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Assessing the Factors Influencing the Timeline of Jordanian Road Construction Projects

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Abstract

Highway construction is an important part of the construction industry and one of Jordan's most important infrastructures. As a result, determining the factors influencing the duration of their implementation is a delicate matter that affects both transportation and the economy. Moreover, the travelers' safety provides an accurate estimate of the project's timeframe in the early stages. It commonly assists in determining the feasibility of constructing the road and determining whether to approve or reject it. The purpose of this work is to investigate the most influential factors on the duration of road implementation by investigating most of the influencing factors used in previous studies and explaining their local impact with road experts and consultants. The historical and analytical approach was used, incorporating reviewing prior research and studies as well as counting the fifteen factors that influence duration. Thereafter, conduct interviews to introduce these factors to the expert, and finally, analyze the interview results to determine the factors influencing highway implementation duration in Jordan. According to the report's results, the following seven factors have the considerable influence on the duration of highway project implementation in Jordan: expected road costs, road location / topography of the area, total length of the road, time required to remove obstacles, soil conditions, expected weather conditions while constructing the road, and industrial facilities on the road.

Keywords: project management, building construction, highway, projects duration, influencing factors, estimating of duration, early stages

I. INTRODUCTION:

Working on construction projects entails a high level of uncertainty on multiple levels; this is where estimation comes in handy. Because it is directly aimed at achieving the project management's main goal: to complete the project on time, within budget, and with the required quality, it is in the pre-design stage (the idea). In general, the project duration estimate is an estimate of the time given to the contractor by the owner to complete all the contract's terms. As a result, because time is money, accurate and realistic time estimates are critical to project success.

Because highway projects are one of Jordan's most important infrastructure fields, estimating the duration is considered early in the development process. The project is very helpful in making the right decision about the project's feasibility, and the factors that affect the implementation period are quarantined. The goal of this study is to establish a common basis and condition for all duration estimation research in the early stages of a project, as well as to identify these local influencing factors.

II. RESEARCH IMPORTANCE:

Despite the importance of accurately estimating duration in the early stages using the factors that influence duration, observation of the local reality in the field of method implementation has revealed that estimation tools are limited to individual experiences and are inaccurate. Obtaining information frequently leads to an overestimation or underestimation. The importance of the research stems from the scarcity of previous research, particularly local research, in the field of determining the factors responsible for estimating the duration of road implementation in the early stages of the project; this is to help and support consultants in the correct prediction of the duration of road implementation in deciding about Project Feasibility.

III. RESEARCH AIMS:

The main objective of this research is to determine the most influential factors influencing the duration of highway construction in Jordan, which will be accomplished by identifying the factors that influence the most reliable period in previous studies, conducting expert interviews to compare these factors while taking into account local realities, and analyzing the interview results to determine the most important factors influencing the duration of road construction in Jordan on a local level.

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IV. RESEARCH METHODOLOGY:

In this research, the historical analytical method will be adopted which indicates the logical flow diagram as shown in Figure 1.

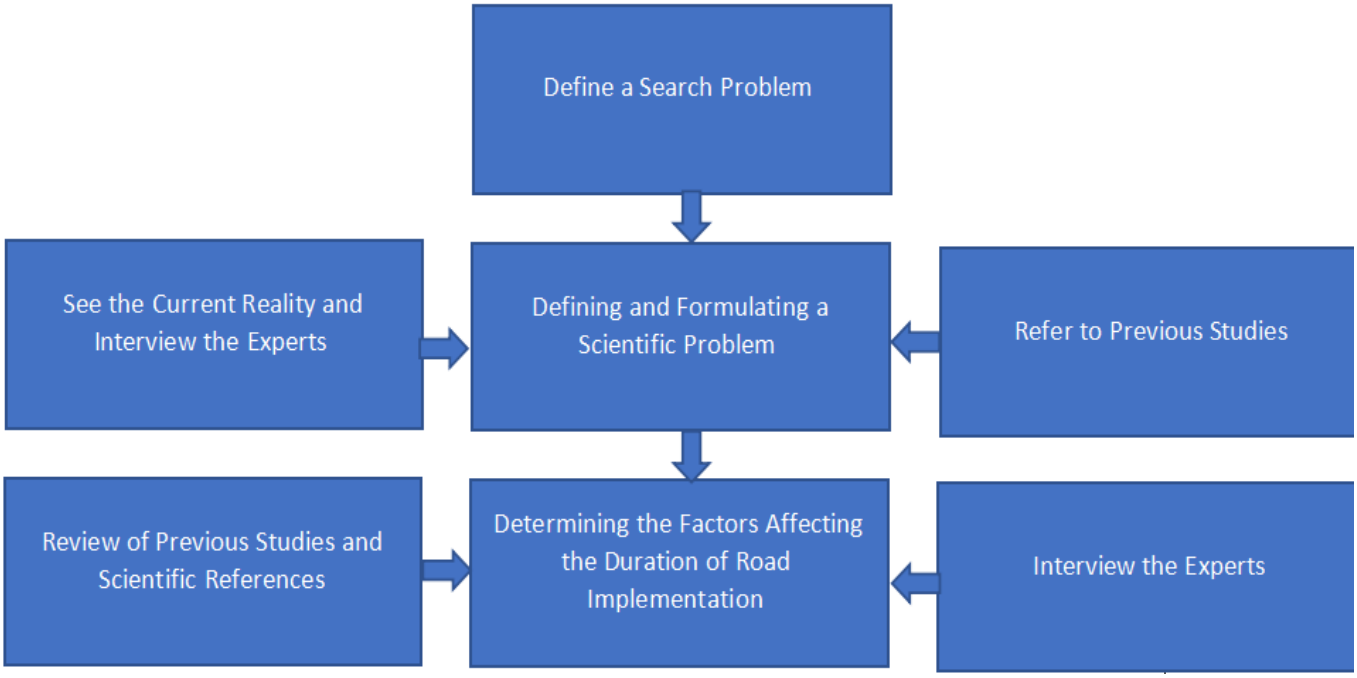

Fig. 1. The logical flow diagrams

V. PREVIOUS STUDIES:

Many prior studies in the subject of time estimate have been conducted, with varied study settings and data accessible. Jeong et al. (2009) proposed a technique for predicting the contract term of highway projects that may be utilized to solve problems. Following the conclusion of the disputes, data from Oklahoma road projects completed over the past 10 years were collected, and a study technique on project classification based on traffic volume was created. Following that, separating the non-dominant activity from others, which is the activity that may be conducted concurrently with other activities without interfering with it, such as constructing a sidewalk.

Determine the estimated production rates for the controlling activities, as the user will need to change these rates to control the activities. Several elements influence the program's use, including the weather, the terrain of the area, the size and location of the project, and the circumstances. Soil, traffic patterns, and the development of the OK-CTDS program, which is an automated application based on a database (ACCESS) that estimates contract length.

Once the production rates of the main activities for the program are supplied, the study concludes with the presentation of this ready-made application to users, the calculation of the durations of each activity, and the presentation of the contract's final schedule and length.

However, because we are not always able, it is difficult to extend this application to assess the variables impacting the duration of a road's implementation in the early phases. Based on a relatively good estimate of the production ratios for each activity, the application given by the user demands a big database when we are in the early phases of the project owing to a paucity of information during this period, restricting its usage in stages.

VI. FEASIBILITY STUDY

Beaudem et al. (2009) used neural networks (ANN) as successful tool in predicting purposes to satisfy the user's need for a huge database in his research. During the building phase, the researchers created an ANN model to forecast the budget and time of a highway's implementation. Data were collected for 51 highway projects in Thailand between 2002 and 2007, and his study technique was focused on creating two distinct ANN models, one for cost and the other for time.

Work start date, contract length (per day), and % of completion has all been given as project duration criteria. Actual completion % vs. planned the neural networks with backpropagation were chosen. Using the proposed model, the research created a final cost and time estimate, with the goal of anticipating risks, cost and time increases that may arise during the building phase. Also, we find it difficult to apply this model

since it is in the building phase, which changes the affecting elements, but the data supplied provides an indication of the work stages.

Therefore, Irfan et al. (2010) performed research during the planning stage, and in this study, the time of a highway's construction was calculated. The research considered only three variables adequate because they are the most known in the early stages of the project, and information was collected from Highway projects implemented in the state of Indiana, USA, and the data included: (the final cost of the project and final time), and the Research methodology on data fragmentation is 80% for model development and 20% for verification.

The projected cost, the kind of project (rehabilitation - constructing sidewalks - bridges, etc.), and the form of contract are the three determining variables evaluated. To estimate the implementation time, a linear regression model was built using these parameters as inputs. Therefore, the outputs of the model were the value of a projected period based on the intended cost. However, for the sake of this study, it is believed that other influencing elements that have a substantial impact on implementation time, such as weather and soil conditions, are neglected.

Most studies may overlook the project type element since it is a constant, such as highway projects. By studying Taylor et al. (2012)'s research, we notice an abundance of influencing elements, and in his study, the accuracy of the employed scheduling methods was evaluated. Data for 66 Kentucky highway projects were collected by two public transportation organizations to estimate contract duration for highway projects between 2004 and 2008, according to the American University, and the research methodology was based on examining the two models used by both companies to estimate contract duration as well as the results of a questionnaire distributed to both companies' employees.

The poll indicated that, while 85 percent of employees are aware with the model and its application, only 50 percent are in the process of adopting it due to the model's poor accuracy and the difficulties in implementing it. Because of the research, a multivariate statistical regression model was built to estimate the contract length, providing an enhanced alternative for the two firms' estimating approaches. The amounts of materials specified in the price analysis table (crushed stone, bitumen, concrete, etc.) works, excavation and backfilling, steel reinforcement, and contract engineer estimate were the inputs to this model. As a result, the study output is an estimate of the ultimate contract duration for a roadway.

However, designers find in this research project an examination of the validity of the models used in the two companies investigated, rather than a general model that can be used, estimating the duration of various highway projects in the early stages, in addition to the need to investigate material quantities and prices rather than the expected total cost, which is often known only at the idea stage.

Furthermore, Nike and Radhika (2015) selected neural networks (ANN) as a useful tool for estimate procedures, as an ANN model for evaluating the length and cost of constructing a highway is utilized in this study, and the database comprises of two highway projects. The data included (preparatory works, excavation and backfill works, foundation layer works, bituminous works, curves, the main and secondary bridges on the road, sewage works, traffic lights), and the research methodology was based on developing the ANN model using the initial data from these two projects, followed by a comparison of the model's results with the actual data from the two roads. The model's effectiveness was achieved due to the convergence of the results.

Because of its shown success in Forecasting, a network with a front-end feed was selected and trained with a teacher via the back-propagation method. Because of the investigation, a final cost and time period were determined. This study is flawed due to a lack of data collecting, as finishing two projects is inadequate to create a neural network model that requires data. The model's efficacy and usefulness are reduced throughout training, testing, and verification.

As a consequence, we offer Mensah et al. (2016)'s research, in which they employed neural networks to construct their model using a bigger amount of data, in the following manner: The study created a model using neural networks to estimate the duration of construction of a prefabricated bridge on rural roads, and data were collected from 18 A projects for completed bridges in Ghana between (2008-2014), and the data included: (The approved final price analysis table- start date and end date) (data related to the bridge components, such as the extent of the bridge, the number of bridge lanes, and the weights of the steel components).

The study technique was directed by the following principles: collecting data suitable for the neural network. The evidence is categorized as follows: 12 training projects (representing 60% of the samples) and 3 testing projects (representing 3% of the samples, 20 projects) and to double-check (20 percent). A network with a single hidden layer and the STATISTICA software were used to train the network. Only two parameters influenced the network inputs: the bridge width and the templates utilized. The time of the bridge implementation was determined by the model and search.

Furthermore, this study presented a model to estimate the time after completing the bridge design and preparing the price schedule, which cannot be used in the idea phase because it is limited to these two influential factors only, ignoring factors such as the location of the bridge and weather conditions.

Pesco et al. (2017) offer a set of influencing factors available in the early phases of the project investigation, which are as follows: The study compares the neural networks model (ANN)

with the SVM model to develop a model for evaluating the cost and time of road construction.

Between 2005 and 2012, data from 166 urban road projects in Novi Sad, Serbia, were gathered, and the study approach was based on categorizing the data into two categories: 149 training projects and 17 testing projects. It is determined that a single hidden layer network will be used. Influencing factors included the following network inputs: Quantities of expected building materials (crushed stone, paving stones, bitumen, concrete,) site preparation activities, excavation and backfill works, sewage works, traffic light works, Project area, road grade.

Calculating the weights of the variables, paying particular attention to the differences in the weights of each element in the cost or time model. The two directors of the model resulted in a final cost and time. According to the study, the findings of the (ANN) model and the (SVM) model converged. However, because the study was done on urban roads, we discover a difference in certain elements, such as the degree of road that has been established in highway research, while neglecting others, such as weather.

Son et al., (2019) found that when providing a model for estimating duration using expected cost as an indicator, it is critical because it is frequently available throughout the project life cycle where: at the planning stage, the research provided a model for estimating the duration of a highway's implementation.

Son et al. (2019) divided the data into 498 training projects (80% of samples) and 125 verification projects using the following study technique (20 percent of samples). The model variables included project location, traffic volume, traffic conditions, weather conditions, soil conditions, and the previously indicated projected cost as a fundamental indication, all of which impacted the implementation time. To eliminate outliers, four models were arranged and the model with the most matching values was picked. The research was good in terms of impacting variables and data, however neural networks have proved to be more effective and accurate in forecasting industries.

Following a study of past studies, a range of approaches for estimating the length of road construction acknowledge the importance of identifying impact variables and serving as a cornerstone in any research including early estimations based on historical data precedent.

VII. THEORETICAL BACKGROUND:

Time is calculated at every stage of the project and is usually essential, especially in infrastructure projects. The better the implementation will be when time is considered. As a result, the closer the estimate is to the logical and necessary boundaries, the more accurate it is. The main challenge in preparing a reliable time estimate for a highway project during the early stages, however, is a lack of project data; while the main project parameters such as location, tilt path, and project type may be available, information required for the estimation process such as a detailed traffic control plan and bid item quantities are not.

Following a study of past research, several approaches for estimating the time of a road's implementation, such as statistical methods and networks, are identified. Neuroscience, although employing various methodologies, emphasizes the significance of finding influencing elements and may be considered a basis in any research involved. Based on previous historical data, these are the preliminary estimates factors affecting the duration of the implementation of a highway.

VIII. PRELIMINARY STUDY:

The following factors have been identified as having the greatest impact on the duration of highway implementation through a review of previous research and studies:

1. The expected cost of the road.
2. The road's location and the topography of the surrounding area.
3. Weather conditions expected during the implementation period
4. Estimated quantities of expected building elements (crushed stone, paving stones, concrete, bitumen).
5. On-the-road industrial facilities
6. Road curves and intersections.
7. The total distance traveled on the road.
8. Sewerage is operational.
9. Work on removing impediments.
10. Soil characteristics.
11. Earthwork
12. Type of contract.
13. The technology, equipment, and mechanisms used in implementation.
14. The labor force
15. Contractors of various types.
16. Project administration.
17. The consultant's estimate of how long it will take to build the road.

IX. INTERVIEW:

Following the gathering of elements impacting length from

earlier research, interviews with road experts and consultants were performed to restrict these aspects depending on the local condition of the road building industry. The interview was chosen as a data collection tool to obtain as many ideas as possible while also ensuring direct access to the expert, who communicates with the most important institutions responsible for road design and implementation, such as the "General Organization", "The General Company for Roads and Bridges", "The Road Transport Company", and "The Studies Company". The maintenance manager, the head of the bridges department, the head of the technical department, and the head of the planning and implementation follow-up department, as well as the project implementation director, the director of studies, the assistant director of studies, and the director of the feasibility study, were all interviewed. In perspective of the interview format: The interviews were of the closed-question form, and the factors impacting implementation length are shown in Table 1 and Treemap Figure 2.

Table 1. Factors influencing the duration of implementation

Agent	**Reason of exclusion effect of local agent**	**No. of experts unexpected effect of this agent**	**No. of experts choose this as effected local agent**
Cost expected of road	-	0	8
Location of the road and topography of area	-	1	7
Expected weather condition during construction	-	2	6
Quantity of material needed for construction	Difficult to determine in initial stages	7	1
Availability of industrial facility in the road	-	2	6
Length of the highway	-	1	7
Curves and intersection	Depend on the length of the highway	7	1
Sewage works	Depend on the obstacle removal	7	1
Soil conditions	-	1	7
Earthworks	Do not considered due for the initial estimation	8	0
Type of contract	Used similar contract	8	0
Implementation technology and the mechanics used	The executing agency is fixed, and construction method is constant	8	0
Manpower	Side effect on the project depend on the mechanics to construct to low	6	2
Type of contractor	Exclude due to fixed construction agency	7	1
Project management	Fixed owner	8	0

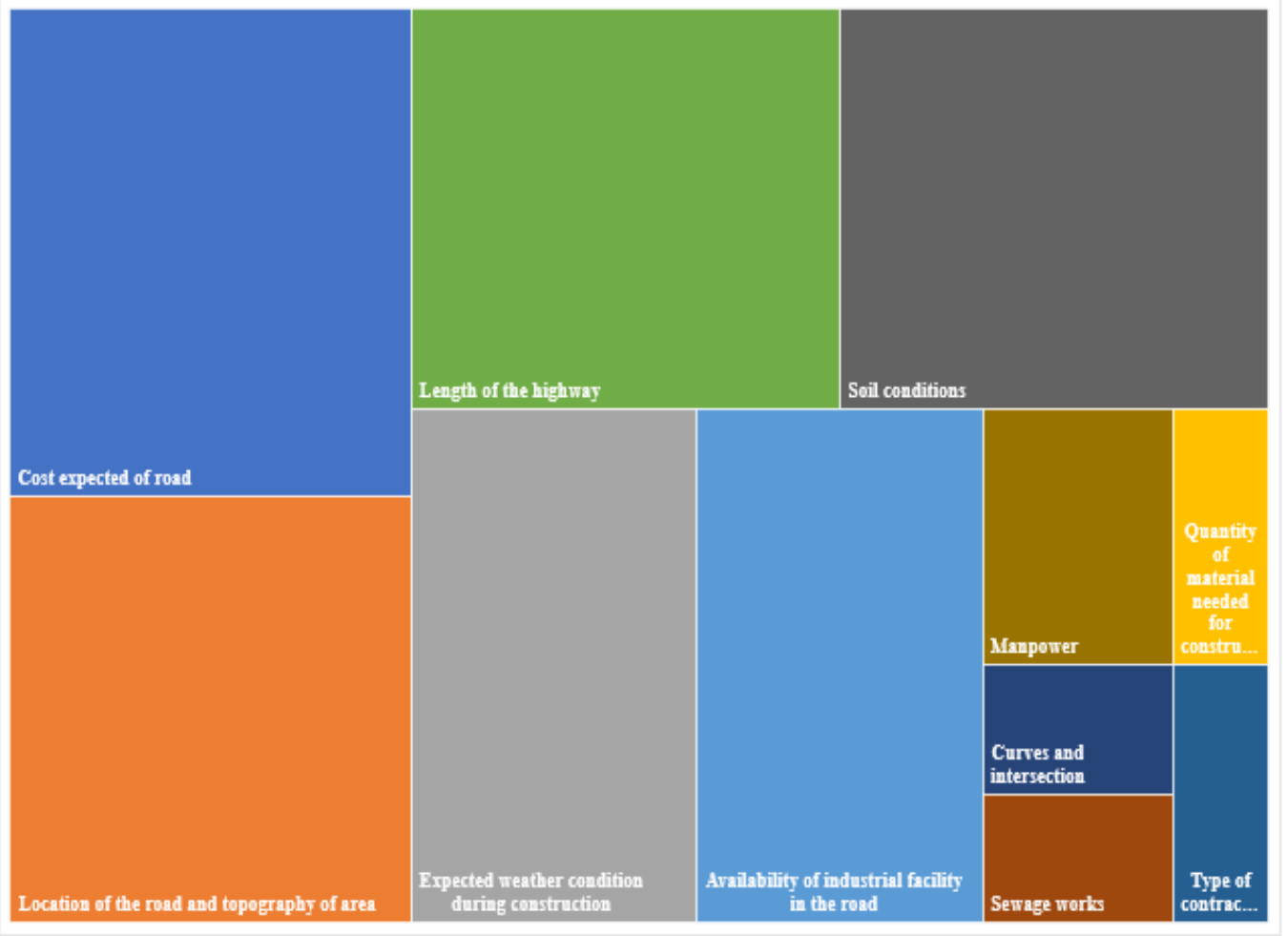

Fig. 2. Treemap indicating Factors influencing the duration of implementation.

Seven experts highlighted an important aspect that was not included in the studies: obstacle clearance time. The selected elements were adopted as the most influential factors on the duration of a highway's implementation by at least six experts after considering expert opinions and comparing the findings of the interviews with prior research. The factors are as follows:

1. The anticipated cost of the road.
2. The road's location and the topography of the surrounding area.
3. The total distance traveled on the road.
4. Time to get rid of the impediments.
5. Soil characteristics.
6. Weather conditions expected during the implementation period
7. On-the-road industrial facilities

X. CONCLUSION

The factors in this study were determined by interviewing experts because it was the only method available within the local conditions; however, the results were tainted by their reliance on the expert's opinion; thus, more accurate results could be obtained by providing historical data and distributing questionnaires to a broader range of experts. The elements influencing the length of a road's implementation discovered in this study serve as the basis for future research in the field of estimating the duration of a highway's implementation and may be utilized as inputs to the created estimate model in the early phases of the project.

Because of the consistency of its efficacy in the field of prediction, it is advised to utilize artificial neural networks to develop a model for forecasting highway execution time, as proven by prior research.

This study evaluated the most important elements determining the duration of a highway's installation in Jordan based on prior studies and expert interviews. In the early phases of the project, consultants utilized these criteria to assist predict the time of implementation. The following variables will be considered: projected road cost, road location and topography of the region, total length of the road, time to remove barriers, soil type and conditions, and so on. Weather forecasts and industrial facilities on the way during the implementation period.

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