COST EFFECTIVENESS COMPARISON OF PRE-FABRICATION WITH CONVENTIONAL CONSTRUCTION METHOD FOR RMAF GROUND DEFENSE BUNKER

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"I hereby declare that i have read this project report and in my opinion this project report is sufficient in term of scope and quality for the awards of the Master in Science (Construction Management)"

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Date : April 2010

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A project report submitted in partial fulfillment of the requirements for the award of the degree of Master in Science (Construction Management)

Faculty of Civil Engineering

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I declare that this project report entitled “Cost Effectiveness Comparison of Pre-Fabrication with Conventional Construction Method for RMAF Ground Defense Bunker” is the result of my own research except as cited in the references. The dissertation has not been accepted for any degree and not concurrently submitted in candidature of any other degree.

Signature	:	…….
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Date:	:	April 2010

I dedicated this to my beloved wife Lydia Nyomek, my dearest father Mr. Tan Teck Lam and mother Mrs. Gan Eng Sin, and my loving sister Ms Tan Chen Chen for their everlasting support and encouragement for me in completing this course of studies.

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ABSTRAK

Kaedah pembinaan pre-fabrikasi bukannya perkara baru dalam industri pembinaan Malaysia, namun penggunaannya masih pada tahap yang rendah. Pihak kerajaan sewajarnya menggalakkan penggunaan pembinaan pre-fabrikasi terutamanya pada projek-projek pembangunan kerajaan termasuk projek pembangunan keselamatan negara. Kaedah pre-fabrikasi merupakan kaedah moden yang diimplimentasikan secara luas di negara-negara membangun dan ia telah dibuktikan berkesan menjimatkan kos pembinaan, tenaga kerja, tempoh pembinaan, dan kualiti pembinaan.

Pangkalan Udara Kuantan telah dipilih untuk kajian kes disebabkan ia merupakan Pangkalan TUDM yang pertama dilengkapi dengan kubu pertahanan pangkalan. Data-data yang diperlukan telah diperolehi daripada tiga fasa kajian kes ini, meliputi tinjauan tapak, temubual, dan perbandingan kos pembinaan antara kaedah pre-fabrikasi dengan kaedah pembinaan tradisional. Penemuan-penemuan daripada data yang dianalisis membuktikan kubu-kubu sedia ada tidak memenuhi speksifikasi dan menimbulkan masalah-masalah kepada TUDM dan JKR sewaktu perlaksanaan projek. Walau bagaimanapun, kaedah pre-fabrikasi akan menyumbang kepada penyelesaian masalah-masalah yang timbul dan terbukti dari segi keberkesanan kos jika digunakan. Kajian ini telah mencadangkan pengagihan kerja dan tanggungjawab menyeluruh perlu diterapkan kepada semua pihak yang terlibat dalam projek pembangunan kubu. Kajian juga mengesyorkan ketelusan maklumat kos pembinaan amat penting diperolehi daripada pihak JKR.

Tujuan utama dan objektif-objektif yang ditetapkan dalam kajian ini telah tercapai di mana masalah kerosakan yang terjadi kepada kubu-kubu yang sedia ada serta masalah-masalah pengoperasian pangkalan harian telah dikenalpasti. Persoalanan berkenaan perbandingan kos pembinaan kaedah pre-fabrikasi telah dibuktikan dan didaati kos pre-fabrikasi lebih berkesan, Maklumbalas daripada kebanyakan respondan menunjukkan penggunaan kaedah pre-fabrikasi yang menyeluruh di semua Pangkalan/ Unit TUDM pada Rancangan Malaysia Ke-10 adalah memungkinkan dan boleh menjimatkan kewangan pertahanan TUDM.

ABSTRACT

Pre-fabrication construction method is not new in Malaysian construction industry yet the utilization of such method still relatively low. Government should conduct thorough study of pre-fabrication method aspects and implement it widely especially for government based projects including national security development projects as well. Pre-fabrication method is a modern construction method that widely use by developed countries and it proven that to be more cost effective and cost saving on the aspect of cost, labor, time, quality and durability.

Pilot project of bunker construction in Kuantan Airbase (KAB) has chosen as case study for this research. While data required for this case study was generated from site survey, interview segment and construction cost comparison of pre-fabrication with conventional bunker construction. The findings showed that none of defense bunkers were fully complied with specifications. Majority of respondents agreed that current construction method caused several problems to RMAF and PWD. Pre-fabrication method was foresees contributed solutions to overcome current problems and furthermore this study identified that pre-fabrication is cost effectiveness for implementation. Recommendations suggested to improve current construction caused problems on site by imposing clear delegations and responsibilities for stakeholders whereas encourage cost information transparency provided by PWD.

The primary aim and objectives of this study has been accomplished successfully in which the findings have eliminated uncertainties and arguments on pre-fabrication method cost effectiveness. Majority of respondents gave a feedback that pre-fabricated bunkers implementation are possibility for mass implementation of pre-fabricated bunkers in 10^{th} Malaysian Plan in all RMAF Bases. This action will save financial of RMAF defense.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

LIST OF ABBREVIATIONS

Brig Gen	Brigadier General
Capt	Capten
CCD	Camouflage, Concealment and Decoy
CDD	Chief Deputy Director (PWD)
CIDB	Construction Industry Development Board
CMU	Concrete Masonry Units
C/ NC	Compliance/ Non- Compliance
Col	Colonel
DP&D	Department of Planning and Development
EXO	Executive Officer
IBS	Industrialize Building System
ID	Identification
KAB	Kuantan Air Base
Maj	Major
MC	Modular Coordination
MMC	Modern Method Construction
NBCR	Nuclear, Biological, Chemical, and Radiology
OPP	Outline Perspective Plan
PWD	Public Work Department
QA	Quality Assurance
QC	Quality Check

QS	Quantity Surveyor
RMAF	Royal Malaysian Air Force
Sect A	Sector Alpha
Sect B	Sector Bravo
SO 1	Staff Officer 1
SO 2	Staff Officer 2
SOP	Standard Operating Procedure

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Ground defense is part of defense plan for every Royal Malaysian Air Force (RMAF) bases. In conjunction with the enhancement of RMAF base ground base defense program, a series of study, planning, design and review has been conducted by RMAF Department of Planning and Development (DP&P) and its' selected project team. A complete RMAF ground defense program proposal had been delivered to the highest-level management of RMAF for their consent and approval. Among all the elements in the proposal, one of the important supporting elements is ground defense bunker.

A great numbers of standardized bunkers will be built throughout all the RMAF bases in Malaysia for the next Tenth Malaysian Plan. However, before the mass implementation of bunkers construction in all the RMAF bases, Kuantan AirBase (KAB) has been selected as the very first base to be equipped with these

bunkers. These bunkers are in the budget of Ninth Malaysian Plan. These pilot bunkers are purposely for design review and feasibility study of the future new designed bunker.

After two consecutive years of the construction of nine (09) bunkers in KAB, project design team assigned faced the same repetitive problems such as unstable yearly costing of bunker construction and no construction standardization in size and other specifications due to the lack of engineering knowledge and incompetency of Class-F contractors selected by Department of Public Work (PWD).

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Furthermore, lack of influential power in contract awarding process and payment process by RMAF personnel has made it even more difficult to select capable contractor and reduce unnecessary cost incurred during construction. While contractor usually tries to gain as much profit as they can and tend to use sub-standard or low quality materials throughout the construction process. RMAF design team in fact generalize this problem after found out that all the contractors were using bricks to assemble the bunker's ventilation part, instead of using reinforcement concrete as what stated in method of construction.

Additional, by selecting any random contractor to work inside the base potentially offer a treat to base in term of information leakage, sabotage, and espionage, during period of On-site construction activities. Therefore, more work forces from military have to assign to project site to monitor movement of contractors.

1.2 Research Background

Issues of construction cost and specification standardization has raised the main concerns of the design team to find a better execution plan to mitigate the existing problems of bunkers development plan. Moreover, potential safety and security issue also have to take into consideration while implementing the plan.

Design team has to propose the alternative solutions and usage of pre-fabrication construction method could be one of the alternatives beside conventional construction method. Comparisons in term of cost effectiveness and specification standardization are needed in order to justify which alternatives are more reliable.

Prefabrication construction has the advantage of rapid erection and a fast onsite construction, and the elements are produced in factories, which secures good quality. But requires a detailed design and connection details are complicated. In the respect of generation of construction waste, a research conducted (Tam et. Al, 2004) had proved that prefabrication construction tends to produce less wastage than conventional construction.

In the RMAF, conventional construction method is the only implementation for the development of all type construction projects, even though issues of inadequate contractors, slow productivity, traditional and costly construction method is still repeating. However, determination to resolve and improve the current problematic situation, RMAF will be adapting contemporary construction method such as pre-fabrication system for the beneficial of RMAF organization.

1.3 Research Problem Statement

Since the establishment of RMAF in the late 50's, RMAF organization Planning and Development Department has been working hand in hand with the Public Work Department (PWD) for the development of building construction project in bases. However, RMAF project team only acts as coordinator that responsible for the planning and designing stages for RMAF development project; where else, PWD has the obligation to fulfill RMAF's requirements as required. In this working environment, RMAF dependence on PWD in contract awarding, monitoring and commissioning of project eventually create some problems to the RMAF.

Engineering professionalism of selected Class-F contractors is the main problem facing by RMAF design team since contractors selected are consider incompetent in the term of knowledge and expertise during construction processes that resulted to unnecessary construction faultiness.

In addition, review done after the completion of 1st and 2nd phase bunkers construction in KAB has generalized that all selected contractors are lack of engineering knowledge while performing engineering-related task. Incompetency shown relatively is the wrong interpretation of construction drawing that ended up in wrong construction of bunker size, opening of windows and doors, weapons support countertop's size, water proofing system and ventilation system. Moreover, contractors tend to use sub-standard material during the construction phase and refuse to comply with specifications and standards given, that eventually resulted to additional cost for correcting constructions faultiness and reinforcing the bunker structure.

Besides that, another problem that should be taking into consideration is the base safety and security problem. As a military establishment, requirement of safety and security is relatively high and tight for any civilian personnel that wish to gain access into the base. To ensure safety, all contractors should be subject to identity filtering, vehicle check, issue of temporary access past for contractors and vehicle, and periodical visual check by military polices at construction site.

Every movement and activity carry out by contractors is recorded due to military policies to prevent possible criminal offences by civilians in the base, ensure off limits civilians businesses and establishments not offended, ensure of weapons safety, access of restricted areas, and photography activities. Therefore, additional manpower from the military security forces is assigned to carry out additional task since contractors and their workers is considered as a threats to the overall safety and security of bases that might lead to problems of classified military information leakage, sabotage of military facilities and assets and any espionage activities.

Generally, problems of this research could be identified and categorized as following:

(i) Safety and security issue;
(ii) High construction cost;
(iii) Lengthy construction period; and
(iv) No compliance to specification and no standardization.

1.4 Aim and Objectives of Research

The aim of this research is to verify the cost effectiveness of applying pre-fabrication construction method compare with conventional construction method in order to save government budget for RMAF base defense program.

However, the specific objectives of this research are as follow:

(i) To identify the existing bunkers faultiness;
(ii) To identify the implications of conventional bunkers construction; and
(iii) To compare the potential cost effectiveness of using pre-fabrication method for bunker construction.

1.5 Scope of Research

Scope of research determined to facilitate the literature research, by focusing on pre-fabrication construction during installation stage in literature research and data collection process for empirical research from the companies' manuals documents study, case studies, and interviews. This research covers:

(i) Case study in KAB;
(ii) Observation and record of problems occurred on site;

(iii) Explore Cost effectiveness of pre-fabrication construction method, and compare to conventional bunkers method.

1.6 Importance of Research

The RMAF Department of Planning and Development is facing challenges in four aspects; cost, time, quality and safety of bases. Actually, by implementing a innovative way of construction method such as pre-fabrication system can ensure the effectiveness in cost, time, quality and safety of any RMAF construction project.

Thus, this research will help to measure the cost effectiveness in pre-fabricated bunker and the compliance of the Military safety and security regulations coupled with the engineering knowledge to provide advantages to the selected contractors. Besides that, it also decreases the cost of construction and the project can be completed with high quality with faster time.

1.7 Brief Research Methodology

The research methodology of this research is divided into five main stages as follows:

(i) Identify problem from existing completed project;

(ii) Identify objectives and scopes for research;

(iii) Collect data via literature review and empirical review through case study;

(a) Site Survey - site visit, record observation;

(b) Interview – all parties involved in previous bunker construction;

(c) Cost analysis – actual current construction cost and comparison cost of pre-fabricated bunkers with current bunkers.

(iv) Conduct analysis and prepare theoretical and empirical results.

(v) Provide conclusions and recommendations for overall findings and propose pre-fabrication method for the repetition construction of another 200 unit bunkers in all RMAF Bases.

1.8 Expected Findings

It is expected that, quantitative and qualitative data collected through three major phases of data collection from site survey, interview segment or cost effectiveness comparison between existing construction cost and quotation given by local precast manufacturer can enable the accomplishment of three main objectives in this study which inclusive of:

(i) Identify the existing bunkers physical construction faultiness;

(ii) Identify the complications caused by conventional method; and

(iii) Identify the cost effectiveness of pre-fabricated bunkers construction.

CHAPTER 2

Pre-fabrication Construction Method

2.1 Introduction

Pre-fabrication method is not a new concept in the construction industry because it was practiced even longer back to the 17th century while timber panels were created and shipped from England to new settlement in America (Shaari, 2003).

However, the use of pre-fabricated method in the military can be observed through some important event such end of War World II, Soviet Union (USSR) had been gathering information on construction methods especially from United State (US) for its country post-war rehabilitation programs. In order to equip its countries' architects, engineers, and students with adequate knowledge, Soviet Union government has officially exhibit United State modern construction method in prefabrication construction, descriptions of plumbing and heating systems, building

materials samples, and proposal of residential construction with the intention of performing its nationwide rehabilitation program.

Soviet Government foresee by implementing modern method of pre-fabricated construction in the rehabilitation program can eventually enable the country to reconstruct the basic need of its citizens and especially for its defense capability. The US modernization and advance in construction are the reasons that inspired USSR to implement the same pre-fabrication construction method to rebuild its country. The modernization of US construction method is shown in Figure 2.1.

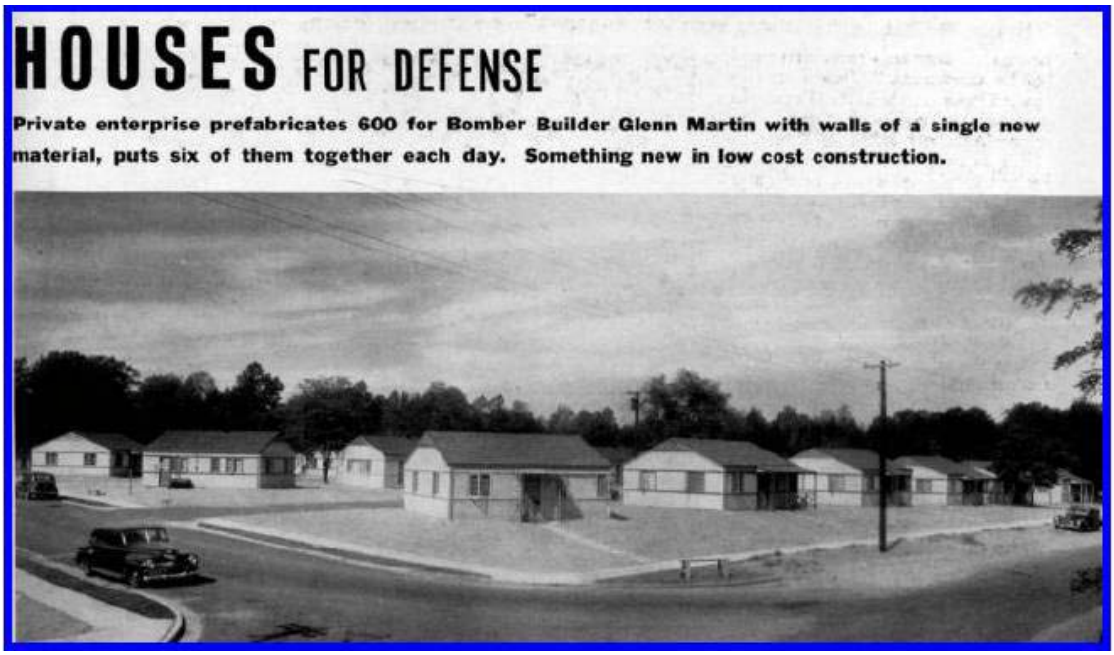

Figure 2.1: Pre-fabricated Houses for Defense Designed by United State (Source: Anderson, 2009)

Integration of knowledge from all construction stakeholders in this radical rehabilitation program not only successfully rebuild war-destructed areas, aerial and land bombarded military installations and establishment. Moreover, it also met the

acute need of housing construction that required by millions of people rendered homeless by war (Anderson, 2009). Furthermore, another observed significance to the event had demonstrated the first giant step in the great work of rehabilitating peacetime housing construction all over the world (Anderson, 2009). Pre-fabrication therefore has further developed into steel and precast concrete technology and has been using until present days.

In Malaysia, pre-fabrication is not a new concept in our Malaysian Construction Industry. With the evolvement of construction method, pre-fabrication has been further popularize with the term of Industrialized Building System (IBS) among the industry stakeholders and manufacturers within the industry had been industrializing components and structures of building or infrastructure part by part to meet the requirement of standardization at site.

Nonetheless, the norm of using pre-fabricated method or industrialized components in Malaysian construction industry is consider relatively low and especially compare with conventional method. In additional, prefabricated method will be implemented if contractors have no other choices due to tide schedule and site condition, and they are preferably to employ relatively cheap foreign workers to create labour-intensive construction activities (Shaari, 2003).