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The Impact of Different Types of Activities on the Project and the Environmental Effect

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ملخص البحث

لكى نتمكن من تحسين مستوى كفاءة المكاتب الاستشارية الهندسية فى أعمال التصميم. يجب علينا تحديد الانتاجية للأعمال المختلفة فى مرحلة التصميم مما يحسن عملية تحديد الوقت اللازم لكل عمل من أعمال مرحلة التصميم وبالتالى تحديد التكاليف المتوقعه لتلك المرحلة. مع مراعاة اختلاف الانتاجية تبعا لخبرة المهندس ومدى كبر ومدى تعقيد التصميم. فى هذا البحث تم التركيز على مرحلة أعمال التصميم الإنشائى للمشروعات للوصول الى العلاقه الزمنية بين حجم الاعمال وخبرة المهندس المصمم وتأثير مختلف العوامل على ذلك مثل التصميم المعمارى, حجم الاعمال, ومااالى ذلك.

ABSTRACT

In order to improve the work quality of the office designer engineers, a good work time and cost estimate leads to a realistic evaluation to accurately put the right price. To do so, the productivity of every aspect of the design phase has to be investigated. In this paper the productivity of the civil design phase had been monitored to get a realistic time frame with respect to the work volume and engineering experience.

SCOPE OF WORK

The civil engineering design projects, major activities of civil design, and the different aspects that affects the civil design activities.

RESEARCH AIMS

Measure and scale the different activities production rates. Identify the impact rate of different aspects on the productivities.

THE MAJOR RESEARCH POINTS

- Identifying civil engineering's design works major milestones.
- The aspects affect different milestones.
- Illustrate the impact of all the aspects on the activities.
- Illustrate the impact of those factors on a working project.

INTRODUCTION

The construction projects are unique and need a lot of work in all their phases. The project is divided into design phase, construction phase, and the operation phase (this phase concerns the owner and the operating and maintenance team only not the consultant office). On the design phase, the special details and requirements of the architectural design and the electromechanical works affect the civil engineering design, so it need a lot of communication and coordination. The civil engineering design time and cost depends on the volume of the project, the experience of the civil designer engineer, the software used by the designer to do the work, the statical system used, and

the required details of the project. In this paper we concentrated on the design phase, monitor some of the aspects affects the civil engineering design, such as; architectural volume, civil engineer designer experience, etc.

ANALYSIS

Different activities of construction projects:

Construction project consists of many activities divided into design activities and construction activities.

In this research, we are going to study the design activities.

Some of those activities are:

- Study and evaluate the architectural designs to apply a statical system for it.
- Structure analysis for the statical system using any of the known statical analysis programs available (ex.: SAP, STAAD, ETAB, SAFE…etc.).
- After doing the structure analysis, the output data of the analysis are used to make the necessary structural design of the different structural members (slabs, beams, columns, and foundations).
- The phase of draw the different structural members come after the calculations of the designs.
- Make the necessary design coordination between different types of drafts (architects, civil, electromechanical, sanitary…etc.).

How these activities affect the productivity of the design phase:

To study those design phase activities and to allocate the different activities impact on the timing of the design phase

To investigate the effect of those factors on the design activities by monitoring the productivity of each design activity on a sample of thirty different design engineers working in ten different civil engineering consultant companies. The staff of the consultant companies has different experience periods. This experimental specimen contains many aspects were monitored in order to illustrate the different effect on the productivity of the office. Those aspects are:

- Project volume
- The civil engineer designer's experience period.
- The number of civil engineer designers allocated for the project.
- The number of the projects allocated to the same engineer.
- The tools used for design.
- Coordination between different design aspects (architectural, civil, sanitary, electromechanical…etc.).

A) The first aspect studied was the project's volume aspect (the project area) and its effect on the project time that divided as follows:

1. The effect of the project volume on the choice of its structural system:

2. As the volume of the project increases, the time needed to choose the structural statical system increase. Also the time of structural system drafting. The statical system approval time by both the architectural engineer and the owner's consultant expert representative. This is done by a real good coordination between teams, the relation between the area of project and the design time required is illustrated in figure 1

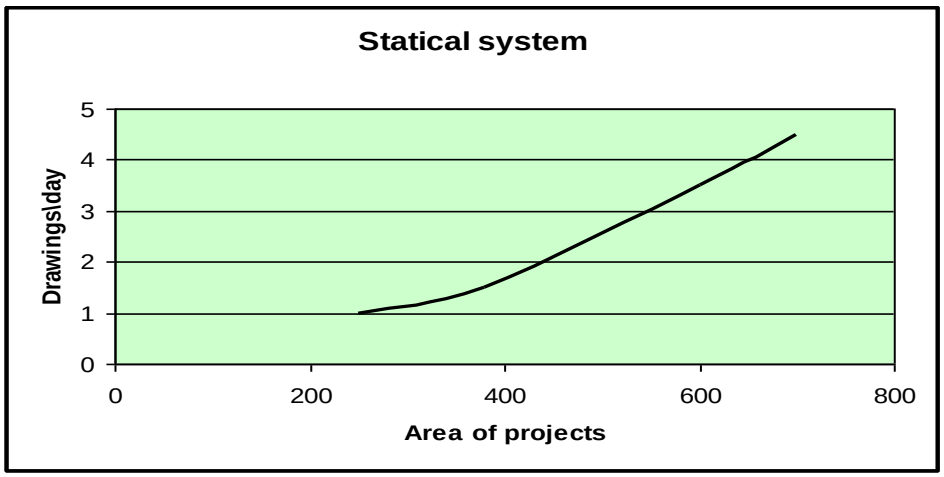

Fig. 1 Relation between the area of project and the design time required

It is also possible that the time required for determine the suitable structural statical system to be as minimum as possible if that system was already chosen upon making the architectural designs.
The reason for that is either because the moderate financial ability of the owner (so he prefer to choose the ordinary slab and beam type structure system or the least cost that can be). Or the contractor wishes (that should be in collaboration with the owner) to use a particular structural system that he is used to construct to make it easier in construction. Or the structural system is pre-determined by the architectural designer for architectural reasons or that the construction conditions in the area that the project is going to be constructed on (made by the authorities)…etc.
Figure (2) illustrate the relationship between design time required and the total number of drafts of the project.

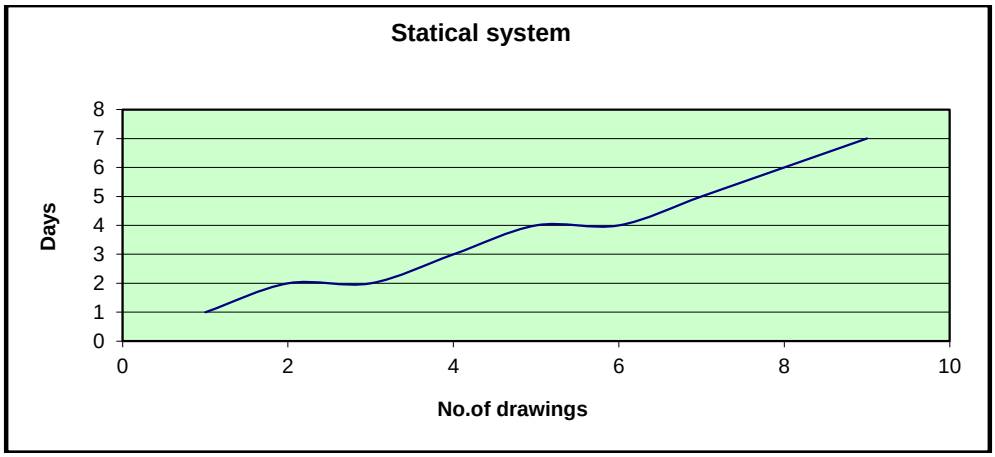

Fig. 2 Time and number of drafts relationship

3. The effect of the project's volume on the structural analysis of its buildings by using the "SAP" program to determine the structural system:
The average analysis time and extracting the structural analytical model by the SAP program in both forms; every element by itself, or the whole structure as one unit. Depend on the volume of the project and the area of the building structure. As the area of the structure grows the number of the structural elements increases (which would be

gradually entered and calculated according to the drawing process for those structural elements into the program and anticipate and update the various members acting loads and to connect all of them together and to all the other structural members of the building). To increase the structural elements numbers means to decrease the structural analysis process or to increase the number of days allocated to the making of the civil engineering SAP model, as illustrated in figure (3).

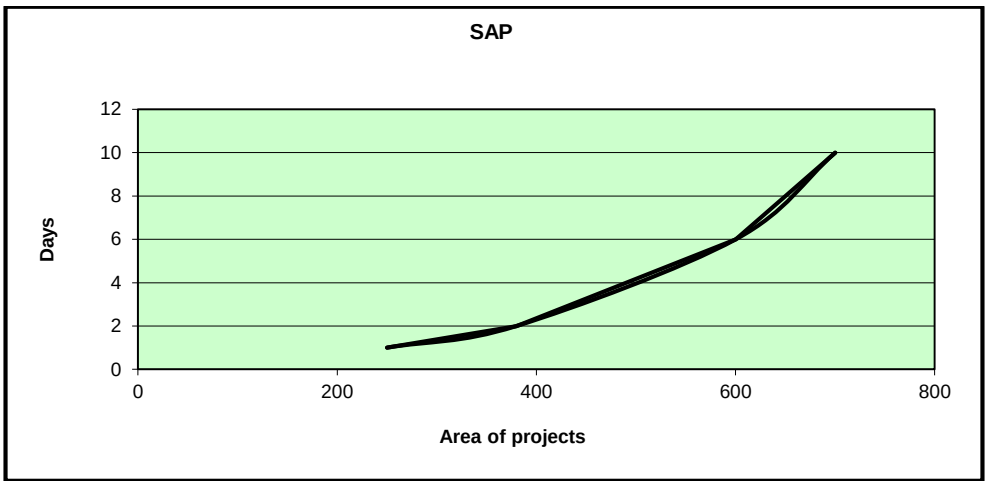

Fig. 3 Area of project to time of design relationship

4. The effect of the volume of the project on the design of the structural elements and on the layout of the drafts and the detailing level of the building: The civil design of the structural members is one of the most important tasks in the design phase of the project. This activity depends mainly and directly on the project area. As the project's area increase the average design productivity of "the design and drafting" decrease with a vast amount as illustrated in figure (4).

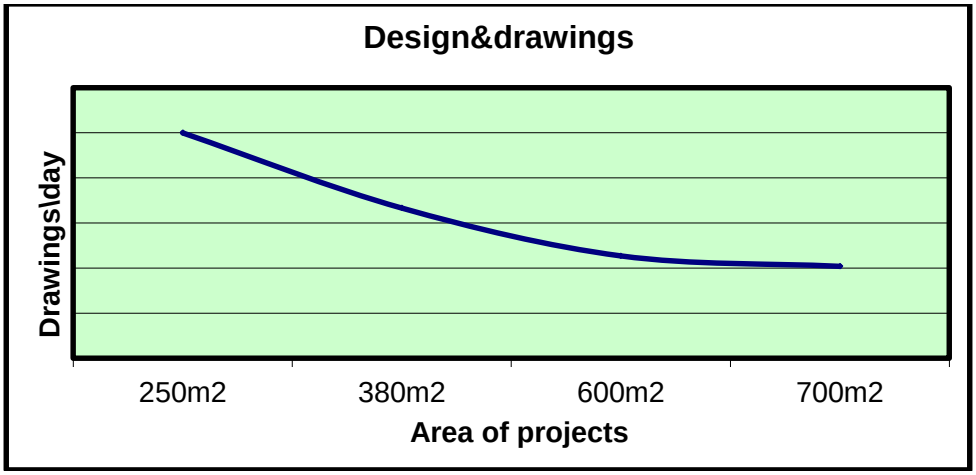

Fig. 4 Project volume to productivity relationship

5. The volume of the project has effect on the rest of the design activities. The activities considered complimentary design process (such as the technical coordination between civil engineering design drafts and the final architectural design details which considered one of the most important last steps as any change made to the architectural

drafts after the finishing of the making process of the final design drafts would double the time allocated for redesign and redrafting the civil part of the project) (in the matter of fact most probably the redesign time required would most probably be more than the time of the first time design time, which will be declared later) as it also has effect on the quantities surveying and the specifications establishing of the project as the bigger the volume of the project, the more time required for both re-design and specifications establishing.

At the end, as the project volume has effect on all the design process it will have a vast impact on the overall required time for completion of the project's design as illustrated in (Fig 5) and (Fig. 6).

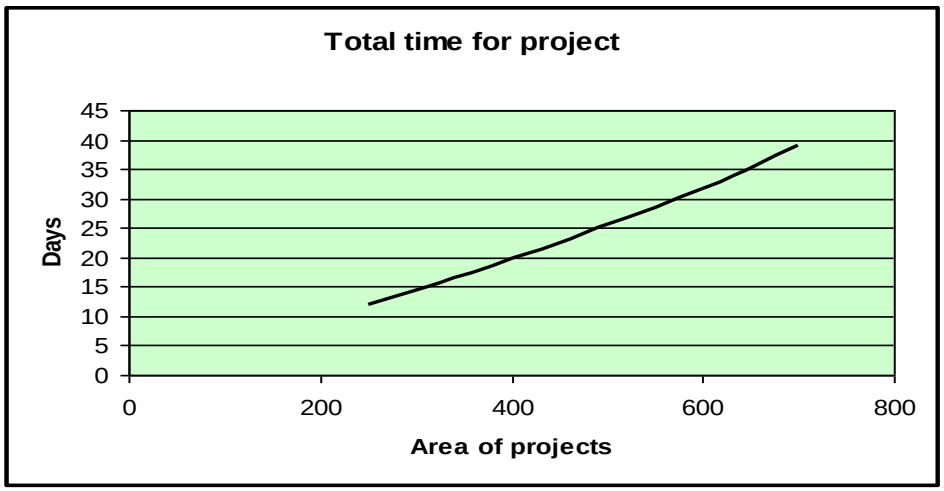

Fig. 5 Project volume to time relationship

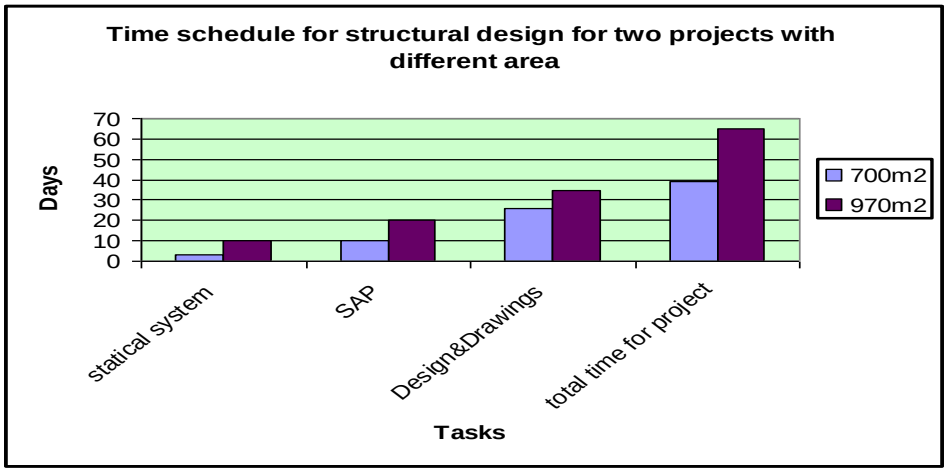

Fig. 6 Comparison of time for two projects

B) The civil engineer designer experience factor

This factor is one of the important factors that affect the productivity rates of the different civil engineering activities. This factor differs at different needs according to different projects. As there are some projects need to be designed by 2 years experienced engineers, other projects need over 5 years experience engineers, etc…. It is obviously that as the experience of the engineers increase

(especially if those experiences are in one field) the productivity rate of the activities increases. This is illustrated in figure (7).

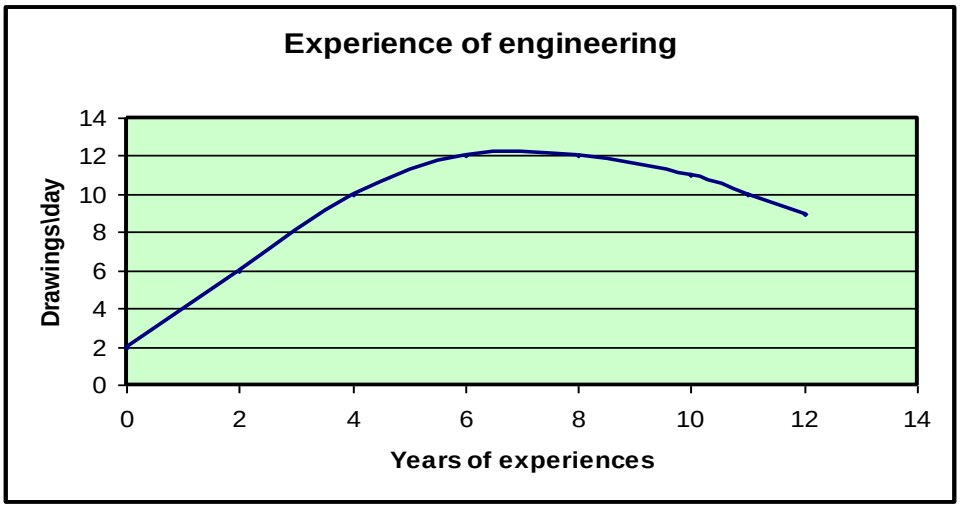

Fig. 7 Experience Vs. productivity relationship

From the previous chart we can notice that the productivity of 7 years experience engineers or more become lower than it used to be (rated by number of drafts per day). This is not mainly for all civil engineering activities, but it is mainly for drafting activities. This is because as the engineer gets more experience his job is getting more and more toward supervising job on those engineers that work by his leading, in addition to his growing responsibilities so he can be responsible for supervising many projects on the same time. That is not against the fact that the more experience the engineer gets the more effective design productivity leading to it is really must to have a designer supervisor with good experience on design projects (at least one supervisor engineer with at least 7 years experience).

C) Number of engineers working on the project:

It is obvious that by increasing the number of working engineers on the project the civil engineering working activities rates increase. This is illustrated in fig.8.

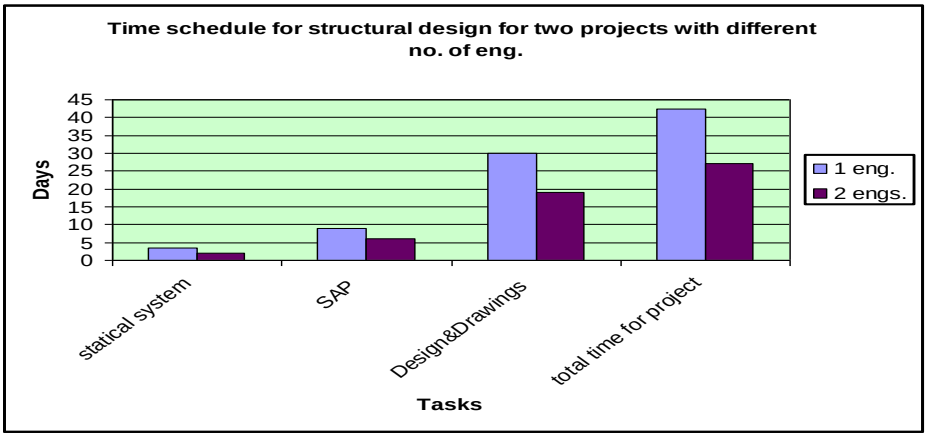

Fig. 8 Number of working engineers Vs. Time of work relationship

It is also worth to mention that there are a number of engineers that score higher productivity than average, but when the number of working engineers together increase the lower the productivity that gets with a noticeable value. This decrease in productivity level increase as the coordination between the engineers decrease (which is valid and with increasing the number of engineers working on the project). This is illustrated in fig. 9

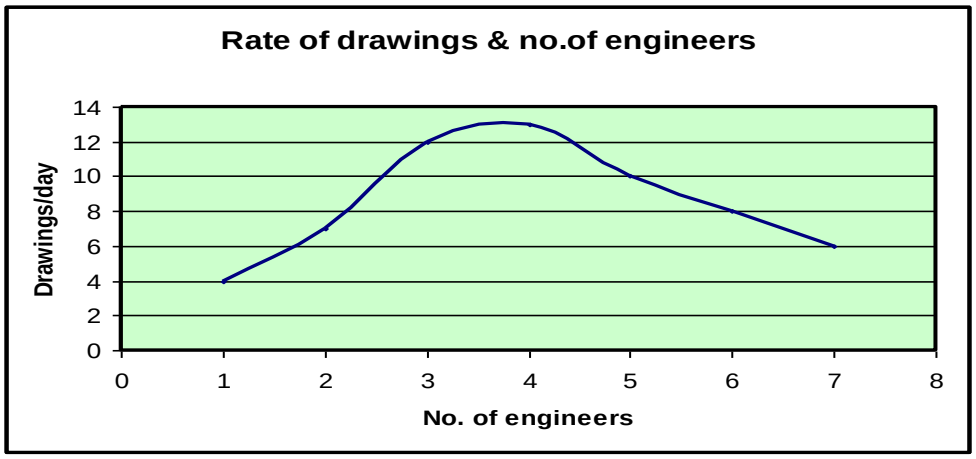

Fig. 9 Number of engineers Vs. Drawing rate relationship

CONCLUSIONS

- In order to improve the work quality of the office designer engineers, investigation had been done for the designers and their working environment.
- The time required to settle on the project statical system increases with the increase of the project area.
- The design time increases due to the increase of the number of drafts as the project's area increases.
- The designer engineer experience affects in a vast amount the design time, till it reaches 7 years' experience, then it deteriorate. As the engineer's drafting capability decreases, this can be overcome by using draftsmen with the designer.
- The number of engineers working together affects the time, but this would need a good communications and coordination between them.
- Another factor is the difference between engineers productivity rate, but this factor is not commonly affects the overall productivity, except for extreme cases.

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