"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Master of Science of Construction Management"

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CABLE STAYED BRIDGE CONSTRUCTION: CASE STUDY OF SUNGAI JOHOR CABLE STAYED BRIDGE

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

Faculty of Civil Engineering
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I declare that this thesis entitled "CABLE STAYED BRIDGE CONSTRUCTION: CASE STUDY OF SUNGAI JOHOR CABLE STAYED BRIDGE" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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To my beloved parents, siblings and friends for their never ending care and support.
Thank you for everything.

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ABSTRACT

Cable-stayed bridges are becoming increasingly popular in the world. However, the lack of experience in cable-stayed bridge construction may lead to unsuccessful projects including cost overruns and schedule delays. In light of these potential problems, a need exists to document the methods of construction used in past cable-stayed bridge projects. This study documents the methods of construction of the Sungai Johor Cable-Stayed Bridge. Throughout the study, issues regarding construction problems and innovation are highlighted. This case study describes the general characteristics of the project, significant construction methods and techniques, and factors contributing to project success. Incremental launching, balanced cantilever, self-climbing formwork are typical important construction techniques been used in this case study. There are 24 problems been identified during the implementation of this cable stayed bridge. A questionnaire was developed to facilitate systematic data collection based on the factors grouped under four main project aspects, namely, project characteristics, contractual arrangements, project participants, and interactive processes. Experts who are involves in this construction industry were invited to participate in the survey. There are six critical success factors addressing budget performance, schedule performance, quality performance, and overall project success been identified with also some pertinent findings of the study are discussed.

ABSTRAK

Pembinaan jambatan kabel-penahan telah menjadi semakin popular dalam dunia. Walaubagaimanapun, kekurangan pengamalan dalam pembinaan jambatan kabel-penahan ini akan menyebabkan kegagalan projek termasuk melampaui kos dan penangguhan jadual pembinaan. Jadi, keperluan mendokumentasikan cara-cara pembinaan projek jambatan kabel-penahan berpandukan project lepas amat diperlukan untuk mengurangkan masalah bakal ini. Pengajian ini mendokumentasikan cara-cara pembinaan Jambatan Kabel-Penahan Sungai Johor. Melalui pengajian ini, isu-isu yang berkaitan dengan masalah pembinaan dan innovasi teknologi yang digunakan akan dipentingkan. Kes pengajian ini menguraikan ciri-ciri umum projek, cara-cara dan teknik-teknik pembinaan yang penting, serta faktor-faktor yang menyumbangkan kepada kejayaan projek ini. Pelancaran tokokan, penyokong seimbang, acuan mendaki diri adalah teknik-teknik pembinaan yang penting yang digunakan dalam kajian kes ini. Terdapat 24 masalah dihadapi semasa menjalankan kerja-kerja pembinaan jambatan kabel-penahan ini. Satu soal selidik telah dibangunkan untuk memudahkan pengumpulan data sistematik berdasarkan faktor-faktor yang dikategorikan dibawah empat aspek projek yang utama iaitu ciri-ciri projek, aturan bersifat kontrak, peserta projek dan proses interaktif. Bakal-bakal yang terlibat dalam pembinaan jambatan ini telah diajak untuk menjawab soal selidik ini. Terdapat enam faktor kejayaan yang kritikal dikenal pastikan dengan dikenali sebagai prestasi belanjawan, prestasi jadual pembinaan, prestasi kualiti dan keseluruhan kejayaan projek serta membincangkan juga beberapa penemuan-penemuan yang berkaitan dengan kajian ini.

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LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
ASCE	American Society of Civil Engineering
BORR	Butterworth Outer Ring Road
CSFs	Critical Success Factors
FHWA	Federal Highway Administration
GPS	Global Positioning System
LLM	Lembaga Lebuhraya Malaysia
OPC	Ordinary Portland Cement
PC	Prestressed Concrete
PE	Polyethylene Pipe
PFA	Pulverised Fuel Ash
PRS	Pollutant Removal System
SDE	Senai Desaru Expressway
SDEB	Senai Desaru Expressway Berhad

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CHAPTER I

INTRODUCTION

1.1 General Overview

Formerly, the only gateway to Desaru is Johor Bahru – Kota Tinggi Highway or Pengerang Highway which consume around 2 hours for typical journey. Nowadays, there is a new expressway (Senai – Desaru Expressway, SDE) which connects Senai in western Johor to Desaru in eastern Johor. It is part of the Iskandar Development Region with a total length of 77km (47.8 miles) constructed at an estimated cost of RM1.46bn. It is also expected to shorten the journey time from 2 hours to 45 minutes which helps to save a lot of money, time and economize the scarce of energy resources.

This tolled expressway will be a four – lane dual carriageway which will be able to improve road connection between western and eastern Johor. The road will start at Senai and link to the following places: Setia Indah, Taman Daya, Ulu Tiram, Pasir Gudang, Bandar Penawar and finally Desaru. It will be an alternative way to Desaru Beach, instead of Federal Route and be the main access road to Desaru from North – South Expressway Route and major road link to Senai International Airport from Kota Tinggi. The road will include four toll plazas and six interchanges, 1 intersection and 2 rest and service areas.

There are two phases for construction of this expressway. The first one is the road from Senai to Pasir Gudang whereas phase two of this project, the concerned one is involving the cable stayed 1708m long sungai bridge across the Johor River. It is soon to chalk up a milestone success in the engineering, operation and maintenance and expected to become a major landmark of Johor and become one of the longest single (central) plane cable – stayed bridges in Malaysia after Raja Pemaisuri Bainun Bridge in Perak. This expressway project is also the third largest highway concession awarded by the Malaysian Government.

A cable-stayed bridge is a bridge that consists of one or more columns (normally referred to as towers or pylons), with cables supporting the bridge deck. There are two major classes of cable-stayed bridges: In a harp design, the cables are made nearly parallel by attaching cables to various points on the tower(s) so that the height of attachment of each cable on the tower is similar to the distance from the tower along the roadway to its lower attachment. In a fan design, the cables all connect to or pass over the top of the tower(s).

This bridge is designed in a harp configuration but in a single central plane (only one set of stay cables) which means that the cables are in near – parallel arrangement, having the merit of cables are attached to various points on each of the two “A” shaped concrete pylon towers. Each tower has a foundation of 34 – bore 2m – diameter steel cased piles. As a result, the distance from the tower along the roadway to its lower attachment is similar to the height of attachment if each cable on the tower.

The total length of this landmark bridge is about 1.7 km long while the main span of the bridge is 500m and the pylon height is 142.5m from the surface of the river. The middle 739m of the bridge has a composite deck with a 250mm thick precast concrete deck slab and a closed structural steel skirt (3.5m deep). There are two 484.5m deck sections on either side of the central section and these consist of a concrete box girder structure.

This SDE is the only one expressway in Malaysia which implements the Pollutant Removal System (PRS) to monitor and control any potential of a spillage of perilous and hazardous chemicals from any vehicle travelling on the expressway because it traverses through the environmentally sensitive water catchment area of Layang Reservoir.

1.2 Problem Statement

Johor is one of the popular destinations for tourists from other counties because of its southward region location in Malaysia. Due to Senai International Airport and Johor Bahru city such a strategic location in the background is connected to Singapore, many passengers are attracted to this region and aid the economy. However, if we probe into Johor's road infrastructure aspect, it is in need of severe improvement. The typical journey time from one place to another place sometimes took a long time.

Senai – Desaru Expressway is one of the endeavors from government to upgrade the Johor's road infrastructure. The construction works for this project is both technically and environmentally challenging especially the cable – stayed bridge. As cable- stayed bridges are becoming increasingly popular in Malaysia. The European community has viewed cable –stayed bridges to be the most advantageous, economical long span bridge since the end of World War II (Rowings and Kaspar, 1991).

Cable – stayed bridges may present a few different alternatives for the cable system. At least harp, fan or modified fan arrangements can be discussed at the beginning of the design (Walther, 1999). Cable – stayed bridges are designed to support load efficiently with all members carrying only axial forces (Rowings and Kaspar, 1991). They typically require less material than conventional bridges and rely on free cantilevered construction methods such that extensive falsework is not necessary.

Problems will occur that were not originally anticipated with the advent and implementation of any new technique or procedure. Contractual and technical problems are more frequent and threaten to stagnate the growth of the cable stayed bridge industry. Projects are completed over budget. Major difficulties occur, forcing significant completion delays. These kinds of projects have experienced major claims and litigation. In some cases, designers or contractors, or both have been terminated. Solutions to these problems must be sought in order to realize the technical and economic advantages offered by cable stayed bridge design.

However, aside from the design advantages, the lack of experience with cable –stayed bridges has posed many challenges to both owner and contractor project participants resulting in cost overrun, and scheduled delays which have to lead major claims, litigation, and termination of contractor and/or designers as seen on past cable –stayed bridges projects (Podolny and Scalzi, 1986). In addition, different challenges existed and critical factors for implementation of cable stayed bridge would be different or beyond if compared to other types of bridges. Therefore, a need exists to document the method of construction used on previously completed cable – stayed bridge projects. The lessons learned from one project, whether they are successful, failures or encounter difficulties, can assist in achieving success on future projects. Otherwise, people just repeat past failures only.

1.3 Aim and Objectives of Study

The aim of this project is to investigate and explore implementation and construction methods of cable stayed bridge in order to maximize its advantageous use and reduce the problems faced in the future. In accordance to, the specific objectives for the study are to be determined are:

i) To study and document the methods of constructing cable stayed bridge.

ii) To identify the problems faced by project participators during implementation of cable stayed bridge.

iii) To establish a frame work of successfully factors for implementation and management of cable stayed bridge project.

1.4 Scope of Study

This study aims to evaluate the construction method, problems faced and critical factors for successfully implementation of cable stayed bridge. In order to accomplish the objectives, the following tasks are carried as:

i) A through literature review based on the previous research works done.

ii) Site visit and interview with client, contractor and consultant are the main process in this study.

This study only focus on cable stayed bridge construction, mainly on problems, construction method statements and critical factors for implementation of cable stayed bridge in order for a better understanding and assisting in future works. Structural analysis and stability is beyond the scope of this study. Some of the information and data can be collect from library, journals and books. However, the outcome of this study cannot represent the situation of all construction processes in SDE cable stayed bridge.

1.5 Methodology

The study will be carry out in two distinct stages. A flowchart of methodology of the study is shown in Figure 1.1. Details descriptions of the methodology are given in Chapter 3.

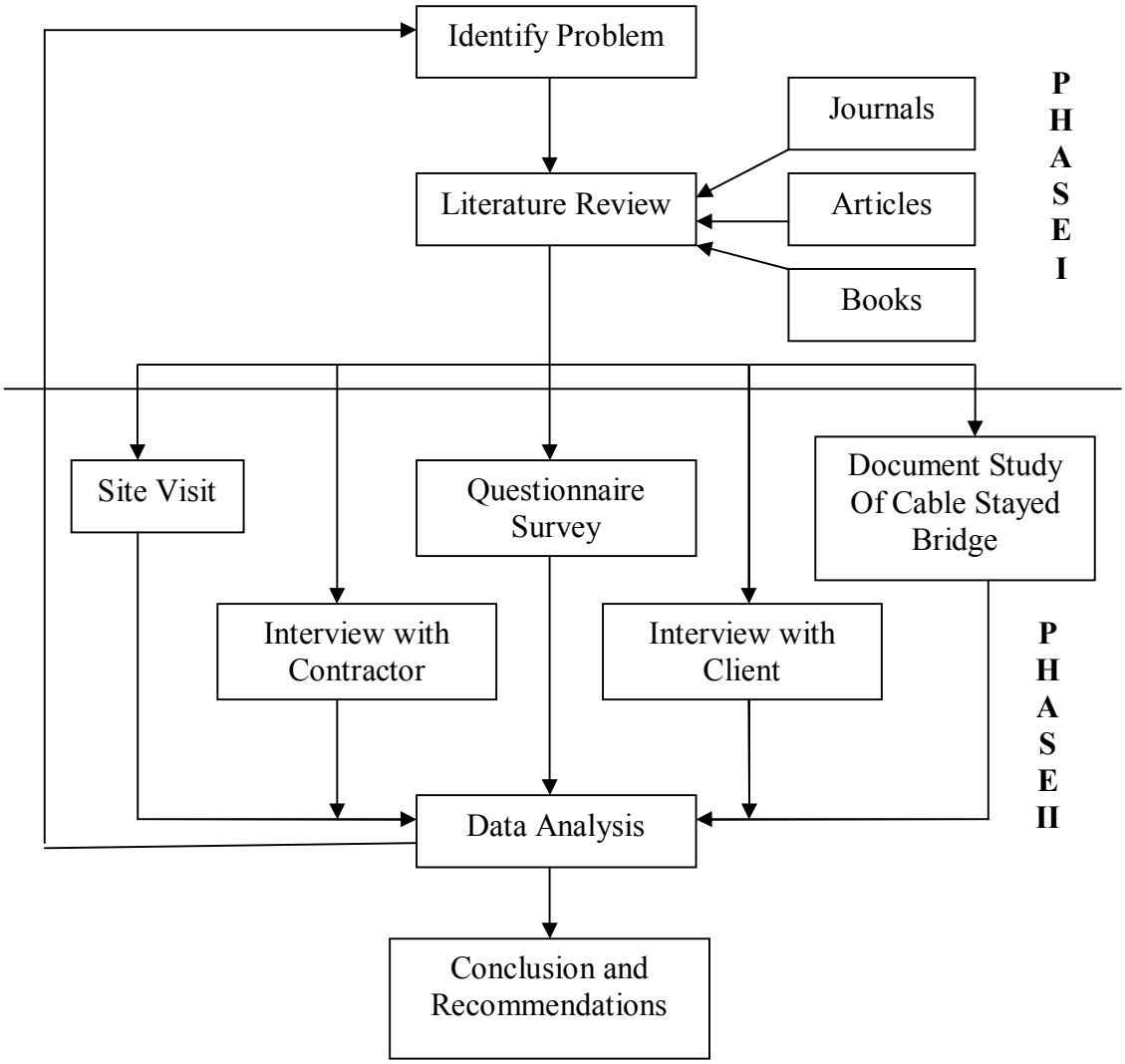

Figure 1.1: Flow chart of Methodology

1.6 Summary of the Chapters

This project paper is divided into six (6) chapters.

Chapter 1 describes the overall intention of the study. It also explains the objectives, the scope and limitation and the brief methodology adopted for the study.

Chapter 2 is a literature review on the cable stayed bridge. It describes historical development of cable stayed bridge, the types of bridge, and the basic concept and construction methods of cable stayed bridge.

Chapter 3 describes in detail the methodologies of study to achieve the objectives. This includes methodology for data collection and data analysis for site visit and interview with expert panels.

Chapter 4 analysis the data obtained from site visit and expert panels.

Chapter 5 discuss in details the data analysed in the previous chapter and present the findings for each of the results.

Chapter 6 concludes the overall study on the subject and evaluate whether the objectives of the study are met. Recommendations for future studies are also suggested.