Developing a Program for Practice Management and Productivity Improvement of Infrastructure Projects by using Business Information Modeling

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ABSTRACT

The employment of Business Information Modeling (BIM) may assist the resident engineering department in reaching its long-term strategic goals. The suggested computer software was created and tested using the first package of new projects for roads, bridges, and tunnels aimed at solving the traffic congestion crisis taking place in the capital city of Iraq, Baghdad. In the context of the current study, questionnaires and personal interviews with specialists in the field of road, tunnel, and overpass construction were employed. The aim of implementing BIM is to assess the introduced program's efficiency, verify its performance, and identify any errors, defects, or challenges that users may encounter during its application. The computer program underwent successful testing at several Resident Engineer's Offices (REOs) within the initial package of new projects aimed at addressing traffic congestion issues in Baghdad through independent verification checks. Initially, the program was utilized with the assistance of a user guide to facilitate its operation and provide a detailed description of each program feature which can provide effective decision-making and enhance REOs' computer skills.

I. INTRODUCTION

In the light of the significant developments in the construction and building sector, as well as the intense competition within this sector, coupled with the competition among engineering management companies to provide the best services at the lowest cost, they find themselves unable to keep up with the race to deliver superior services. They still adhere to outdated methods in service provision, failing to adapt to the aforementioned advancements. Therefore, there is a pressing need to re-manage the processes and business provided by the engineering management organizations to beneficiaries, following a novel business information model that enhances service quality while reducing unnecessary costs and improving productivity [1, 2]. Creating and capturing value can easily be stated as one of a BMI's roles. Since information systems offer management tools and support all users in their actions, their implementation has become ordinary and an inherent component of any activity [3]. Contract companies began to re-standardize their projects, relying on modern methods to reduce the increasing expenses of the provided services, as they found themselves suffering from financial losses in their projects [4].

Efficient process management can help companies align their business initiatives, improve workflow efficacy, and reduce operational redundancies. Process managers can use a range of strategies to boost efficiency and streamline operations, including re-managing processes [5]. Construction projects are distinguished by time and cost-intensive manufacturing processes, making them vulnerable to risk and failure [6]. Perhaps the most difficult issue in the construction field is financing. The Iraqi government has faced a severe lack of financing due to financial crises and security conditions, resulting in many incomplete projects [7]. There is also a weakness in supplying the necessary work structure information to monitor costs, and a lack of data processing for mechanisms, equipment, and difficulties, which renders estimation accuracy, as well as the management and recording of worker wages challenging [8] Creating expert systems for

facility applications entails diagnosing problems with the existing facilities and equipment. However, establishing expert systems for quality assurance in construction follows a different strategy than on failure diagnosis. By applying the concept of real-time process control to certify construction quality, a system that allows inspectors to receive recommendations before, during, and after construction can be created [9]. The construction business is critical to the economy of many countries, particularly of the developed ones. This point encourages the relevant institutions to use innovative methods and combine multiple techniques to optimize construction benefits [10]. However, poor knowledge about new methods and techniques for project management in the construction sector has negatively impacted the latter and raises the need for further training in modern technology [11].

Failure to meet the project's objectives is a serious problem faced by all countries, particularly Iraq. Nearly two-thirds of all construction projects in the globe have encountered substantial issues, such as cost increases, delays in project implementation, and project cancellation. As a result, new methods for managing construction projects must be studied and implemented to ensure the success and achievement of their objectives [12, 13]. Delays in construction projects consist a particularly severe issue in Iraq, where only a small percentage of construction projects are completed within the contractual period [13]. Investing in Information and Communication Technology (ICT) can improve the performance of information and communication management in building projects. The job begins with an investigation and diagnosis of the difficulties, challenges, weaknesses, and inefficiencies associated with information and communication management in Iraqi construction projects. The findings indicate that the suggested system can ameliorate the performance of current project management practices by improving information and communication management procedures [14]. Integrated project delivery is the coordinated use of all contributors' skills and knowledge to optimize project results, increase owner value, and maximize efficiency during the design, manufacturing, and construction phases [15].

The current study attempts to shed light on the working reality of engineering management, such as REOs, as a case study within the Ministry of Housing, Construction, and Public Municipalities in Iraq by adopting BIM to enhance productivity within the available resources.

II. METHODOLOGY

Due to the nature of the current study, the descriptive and analytical approach will be followed through describing the services and business provided by the REOs, as well as analyzing the jobs and roles of their employees. Computer Aided Tools (CATs) will be also adopted through re-describing the jobs, processes, and business which contribute to the building of BIM to develop practice management and improve productivity. Re-managing processes is an action contracting companies may utilize to help them reach their long-term strategic objectives. It is an organizational strategy employing many methodologies, organized approaches, and technologies. Re-managing processes is an ongoing procedure, where teams and companies can constantly look for ways to improve

efficiencies and manage processes effectively. The re-managing processes go through several important stages, as observed in Figure 1.
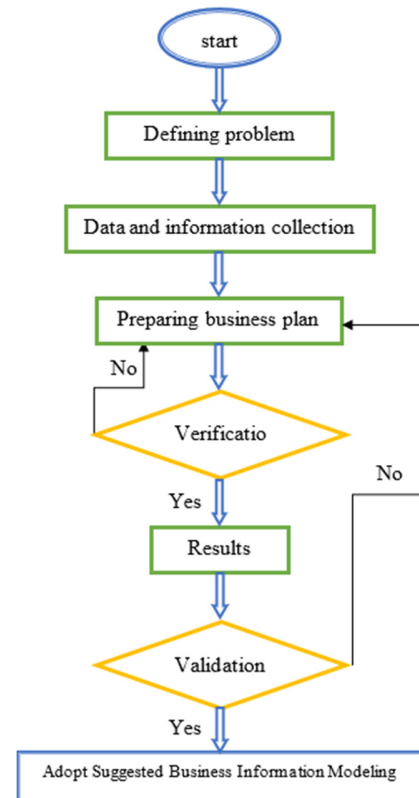

Fig. 1. Stages of BIM using re-managing of processes.

A. Defining the Problem

The first stages in re-managing processes involve identifying the problems associated with working with REOs in construction projects, with the most important of them being:

- Absence of electronic documentation: Most REOs suffer from the absence or loss of paper documentation of data and information, in addition to electronic documentation, which is almost non-existent. Thus there is a difficulty of obtaining the required data or information when necessary and benefiting from them in future projects. This occurs due to the poor efficiency of the human resources working in the REOs, as well as the former's lack of experience in using software for electronic documentation and archiving, as well as the inferior quality of the electronic devices used.

- Weak communication: Most REOs suffer from poor communication between the administrative units that make them up, in addition to the deficiency of a communication network linking these administrative units, which leads to each of these units working independently, causing conflicts at the workplace and delays in task completion.

- Human errors: The human element working in the REOs comes from multiple engineering and administrative fields.

The working experience they possess, though, stems from the personal skills they have acquired, without having international certificates, such as PMP and PMO, or having participated in specialized training courses in Information Technology (IT) and project management to develop their skills and abilities.

- Viruses: Most of the computers and network systems in the REOs are afflicted by the presence of viruses in the software used. Additionally, the software may sometimes reach a sudden stop caused by employees utilizing it for entertainment purposes with unlicensed and hacked applications.

B. Data and Information Collection

This stage begins with collecting data on the REOs activities and the numbers of laborers and equipment involved. Moreover, the most important duties and tasks of the REOs, such as supervising and following up on the project implementation, coordinating with consultant engineers in all specialties, following up on the work according to the schedule, and matching the specifications of the completed work, are explored. With the engagement of drawings, technical reports are prepared and submitted to the project manager who approves them so that they will be presented to the owner. At the beginning of 2023, the Iraqi government launched the first package of new projects for roads, bridges, and tunnels aimed at solving the traffic congestion crisis taking place in Baghdad. It consists of 19 projects. The budget allocated to these projects was estimated at three trillion Iraqi dinars, and the period for completing these projects is estimated at 19 months. Implementation is carried out by Iraqi, Chinese, and Turkish engineering companies, and under the supervision of the resident engineer departments in the Ministry of Construction and Housing and Public Municipalities.

C. BIM Utilization

After collecting data and information and diagnosing and identifying problems in the REOs, the next step, which constitutes the business plan preparation, begins. This step includes presenting the suggested BIM to develop practice management and improve productivity using process re-managing for the first package of the new projects mentioned above. The particular step is performed by:

A specialized work team was formed consisting of five engineers with expertise in computer engineering, IT engineering, and project management engineering, with no less than 20 years of experience, as portrayed in Table I, to audit the digital content in the Resident Engineer Department for all business and processes. The implementation of the discussed package is monitored and supervised. Furthermore, a quality control of the executed business is performed, auditing the designs, and preparing periodic reports for the owner.

Five computers were prepared and provided in the REOs for each project, which equals to a total of 95 computers for all projects. This preparation is carried out by formatting and reinstalling operation systems, adding anti-virus software, configuring the hardware side, and installing original licensed software.

TABLE I.   WORK TEAM QUALIFICATIONS

Specialization	Practical experience	Current place of work
Civil Engineering/ Project Management	30	Engineering Consulting Office/ Wasit University
Computer Engineering/ Information Systems	25	College of Computer Science and IT/ Wasit University
Computer Engineering/ Software	22	
IT Engineering/ Networks	20	
IT Engineering/ Communications	20	

Preparing and supplying a special place in the Ministry of Construction and Housing and Public Municipalities to be a data center (Private Data Center: It is based on establishing a data center for the REOs in the first package of new projects in Baghdad, and its mission is to connect all branches and collect, preserve and disseminate information and data, while keeping additional copies on external storage devices). The data center consists of a server with high specifications and a large storage capacity. It is connected to the Internet and to an efficient communication network with the rest of the 95 other computers. It is equipped with protection applications (Firewalls). The main reason for establishing the data center is to protect data and information, maintain confidentiality, and prevent hacking.

BIM was validated by conducting an exploratory experiment for one month in REOs to identify and avoid errors that may occur during the work period. After that, a final judgment about the BIM's performance was made by the experts and beneficiaries and our own observations.

III. DATA EXTRACTION AND ANALYSIS

The proposed BIM is an information model in an organizational framework used to categorize business information. The model assists stakeholders in all REOs working on the first package of the new project, to provide essential information to the various managerial levels in decision making. To make the suggested BIM effective and sufficient, some considerations and demands should be taken, including moral requirement: This requirement addresses to how the operation of the suggested BIM is appreciated by the REOs given that the former is not aimed at monitoring their work to prove any potential negligence in conducting it. Its purpose, instead, is to develop practice management and improve productivity. In addition, reports of forms related to the processes and business implemented by REOs working in in first package of the new projects were generated. These forms are deployed to enter the data collected from the REOs in all projects and are presented below:

- General data entry form for projects: It includes entering or updating all the data related to the projects, represented by project number, name, location, cost, start date, expected execution date, and other general information, as disclosed in Figure 2.

- Data entry form for the project items: It entails entering or updating data for the project activities represented by the item number, its details, total quantity, units, and the start, execution, and completion dates, as displayed in Figure 2.

- Data entry form for manpower and machines deployed in the projects: In this form, all data related to these resources are entered. For manpower in the project, data that include the worker's number, name, profession, and wages are entered. Regarding the machines and equipment utilized in the project, the machine number, type, and weight are entered.

- Data entry form for sub-contracts: It involves entering data for sub-contracts, represented by the construction company number and name, code of contracts, start date, finish date, quantities, and unit price of the item.

- Data entry form for materials entering the warehouses: It is represented by material code, name, quantity, and unit price.
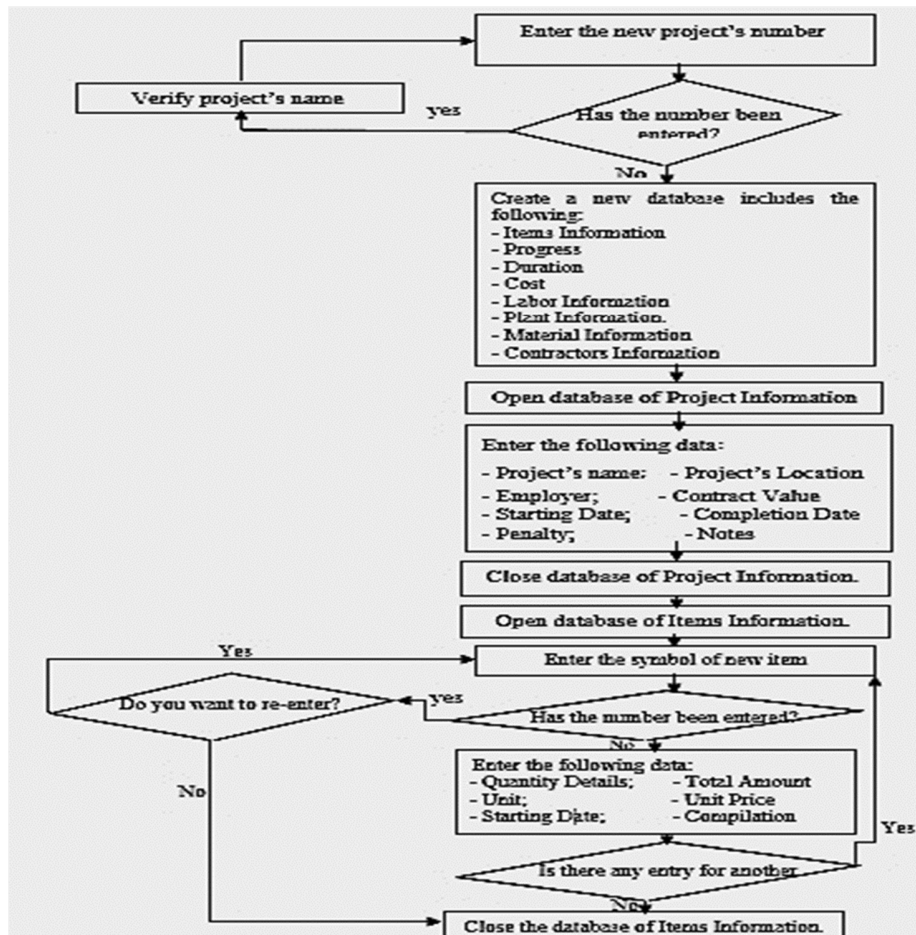

Fig. 2.   Entering data related to the project and its working items.

IV.   DEVELOPING THE PROPOSED PROGRAM

When the program is turned on, as revealed in Figure 3, there is an introductory window that appears for half a minute. If the user of the program does not want to wait this period, the command (following) could be pressed, whereby the window enters the main menu (Figure 4). The main menu window encompasses three main commands, which are:
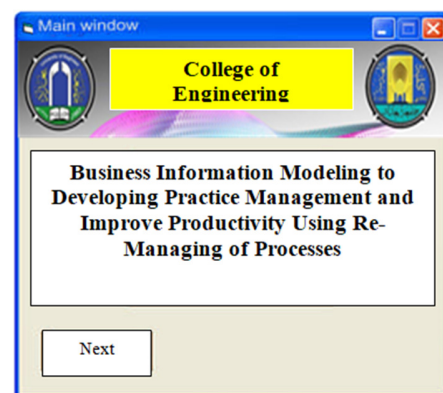
- Basic project data

- Follow-up data

- Reports

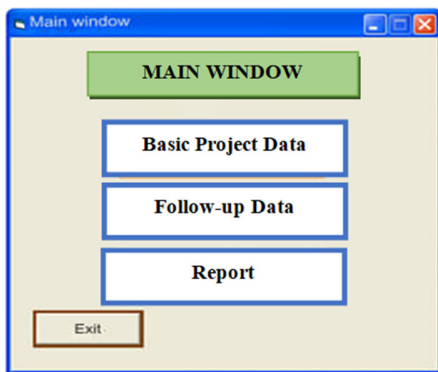
Fig. 3.   Starting window.
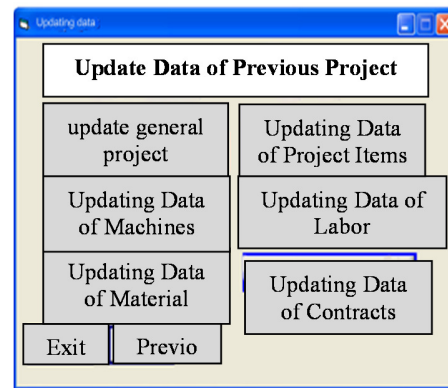
Fig. 4.   Main menu window.

A. Basic Project Data

This window, portrayed in Figure 5, appears when the user clicks on one of the following two commands: (General Project Information) and (Update General Project Information), as shown in Figures 6 and 7. This window contains data such as project number, project name, etc. After entering these data, the user has to click on the command (Save) to accept the data. When the user wants to search for data on a specific project, he can click on the command (Search) and a dialog box appears in which the project number they want to search for is entered. Then the data for that project appear. To erase the data of a specific project, the former must be displayed and the command (Delete) must be pressed. The command (Back) returns the user to the previous window.
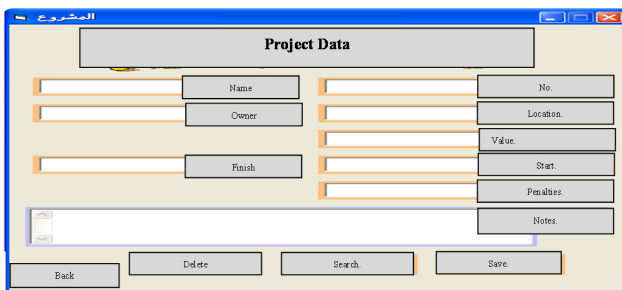

Fig. 5.   Window of project data.

Fig. 6.   New project data window.

Fig. 7.   Update data of a previous project.

B. Follow-up Data

This window (Figure 8) appears when the user clicks on the command (Follow-up Data) from the main window. This window contains the commands (Work Progress Data, Labor Follow-up Data, Used Machines Follow-up Data, Used Materials Follow-up Data, Costs of Machines Used Follow-up Data) and through these commands, the databases for follow-up data are entered either daily or weekly in relation to the actual work reports of the project. This window contains the (Previous) command to return to the main window and the (Exit) command to exit the program.
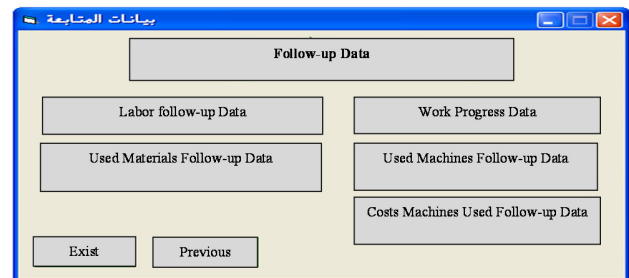

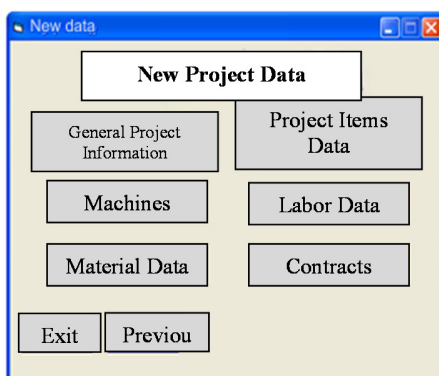
Fig. 8.   Window of follow-up data.

C. Reports

This window, presented in Figure 9, appears when the user clicks on the command (Reports) from the main window. It contains 11 commands representing the number of reports that can be concluded from the projects' basic data, follow-up data, and the calculations that can be made between them. These commands are: (Work Progress Follow-up Report, Cost Components Follow-upRreport for Work Items, Used Materials Follow-up Report, Used Machines Follow-up Report, Performance Status Follow-up Report for Work Items, Unit Cost Follow-up Report for Work Items, Project Status Follow-up Report, Report of Follow-up Project Completion Rates, Project Cost Follow-up Report, Report of Follow-up Project Completion Rates and Actual Cost, Costs of Machines used Follow-up Report). Through these commands, the required follow-up is determined. Again, this window contains the (Previous) and (Exit) commands.
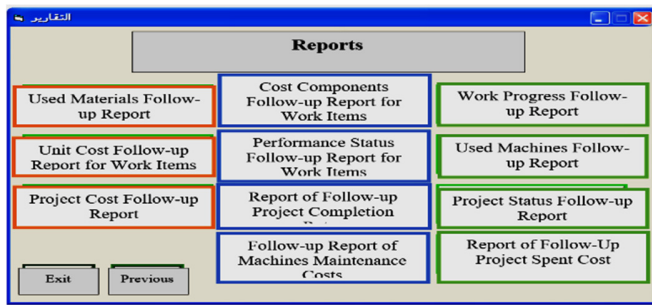
Fig. 9.   Window of reports.

V. ASSESSMENT OF THE PROPOSED PROGRAM

The proposed program assessment process should consider implementing the program before engaging in an open discussion with specialized experts in this field. This process involves two steps.

A. Proposed Program Implementation

The aim of implementing the proposed program is to assess its efficiency, verify its performance, and identify any errors, defects, or challenges that users may encounter during its application. The computer program underwent successful testing at several REOs within the initial new projects package. The program was utilized for independent verification checks.

B. Conducting Evaluation Interviews

The assessment process occupied 30 experts from the REOs within the Nassour Square overpass project, Aden Square overpass project, and Dora Junction overpass project, who are experienced in planning, business analysis, and IT. The evaluation form, indicated in Table II, was provided to the participants to obtain their opinions, comments, and suggestions about the execution and feasibility of the recommended program. The findings suggest that the introduced computer program's development meets the standards and is capable of attaining the necessary control of REOs in the business information field. This implies that the proposed program is both efficient and comprehensive, with the potential for increased effectiveness if endorsed by decision-making authorities. While the proposed program demonstrates efficiency, it necessitates personnel with specialized skills. Thus, its implementation may need to occur gradually, allowing time for the training of qualified computer staff.

TABLE II.   EVALUATION QUESTIONS AND ANSWERS

No.	Questions and program characteristics	Observed frequency						Mean score	Results
		<50	50-60	60-70	70-80	80-90	90-100		
		Poor	Acceptable	Moderate	Good	Very good	Excellent		
1	The importance of the proposed program to your REO.	0	0	0	5	10	15	88.33	Very good
2	Assistance the program provides to the stakeholder (effectiveness)	0	0	0	0	8	22	92.33	Excellent
3	Accuracy of degree	0	0	0	3	10	17	89.66	Very good
4	Flexibility of collecting and entering data in the program (User Interface) (usability)	0	0	0	0	10	20	91.66	Excellent
5	Need for support from decision-making authorities	0	0	0	0	5	25	93.33	Excellent
6	Need for qualified users	0	0	0	2	8	22	97.33	Excellent

VI. CONCLUSION

Through the implementation of Business Information Modeling (BIM) to enhance practice management and improve productivity using processes re-managing, and the development of the introduced program, the following points are concluded:

- There is a pressing need of re-managing the processes and business provided by engineering management to beneficiaries in Resident Engineer's Offices (REOs) in road overpasses and tunnel projects in Iraq, following BIM that enhances the quality of services offered while reducing unnecessary costs and improving productivity.

- Through field visits to multiple REOs in many construction projects implemented for the Ministry of Construction and Housing and public municipalities, we found that the most important problems and challenges that could be encountered in applying the concept of re-managing processes in REOs are: different environments, weak social motivation, and weak financial motivation.

- The most important problems associated with REOs in construction projects were the absence of electronic documentation, weak communication, human errors, viruses, legal aspects, and professional ethics.

- Although BIM is based on data collected from the Iraqi construction industry, the methodology it follows has much broader geographical applicability.

- The use of the proposed program proved to be practical, reliable, fast, and efficient in BIM in terms of both principle and applicability. Furthermore, every construction company can cover its needs with this program.

- The evaluation result of the proposed program shows the importance of implementing such a program in construction companies.

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