within the suggested dimensions allows project managers to determine the appropriate level of project management efforts. The project manager's decisions may involve: allocating resources, planning, and assessing risk, selecting the project management style, designating the project's structure, building processes, and choosing appropriate tools. [5]

In this research, An ANN-Based model will be developed to predict the compliance with project time - frame for public building construction projects. The impacts of different factors on the compliance with project time - frame will be deeply investigated. Twelve factors were considered to be the most influencing factors in the project typology issue. These factors are the: project budget, project duration, project client, number of project parties, project scope definition level, external constraints, number of project elements, interdependency between elements, and level of interface between elements, type of project resources, project resources availability and time urgency. [5]

Research Methodology:-
Data Collection:-
Through reviewing previous literatures, all factors regarding the project attributes that affect the public building construction projects success were being identified, then a number of data about these factors were collected for the purpose of training and testing the proposed ANN model. The data were collected from thirty five previously executed projects constructed in: Egypt, gulf area and North Africa. As the proposed model is developed for the public building projects, the data were collected from this type of projects as: hotels, malls, educational institutes, airports and office buildings. [5]

Through analyzing these projects, data were extracted to include information regarding the previously mentioned twelve factors which will constitute the input to the proposed model through its training phase. The target output of the proposed ANN model is the degree of variation on the project's time frame for the previously collected data

projects through the training phase of the proposed ANN model. About 15% from the collected data, i.e. five projects data were selected randomly and set aside randomly for the proposed ANN model validation purpose. [5]

Creating data file for Neural Network Model:-
Once the data have been collected, the first task to be under taken is pre-processing. This involves a wide range of techniques for manipulating the data in order to extract the data fields to be used by the proposed neural software package which is the IBM® SPSSS® Statistics software version 25.

An excel sheet is developed, that contains a data for thirty five sample of previously constructed public building construction projects, conducted in rows. Each row presents data for a project that contains thirteen columns, the first twelve columns are the model input data while the last column is the target output. [5]

The proposed ANN Model:-
This study used the IBM® SPSSS® Statistics software version 25 to develop the proposed ANN Model. This implicational software is very easy to be used and its predicting accuracy is very high compared to other software programs. It is compatible with Microsoft Windows all versions. IBM® SPSSS® Statistics software uses the back-propagation algorithm in its engine. Past researches proved that the back-propagation rule is a suitable learning rule for most problems. It is the most commonly used technique for solving estimation and prediction problems.

In order to develop the proposed ANN model, the IBM® SPSSS® Statistics software guidelines were used for assistance, then in order to verify this research work the trial and error technique was used to arrive at the best model structure. During the proposed ANN model training process and in order to reach at a satisfactory level of accuracy. A number of procedures were taken as: using one/two hidden layers, increasing /decreasing hidden nodes in the hidden layer/layers, changing the transfer data function of the proposed ANN model and other procedures needed for the purpose of predict/assess the target output of the proposed ANN model which is the degree of variation on the project's time frame with an acceptable error limit. [5]

Results:-
A careful review for table (1) clearly shows that the model which has an input layer contains twelve node, one hidden layer contains five hidden nodes and an output layer contains one node with a softax transfer function, this model was found to be the most reliable model that gives the minimum value for the calculated cross entropy error and greatest accuracy percentage for the predicted target output. [5]

In addition a sensitivity analysis is conducted through data shown in Figure 1 Table 2, that definitely clear that from between all the input data factors, the time urgency factor is the most significant one for predicting the compliance with the target output which is the project time-frame, as seen in Figure 1. Table 2 show the value of importance of time urgency among the twelve variables is 0.160. [5]

Then for the validation purpose of the developed ANN model, the previously randomly selected projects were being used as inputs to the final developed ANN model while the target output was held away from the proposed ANN model for being used after in testing the predictive ability for the proposed ANN model. [5]

For the five projects under investigation we found that 80% of their actual output values are correctly predicted within their acceptable percentage of confidence. On the other side only one project from the total five projects, was found to have prediction different from the actual one. Hence it is safe to say that there is a probability of 80% that the results of the proposed model will be located within their acceptable limits. Table (3) provides a comparison between the results of the model output parameters with their corresponding actual values for the five cases under investigation.

These results show that the proposed ANN model has a prediction error about 20% as a deviation than the target output. This can be considered as a good result taking into consideration the little number of sample projects used through this study and also the different climate, environmental, regulations and policies ….etc. among the different markets which the data were collected from; Egypt and Golf area. [5]

Conclusions:-

This study has attempted to identify the main factors that influence the compliance with project time – frame for public buildings' construction projects. Twelve factors were identified. An ANN- model was developed to predict the compliance with project time - frame for public building construction projects with a level of accuracy of about 80%. Based on the results, the following can be concluded:

1. Time urgency, project constraints, degree of project scope definition, interdependency between project parts, project size and type of project resources (Joint-ventures / sub-contractors) are identified as the top six factors that affect the project success specifically compliance with project time – frame for public building construction projects, in Egypt and Gulf Area;

2. Nature of the client and project resources availability are the least affecting factors in the project delays for public building construction projects, in Egypt and Gulf Area.

However, the results of this study shows that there is a need for more investigation and research on the topic but for the time being the identified twelve factors were found to be the most to affect project success in terms of compliance with project time-frame, it is highly recommended for future studies to study the effect of these factors and others on other project success criteria such budget, performance,..etc.

Table 1:-Experiments for determining the best model

Function	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Input Layer Neuron	12	12	12	12	12
Hidden Layers	1	1	1	1	1
Hidden Layers Neurons	5	10	15	20	25
Transfer Function	Softax	Softax	Softax	Softax	Softax
Cross Entropy Error	10.88	13.072	17.189	17.393	15.545

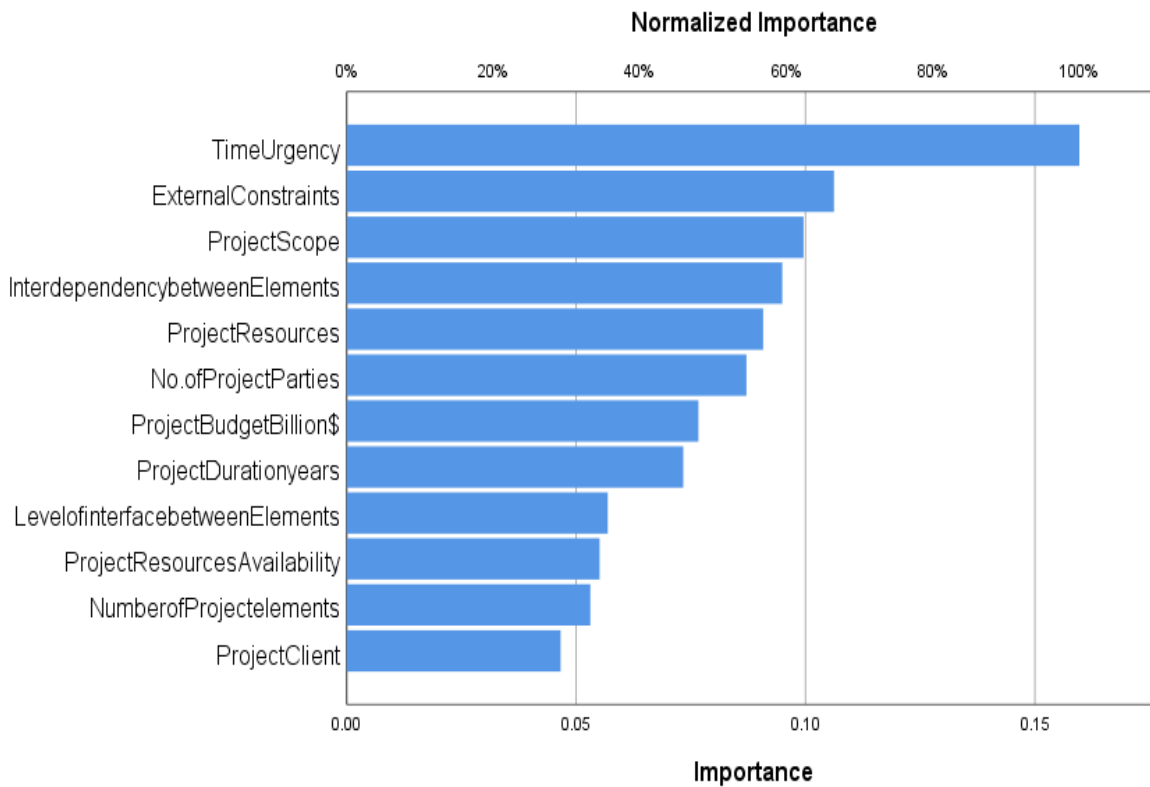**Figure 1:-**Importance of input variable at optimal number of hidden neurons

Table 2:-Independent variable importance

Variables	Importance	Normalized Importance
Project Budget (Billion $)	.077	48.0%
Project Duration(years)	.073	45.9%
Project Client	.047	29.2%
No. of Project Parties	.087	54.6%
Project Scope	.100	62.4%
External Constraints	.106	66.5%
Number of Project elements	.053	33.2%
Interdependency between Elements	.095	59.4%
Level of interface between Elements	.057	35.6%
Project Resources	.091	56.8%
Project Resources Availability	.055	34.5%
Time Urgency	.160	100.0%

Table 3:-Actual and predicted degree of variation in project time-frame in test sample

Project No.	Actual Real - life variation	Network output (predicted variation)	Confidence percentage	Comments
1	Major variation	Major variation	100%	Correct
2	Major variation	Major variation	100%	Correct
3	Major variation	Major variation	93%	Correct
4	Major variation	Major variation	81%	Correct
5	Minor variation	Major variation	-	Wrong

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