Earthwork Activities in Private Housing Industry

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For my loving wife, Ho Chee Peng, and daughters

Christine, Stephanie, Odelia and Gene….

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ABSTRAK

Kejayaan dan kegagalan sesebuah projek perumahan bergantung kepada aktiviti kerja tanah kerana aktiviti kerja tanah adalah aktiviti pertama dalam projek perumahan. Dalam pelbagai situasi, keadaan yang tidak dapat diramalkan boleh mempengaruhi anggaran perlaksanaan serta output jentera menyebabkan tempoh aktiviti sebenar lebih panjang daripada tempoh perancangan. Tujuan kajian ini adalah untuk mengkaji operasi pemindahan tanah dalam projek perumahan, mengkaji kadar penghasilan permindahan tanah dalam projek perumahan, mengenalpasti masalah yang dihadapi oleh pihak kontraktor semasa aktiviti permindahan tanah dan untuk mengenalpasti faktor-faktor yang mempengaruhi harga tender kontraktor. Data dikumpul dari organisasi pembinaan melalui soal selidik. Data yang diperolehi dianalisa dengan kaedah indeks purata. Perbandingan pengeluaran pemindahan tanah menggunakan kitaran purata masa berdasarkan kepada jadual anggaran permindahan tanah dan kajian masa dan pergerakan yang dijalankan di tapah bina dilakukan. Hasil kajian didapati secara am, prosedur kerja tanah bagi projek perumahan tidak mengambil berat tentang persekitaran dan kawalan kualiti, meyebabkan kerja kerja pemindahan tanah tidak mengikut spesifikasi piawai JKR. Tiada perbezaan yang ketara bagi pengeluaran permindahan tanah di antara jadual anggaran pemindahan tanah berbanding dengan kajian masa dan pergerakan semasa pembinaan. Masalah dihadapi oleh kontraktor berpunca daripada keputusan klien dan kepastian asas pelantaran akhir projek, rekabentuk daripada perunding dan maklumat ukur tanah yang tidak tepat. Harga tender kontraktor dipengaruhi oleh reputasi klien untuk membayar serta kelarasan penjualan rumah oleh klien.

ABSTRACT

The success and failure of a housing project depends on the earthwork activities as it is the first activity in any housing development project. In many instances, many unforeseen circumstances that affect the estimates of plant performance, output, and hence the duration of activities, fall short of the actual situation once construction start. The purpose of this study is to study the earthmoving operation in a private housing development project, to study the earthmoving production in a private housing development project, to identify the problems faced by the contractors during the earthmoving activities and to identify the factors that influence the contractors pricing during bidding. Data was gathered from the local construction organizations by means of a survey questionnaire which was further analyzed using the average index computation to portray the ranking of the associated factors. A comparison of earthmoving production using the average cycle time based on earthmoving production estimating table and the motion and time study conducted at one of the project site. The finding revealed that generally earthwork procedure for private housing project does not emphasize on the environmental and quality control and thus the works carried out do not follow the standard JKR specification. It was apparent that there is not much variation from the earthmoving production estimating table for the excavator cycle time as compare to the excavator cycle time from the motion and time study during construction. The main problems that the contractor faced stem from the client's decision and confirmation on the final platform levels of the projects, the design provided by the consultant and the inaccurate survey information. The final pricing during bidding was highly influence by the client's reputation to pay and the financial status which normally depends on the sale of the houses built.

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

The rapid development of the housing construction industry in Malaysia in recent years and the magnitude of the present-day constructions involved the movement of large amount of earth excavations, cuttings and embankments may be a substantial part of the overall project. These operations are relatively repetitive and machine-oriented, being performed under the pressure to improve productivity, efficiency and safety. (Jagman Singh, 1980) described the conventional procedures for equipment management involving selection, performance, estimating, maintenance, repairs and replacements etc. are not enough in view of their incapability of approximating the real life phenomena closely. These procedures usually provide estimates that are quite off the true values. As the problems of management become more complex, the divergence of results as obtained through conventional procedures and actual results becomes greater. To a housing developer time is of the essence and the duration for the completion of the projects will be as short as possible. To achieve the success of the project within cost and time will require adequate planning and implementation of earthworks and earthwork activities.

Earthmoving operations in the Malaysian housing industries normally consist of a continuous process of the following phases:

Phase 1: Site preparation

- Demarcation of site boundary
- Clearing and grubbing – vegetation, and debris (e.g., tree, brush, buried vegetation, trash, stumps, roots, etc.)
- Stripping top soil

Phase 2: Bulk excavation and filling

- Cutting and filling
- Load, haul and dump
- Spread and compact

Phase 3: Finish work

- Formation of roads and building platforms
- Grade and trim to finish level

Phase 1: Site preparation

The earthwork starts with the demarcation of the site boundary and preparation for the materials to be moved. Site clearing consist of clearing, grubbing and stripping topsoil in the area designated in the drawings. Clearing consist of cutting and/or taking down, removal and disposal of everything above ground level. Grubbing consist of the removal and disposal of surface vegetation, the bases of stumps, roots, the underground parts of structures, and other obstructions to a depth of at least 0.5 metre below ground level.

Stripping of top soil consist of the removal of topsoil to an average depth of at least 150mm below ground level, from the areas within cuttings and embankments and stockpiling for reuse for any purpose such as the soiling of slopes of cuttings and embankment, and benches.

Phase 2: Bulk excavation and filling

Bulk excavation consist of materials excavated from the designated high areas to the required depths and levels in accordance with the drawings, for formation of roads, open spaces and building platforms within the limits of the contract area.

Filling, consist of the excavation of suitable materials from high areas and other approved sources is used for filling up of designated low areas to the required levels in accordance with the drawings for formations of roads, open spaces and building platforms. Filling can only be carried out after the original ground has been cleared and any trees or organic materials removed. All materials used in embankments and as fill is then compacted as soon as practicable after being placed and spread.

Phase 3: Finish work

Surface finish for the formations of roads and building platforms shall be finished fair, free of potholes, gullies and depressions where water may accumulate. The surface of slopes shall be trimmed to an even profile.

In Malaysian housing industry earthmoving operation, normally involve excavators loading a fleet of trucks and their proper matching in size is quite important. The current procedures for equipment management involving selection, performance, estimating, maintenance, repairs and replacements etc. are not enough in view of their incapability of approximating the real life phenomena closely. These procedures usually provide estimates which are quite off the true values. As the problems of management become more complex, the divergence of results as obtained through current procedures and actual results becomes greater. The sizing of the haul units and estimation of production of the team is done using

average values of arrival rate of trucks at the loader and loading rate by the excavator. Experience, however, indicates that this procedure does not give accurate results, and the performance as estimated is usually on the higher side. The reason is that the arrival and the loading of the trucks at the excavator are random phenomena which cannot be approximated by working with average values.

Some other procedures have, therefore, to be devised which would help analyze the problems in a more realistic manner in order to complete the project in time and within estimated cost. Motion and time study conducted at the start of the project and by comparing it with the earthmoving production estimating table offers the prospect of a useful management and monitoring tool.

1.2 BACKGROUND OF STUDY

In the earthmoving industry for a housing project is a constant challenge to a contractor's vision, ingenuity and to his experience and it has been termed the biggest gamble in the business field. This is mainly due to a combination of various factors which influence the operation performance, among them, earthwork characteristics, job-site conditions, equipment characteristics, and construction methods.

The operation performance can be measured by several performance criteria, which can be classified into time (duration), cost, and safety. It is evident that effective operations are a multi criteria problem. However, in this section, the focus is on the duration and cost of operations.

The production rate can be calculated by dividing the number of units produced by the duration of earthwork operations, and the minimization of project duration is highly dependent on the production rate. There are a wide variety of factors that affect the duration of earthwork operations. Considering the significance of their influence, the affecting factors can be categorized into four

groups (Automation in Construction 12 (2003) 1-13, Kim and Jeffrey), which are closely correlated with each other:

Work characteristics

- Magnitude of the job (quantity of earth to be moved)
- Layout and space constraint

Job-site conditions

- Weather
- Soil types and conditions
- Haul road and gradients.

Equipment characteristics

- Capacity (production rate)
- Efficiency
- Cycle time (combination of excavators and trucks)
- Unexpected breakdown rate of equipment.
- Economic haul distance
- Motion and path planning strategy

Management

- Planning the sequence of work
- Method of construction.
- Select a proper number of equipment

In the first group, Magnitude of the job (quantity of earth to be moved) is directly related to the duration of earthwork operations. Obviously, different magnitude of the job will result in different duration. Even the same type of work will have different work durations due to the differences in work volume, site conditions, construction methods, and so forth. The layout and space constrain affects the productivity of equipment in the given project. Concurrent activities of multi equipment interfere with each other because of their requirement for workspace within a confined area.

There are several affecting factors associated with the job site conditions which include weather, soil conditions, and road conditions. As for Malaysian weathers which is unpredictable greatly affects the duration of the earthwork operations. In general, bad weather decreases the efficiency of construction equipment. Various types of soil create different levels of difficulty in stripping and excavating soil, and are related to the rolling resistance that affects both production rate and the financial investment of an earthwork contractor. The haul road and gradient is related with the effectiveness of haul and return trip of construction equipment.

Equipment is an important resource for earth moving construction projects that require a large concentration of construction equipment. In housing project, the selection of equipment is directly affected by the magnitude of the job. In an equipment-intensive project, it is clear that the proper equipment selection will result in the minimization of project duration and the maximization of output of work tasks.

The last group, management of operations, includes construction method, planning the sequence of work tasks, and allocating the proper amount of required equipment. For example, if two or more equipment fleets are involved in earthwork operations at the same time at a constrain area, to transport the stripped

soil to the fill area, there will be space interference that will result in the decrease of productivity. To avoid this problem, the combination and number of equipments to be used for interference free sequence of work tasks should be planned in advance. Depending on the work environment and hauling distance, a variable amount of construction equipment should be assigned to each equipment fleet rather than a fixed amount throughout the earthwork operation process.

Among various affecting factors, planning the sequence of work tasks, equipment selection, and equipment motion and path planning are controllable factors to minimize the duration of earthwork operations.

1.3 STATEMENTS OF PROBLEM

The common choices of machineries for bulk excavation in housing projects are combination of excavators and dump trucks. Like many construction activities, earthworks are planned using data from previous projects together with manufacturer's performance charts. In many instances, many unforeseen circumstances that affect the estimates of plant performance, output, and hence the duration of activities, fall short of the actual situation once construction start. To understand the project the researcher conducted a study on the earth work activities carried out in various projects by interviewing with the project site people. From the interview the researcher found that most of the projects were either delay or cost overrun and it was due to 1) low bid, 2) insufficient knowledge of job conditions, 3) adverse weather conditions, 4) improper selection of construction equipment and 5) inefficient management and supervision. How far these factors given will affect the project, here a study will be conducted. Consequently, the potential for contractors' losses on earthwork is large: this will lead to contractual claims to recover those losses. Staples et al. (1992) estimated that the annual value of earthworks claims during the early 1990s ran into many millions of pound.

The selection of equipment is very important, for its selection and operation determine both cost and time. Methods and equipment which give the minimum unit cost within the construction schedule have to be adopted. A cubic metre forms the basis of calculation. The contractor figures costs and profit on a cubic metre basis. If his estimates are correct and his bid low, he clinches the contract. But he should know that the simple cubic metres on the basis of which he bids differ from the loose cubic metres which he actually hauls. It seldom weights the same and expands when disturbed. When hauling the cubic metre, a dump truck will need to overcome rolling resistance. The contractor should also reckon the cost and time in loading and dumping accelerating, breaking and shifting gears. Lastly he should remember that neither people nor machines work 60 minute hours and should make allowance for operation fatigue and routine maintenance. All these considerations should determine the final time of cubic metre. Experience and practical judgement, of course, play an important role and the key to success.

Earthmoving operations are a major part of housing construction projects. Because of their labour and plant intensity, the planning, estimating, monitoring and control is crucial to both cost and duration of the project. Earthworks are the first activity for a housing project and are considered by many to be indicators to a success or failure of the project as a whole. The fact that quite often contractors have gone bankrupt establishes that success is more elusive today in every area of construction. This may be due to various reasons such as hard competition and tighter economic conditions. But at many jobs contractors have lost mainly due to bad management, wrong selection of equipment and unrealistic assumptions made in the bids like work characteristics and job site condition.

1.4 OBJECTIVES OF THE STUDY

This study is to analyze and identify the different constrain that affect the daily work output production rate and cost by earthwork contractors specialized in bulk

excavation and filling platform for housing development in Malaysia. In this study we shall only consider excavators and dump trucks.
The objectives of the study are:

1. To study the earthmoving operation in a private housing development project.
2. To study the earthmoving production in a private housing development project.
3. To identify the problems faced by the contractors during the earthmoving activities.
4. To identify the factors that influences the contractors pricing during bidding.

1.5 SCOPE OF STUDY

This study focuses on the bulk earthwork excavation for private housing development projects which has either been completed or currently in progress. One of the project sites will be selected to conduct a time and motion study to study the excavator and truck cycle time. The targeted participants would comprise of contractors involved in earthwork for private housing development projects in the state of Johore, Selangor and Negri Sembilan.

1.6 SIGNIFICANCE OF RESEARCH

The earthmoving industry continues to challenge construction men, possibly largely because no two earthmoving jobs are the same. Each present its own problems; each differs from another; and each requires different (or at least, 'modified') approach. It has been rightly said that "earthmoving is the biggest gamble in the construction world". Proper emphasis should be given to a basic

principle: “Reduce downtime, achieve optimum equipment utilisation and increase production at minimum cost”.

The rapid development of the housing construction industry in Malaysia in recent years and the magnitude of the present day constructions involved the movement of large amount of earth excavations, cuttings and embankments may be a substantial part of the overall project. The developers are more concerned with time and cost and since time is of the essence it was also noted that the duration is short and cost reduced. This study attempts to examine the sequence of earthwork activities carried out in a private development project that will influence the pricing during bidding and to complete the project in time. The study aims to look at the effects of using the earthmoving production estimating table and identify some of the problems that may arrive during construction using motion and time study. The study also aims at identifying the problems faced by the contractors during construction and the factors that will influence the pricing during bidding. The researcher hope that the introduction of the motion and time study of daily trips the contractors, engineers and client or developer will enhance the awareness on the important of tracking the actual earthmoving production that will have consequential influence to the duration and cost. Hence to improve and strengthen their organization, in order to increase the awareness at an early stage the actual project performance and to achieve the completion of the project performance within time and cost for every construction development carried out by them.

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