ELEMENT OF V-MODEL IN CONSTRUCTION PROJECT

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FACULTY OF ENGINEERING
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THESIS SUBMITTED IN FULFILLMENT FOR THE DEGREE OF BACHELOR OF CIVIL ENGINEERING

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ABSTRACT

This study explains the element of Software Development Lifecycle (SDLC) model which is V-model in details, regarding its application in software development industry, the advantages, and disadvantages of this specified model, and the application of this model towards the construction industry project management model specifically in Sabah. Before the application is analysed, the first thing to be determined is the similarity and the elements included in the model and in typical construction projects. There are three objectives that included in this study which are to describe the V model principle to distinguish the elements of V model in construction project in Sabah, and to analyze the applications of V model in construction project in Sabah. This study focuses on the implementation into the construction industry in Sabah with some discussions about to the project delays factor that might be related to the application of V-Model, or any foreseen impact if V-Model is applied. The methodology used in this study is qualitative method, by doing secondary research and data collecting from previous studies, and document analysis from Sabah's construction project documents from *Jabatan Kerja Raya* (JKR) Malaysia. There are three construction projects that has been analyzed which are the *Cadangan Pembinaan Kolam Renang, Balai Bomba dan Kuarters Kimanis* and *Cadangan Pembinaan Hospital (76 Katil).* The elements of V-Model used in all three projects were specified, and the application of V-Model also has been analyzed throughout this research. The limitations of this research are time and also not many open resources available for the application of V-Model in construction projects. Further recommendations and suggestions are also specified in the final chapter of this study, to be used for the future study of the same field.

ABSTRAK

ELEMEN MODEL V UNTUK PROJEK PEMBINAAN

Kajian ini menerangkan elemen model Kitaran Hayat Pembangunan Perisian iaitu model V, secara terperinci, berhubung aplikasinya dalam industri pembangunan perisian, kelebihan, dan keburukan model tersebut, dan aplikasi model ini terhadap projek industri pembinaan khususnya di Sabah. Sebelum aplikasi dianalisis, perkara pertama yang perlu ditentukan ialah persamaan dan elemen yang disertakan dalam model dan dalam projek pembinaan tipikal. Terdapat tiga objektif yang disertakan dalam kajian ini iaitu untuk menerangkan prinsip model V, untuk membezakan elemen model V dalam projek pembinaan di Sabah, dan menganalisis aplikasi model V dalam projek pembinaan di Sabah. Kajian ini memberi tumpuan kepada pelaksanaan ke dalam industri pembinaan di Sabah dengan beberapa perbincangan mengenai faktor kelewatan projek yang mungkin berkaitan dengan aplikasi V-Model, atau sebarang kesan yang diramalkan jika V-Model digunakan dalam projek pembinaan. Metodologi yang digunakan dalam kajian ini adalah kaedah kualitatif, dengan melakukan penyelidikan sekunder dan pengumpulan data daripada kajian lepas, dan analisis dokumen daripada dokumen projek pembinaan Sabah dari Jabatan Kerja Raya (JKR) Malaysia. Terdapat tiga projek pembinaan yang telah dianalisis iaitu Cadangan Pembinaan Kolam Renang, Balai Bomba dan Kuarters Kimanis dan Cadangan Pembinaan Hospital (76 Katil). Elemen-elemen V-Model yang digunakan dalam ketiga-tiga projek telah dinyatakan, dan aplikasi V-Model juga telah dianalisis sepanjang penyelidikan ini. Batasan penyelidikan ini adalah masa dan juga tidak banyak sumber terbuka yang tersedia untuk aplikasi V-Model dalam projek pembinaan. Cadangan dan saranan lanjut juga dinyatakan dalam bab akhir kajian ini, untuk digunakan untuk kajian masa depan dalam bidang yang sama.

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LIST OF ABBREVIATIONS

SDLC	-	Software Development Lifecycle
V&V	-	Verification and Validation
HLD	-	High-Level Design
LLD	-	Low-Level Design
PID	-	Project Initiation Document
KPI	-	Key Performance Indicators
OPR	-	Owner's Project Requirement
BOD	-	Basis of Design
DB	-	Design-build
EOT	-	Extension of Time

CHAPTER 1

INTRODUCTION

1.1 Overview

V-Model is one of the models that are included in the Software Development Life Cycle (SDLC) where it is a process that executes in a sequential manner in the shape of letter 'V'. It is also known as Verification and Validation model. This V-Model is an extension of the waterfall model and is based on the association of a testing phase for each corresponding development stage. Every single phase that is included in this development cycle is directly associated with a testing phase. V-model is a highly disciplined model where the next phase of its development will only start after the completion of the previous phase.

There are several advantages and disadvantages of implementing this V-model. V-model is a very simple model and very easy to understand and to be applied. The simplicity of this model also makes it easier to manage. V-model is suitable to be applied in smaller scale projects where there are not so many requirements needed and the concept of the project is very well understood. This is because each phase in this model has its specific deliverable and review process. In the other hand, V-model is considered to not be a match to larger scale projects as it is not flexible to changes. Higher risks projects with many uncertainties in it makes it harder to work with V-model because this model need a specific testing for a specific phase. Once a work is in the testing stage, it is difficult to go back and change a functionality.

There are different stages and phases that are included in the V-model which are generally the designing phase and testing phase. The similarity between this V-model and construction project is that they both have the designing phase where it starts from the requirement analysis and ended with the manufacturing of the product, which is coding, in the case of software development, and construction work commencement, in the case of construction project.

1.2 Background of Study

Construction project management is one of the complicated specialties that entails dealing with a variety of issues, in which it includes the cost control, scheduling, procurement, and risk assessment of a certain project. Generally, project management is distinguished from the general management of corporations by the mission-oriented nature of a project. A project organization will generally be terminated when the mission is accomplished (Santos, 2019). Construction project management involves directing and organizing each part of the project life cycle, from ideation to completion ("Construction Project Management: Definition, Processes, and More | EcoSys," n.d.).

Project means a piece of planned work or an activity that is finished over a period and intended to achieve a particular purpose. A project is a series of actions that employ resources (finance, persons, resources, labor, space, supplies, communication, quality, risk, and so on) to accomplish pre-determined goals (Hassan Abu Bakar, 2011). Meanwhile, management means the control or organization of something. Thus, 'project management' means the activity of organizing and controlling a project ("PROJECT MANAGEMENT | meaning in the Cambridge English Dictionary," n.d.).

Generally, there are five (5) different stages in construction projects that is included in the project managing schedule which are Planning & Development stage, Design stage, Preconstruction stage, Procurement stage and Construction stage. Even though the concept of project management in construction industry keeps

evolving since past years, and will keep evolving in the future, the development of knowledge for project management field is still a concern, to find the best that suits the trend of the industry. Thus, in this research, the relevancy, and the impact of V-Model for delay of construction project in Sabah will be determined.

1.3 Problem Statement

Construction industry is one of the fastest growing industry in developing countries including Malaysia, in which this automatically will include the story of construction delay among the citizens at a certain area. Even though the Malaysian construction industry is critical to the country's economy, it has a bad reputation for the result of mismanagement such as cost overruns, unrealistic schedules, accidents, poor workmanship, conflict among project team members and many others, as quoted by Haron et al. (2018) from Ting et al. (2009).

Haron et al. (2018) also mentioned that Bash et al. (2015) suggested the 12 CSFs most generally associated with successful project execution are divided into three main categories which are project management success, individual project success and lastly, corporate success. By referring to the statement above, the project management method is also one of the main factors affecting the success of a particular project. To make sure a project is done successfully, the project manager is responsible and must have the knowledge of managing a project, by applying the best method out of the methods that have been proposed globally.

Project delay and project success are always related to each other as both can be achieved through the management team or person in charge of it. Many construction projects suffer from delay, and it gives disruption towards the works executed and loss of productivity. Besides, it also causes late completion and increases the cost of project due to dragging time. It is important that the management team of a particular project keep the track of the current progress to avoid delay in completion and to identify issues at the early stage of project to reduce the damage caused. Al et al., (2009) suggested a few different researchers' views on

project delay where he quoted from Cleland (1999) and Abdul-Rahman and Berawi (2002), monitoring provides early notice of potential contractor delays and aids in predicting the impact of any adjustments that may be required.

1.4 Objectives

By reviewing the V-Model that has been mentioned before, the main goal of this research is to identify the application of the V-Model in the project management of the construction industry, and to determine the relevancy and the impact of V-Model for delay of construction project in Sabah. Thus, the objectives of this research are specified as follow:

a. To describe the V model principle.
b. To distinguish the elements of V model in construction project in Sabah.
c. To analyze the applications of V model in construction project in Sabah.

1.5 Scope of Study

The scope of this study has focused on the application of V-Model into the project management of construction industry in Sabah, Malaysia. The existing V-Model of Software Development Life Cycle (SDLC) has been studied and will outline each phase of it to be implemented on managing project in construction industry particularly.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter includes information gathered by doing secondary analysis to answer objectives that were mentioned, which includes the Software Development Life Cycle (SDLC), the history and background of V-Model, advantages, and disadvantages of V-Model, life cycle phases of a typical construction project, and factors that affecting the project's delays.

2.2 Software Development Life Cycle (SDLC)

In the field of software development, the Software Development Life Cycle (SDLC) is a series of phases that provide a common understanding of the software building process (Mohamed Sami, 2012). To guarantee the project's success, it will be necessary to select the appropriate SDLC model based on the project's unique concerns and requirements, as well as to translate business concepts and requirements into functions and features, which will then be used and operated to meet the business demands.

Software Development Life Cycle is a technique that oversees the whole development process Kumar Dora & Dubey (n.d.) and is a strategy for developing software in a methodical manner, increasing the likelihood of finishing the project on schedule and preserving the quality of the software product to industry standards (Mishra and Dubey, 2013). Software Development Life Cycle (SDLC) is also a framework that defines the steps that are included in the development of software at different stages. It also defines the complete cycle of development including all the tasks involved in planning stage, creating stage, testing stage, and implementing stage.

All these stages are covered with a detailed plan to achieve the delivery of high-quality end products. There are various stages included in SDLC which are Requirement Gathering and Analysis Stage, Design Stage, Implementation Stage, Testing Stage, Deployment Stage and Maintenance Stage (*SDLC Phases, Process, Models,* 2021). According to Mishra & Dubey (2013), the phases that are usually included in SDLC are Gathering Stage, Designing Stage, Coding Stage, Testing Stage and Deployment & Maintenance Stage.

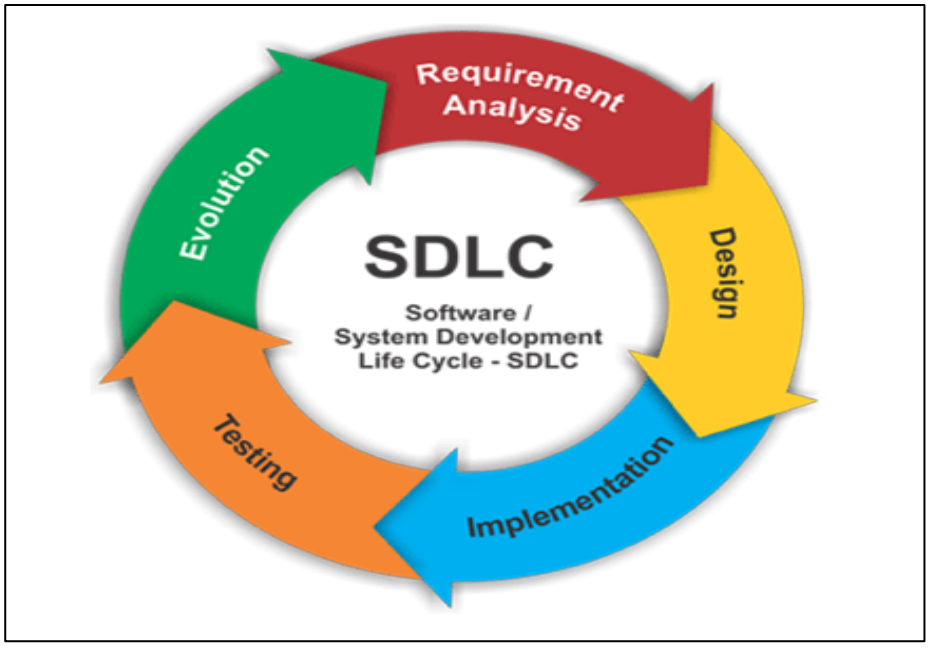

Figure 2.1: Software / System Development Life Cycle (SDLC) Phases

Source: Mohamed Sami (2012)

From a previous study by Kumar Dora & Dubey (n.d.), they have stated that SDLC is categorized in two different methodology which are Traditional SDLC or known as heavy weight methodology, and the other one is Agile SDLC or known as light weight methodology.

2.2.1 Traditional SDLC

In the traditional method of SDLC, traditional approaches are plan driven in which work starts with the elicitation and documenting of a comprehensive set of requirements, followed by architectural and high-level design development and inspection (Kumar Dora and Dubey, n.d.). Due to these substantial elements and heavy aspects included in it, this system started to be known as heavyweight. These approaches are built on a sequential sequence of processes, such as requirements formulation, solution creation, testing and deployment. Heavy weight techniques demand creating and documenting a consistent set of requirements of a project outset.

Heavy weight methodology approaches tend to initially plan out a major part of the development process in detail over a lengthy stretch of time. This technique follows an engineering discipline where the development is predicted and repeatable. A lot of attention is focused on the designs concentrating on the requirement of the system and how to resolve those issues effectively.

The property of classic software development process based on four phases. The first stage is to draw up the specifications for the project and assess the amount of time it will take to execute the various phases of development while attempting to forecast any difficulties that may come in the project. The following stage continues into the design and architectural planning phase when a technical infrastructure is developed in the form of diagrams or models. Once the team is content with the architectural and design plan, the project goes onto the development phase when

code is developed till the stated objectives are met. The testing phase typically overlaps with the development phase to ensure concerns are addressed early on. Once the project nears completion and the developers are close to achieving the project criteria, the customer will become part of the testing and feedback cycle and the product was delivered once the client satisfied with it.

There are several essential natures of the traditional SDLC which are listed as follows:

a. The aims are to properly grasp users' wants, build a strong design, develop software perfectly, and implement a working system that fulfils user needs.
b. There is a heavy emphasis on detailed preparation to cope with hazards.
c. Such an approach implies that issues are clearly defined and that an ideal solution can be arrived at by thorough, up-front preparation.
d. It also presupposes that the processes are predictable and can be streamlined and made repeatable.
e. It is also founded on the idea that processes can be effectively monitored and that causes of variability can be recognized and managed throughout the development life cycle.

2.2.2 Agile SDLC

Agile SDLC is a series of software development approaches centered on iterative and incremental development, where requirements and solutions evolve via cooperation between self-organized, cross functional teams. It fosters the adaptive planning, evolutionary development and delivery, a time-boxed iterative method, and encourages quick and flexible reaction to change. Software creation may be a hard process if not done appropriately. The key to a successful software project is communication, adaptability, and thorough analysis. That is why agile methodology is embraced and well-known in the industry of software development because it signifies the ability to adjust as circumstances change.

Agile development approach is a conceptual framework for performing any software engineering initiatives that supports anticipated interactions throughout the development cycle. There are a lot of agile software development approaches however the most prominent agile methods include Extreme Programming (XP), crystal methodologies, Scrum, Feature Driven Development, which will not be mentioned again in this study. The following are the primary feature of agile approach which contrasts from Heavy weighted methodology:

a. People oriented and team competence
b. Adaptive
c. Balancing flexibility and planning
d. Empirical process with decentralized approach
e. Simplicity
f. Small Self-organizing teams.

2.3 V-Model

2.3.1 Conventional V-Model

As mentioned by Durmuş et al. (2018), the V-model lifecycle was first developed and established by Paul Rook in 1986 as a guideline for software development methods. V-model is one of the models included in Software Development Lifecycle (SDLC) where it is derived from an older model known as the Waterfall model. The concept of both models is almost the same except that the testing and modelling stage started early in the V-model.

The V-model are also known as Verification and Validation Model (V&V Model), Integrated Verification and Validation Model (IV&V Model) and Independent Verification and Validation Model (IV&V Model). It accurately represents the key aspects included in traditional development of project managing models. V-model is one of the most important models to show the development process and links between software development and testing. As mentioned, these models are

generally used for software development. Hence, in this research, the V-model will be analyzed and interpreted in the use of project management in the construction industry.

V model is the most prominent paradigm for conventional or traditional software testing administration. The goal of the V model is to increase efficiency and effectiveness of software development and represent the interaction between test activities, development activities and maintenance operations. Once the system has been made functional and all activities have been conducted, if it is not maintained effectively, all the development and testing efforts will go in useless.

Referring to the name of the model, there are two functions included. The first one is the 'Verification' function, where it means the key output of the controlled quality process and is focused on ensuring the service or product result followed the requirements and specifications mentioned. Meanwhile, 'Validation' function is a scope of management process that is focused on formalizing the acceptance of the project deliverables by the client (*V&V = the Verification and Validation of Deliverables*, n.d.).

Validation examines if the system will fulfil the customer's genuine requirements, whereas verification examines whether the system is well-engineered. Validation is the process of ensuring that the specification accurately reflects the demands of the client, whereas verification is the process of ensuring that the technology complies with the specification. In software engineering, the phrases verification and validation refer to two separate forms of investigation. The common definitions are:

a. Validation: Are we building the correct system?
b. Verification: Are we building the system correctly?

In the traditional methods of software development lifecycle, there is a mis-view of the concept of verification and validation as it was seen that verification is only for checking the products if they satisfy the requirements set it the previous stage, while the validation is only relegated to the beginning and ending of a project.