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## Heavy Equipment Scheduling for Horizontal Construction Projects

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### Abstract

Construction project scheduling requires additional parameters and estimation if the projects are equipment intensive. Since preventive maintenance, multiple movement operations, and sitting idle vehicles affect not only the activity or the total project duration, but also the budget of the project, heavy equipment scheduling deserves a special focus. In this study, a survey was conducted within construction companies to collect information about how their productivity analysis and project scheduling were executed, and upon which parameters they were based. Additionally, in a selected residential building construction project, Monte Carlo simulation was applied for estimating the productivity on a construction site with selected parameters. The results reveal that Turkish construction companies have a poor focus on heavy equipment scheduling as well as productivity and their productivity data just relies on daily documents from a machinery department and basic extrapolation for future construction activities. This paper briefly reveals the characteristics of the Turkish construction industry towards equipment scheduling and productivity analyses and recommends simulation methods such as Monte Carlo for cost, as well as productivity estimation to provide extensive cost savings during construction projects.

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*Keywords:* equipment planning; Monte Carlo Simulation; productivity; construction projects

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### 1. Introduction

Contractors have undertaken many great projects in Turkey where different activities require different equipment types, sizes and skillful operators. The dependency and urgent need for utilization of heavy equipment have grown with size and complexity of construction projects. These work environments also require site improvements, on-site management improvements as well as better overall management, including productivity analyses and cost estimation efforts. Whether as a prime contractor or subcontractor, project planners and estimators have a responsibility to match the right type of machine or combinations of machines (crew) to the work to be performed because it has a great

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influence on the success of a construction project as indicated by Grainsberg et al. [1]. On the other hand, data collection from past projects is very important, whether as a basic extrapolation for productivity analysis or more comprehensive simulation techniques are to be used. Briefly, modern and advanced project management requires the combination of site observation, reporting, and documentation with statistical analyses and/or simulation techniques for better productivity, especially on sites where heavy equipment utilization is high. Recently, the Turkish construction industry has utilized heavy equipment but in an unplanned way and using traditional construction methods, causing extra expenditure and time for the companies involved. Therefore, the characteristics of the Turkish construction industry towards equipment scheduling, productivity analyses and simulation methods for cost as well as productivity estimation methods which companies have been using were investigated by the aid of a survey. The aim of the survey was also to collect information about how the companies' productivity analysis and project scheduling were executed and which parameters they were based upon. All the survey results are presented in a table summarizing collected data from the companies.

## 2. Questionnaire Survey

Within the scope of this project, firstly, a questionnaire survey was conducted in Istanbul where huge construction projects have been conducted in recent years. 104 companies were visited to conduct a questionnaire survey. 13 of these have later been excluded due to insufficient information. The majority of the companies seem to be “sub-contractors” but because of their project scope they are experienced and relatively bigger companies when compared with the companies operating in other regions of Turkey. A great majority of them were performing productivity analysis based on former projects and basic experience or sometimes just experience with no analysis. They highly rely on the information collected by site staff or freight bills and dispatch notes. Almost half of them observed cost deviations between 5 to 15 percent after performing the productivity analyses. A minority of the companies employ float when scheduling, especially for equipment related activities, and interestingly enough, although the majority of the companies use CPM based software, only 27.3 percent of them gave an answer as “we use CPM technique for planning”. It may be argued that they seem to use only the output of the software without any evaluation or critical analysis. The survey results are given in detail in Table 1.

Table 1. Heavy Equipment Utilization and Planning Survey Results.

	Frequency	Percent
<b>The Role of the Company</b>		
Prime Contractor	24	26.4
Sub-Contractor	40	44
Trade Contractor	19	20.9
Consulting Company	8	8.7
<b>Type of Construction</b>		
Highway and Bridge	8	9.1
Industrial Building	5	5.7
Other*	12	13.6
Residential Building	38	43.2
Infrastructural Works	7	7.9
Shopping Center	3	3.4
High-Rise Buildings	6	6.8
Hospital	5	5.7
Railway	4	4.6
<b>Number of Employees in the Construction</b>		
0-50	24	26.4
50-99	15	16.5

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