Integration Studies of Coupling Custom Project Life Cycle with Custom Project Governance Framework in The High Mix, Low Volume Industry

by

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LIST OF ABBREVIATIONS

5G	Fifth generation wireless technology for digital cellular networks
BD+SW Int	Bundling and Software Integration
CAP	Customer Acceptance Plan
CD	Contract Design
FWB	Financial Work Book
H1	Hypothesis 1
H2	Hypothesis 2
HMHV	High Mix, High Volume
HMLV	High Mix, Low Volume
HVLM	High Volume, Low Mix
HW Int	Hardware Integration
HW+SW Int	Hardware and Software Integration
IoT	Internet of Things
ISO	International Organization for Standardization
LTE	Long-Term Evolution
LVLM	Low Volume, Low Mix
MDR	Manufacturing Development Report
ODM	Original Designer & Manufacturer
OPM	Organizational Project Management Model
PMBOK	Project Management Book of Knowledge
PMI	Project Management Institute
PMP	Project Management Plan
PO	Purchase Order
QSO	Quality Sign Off
RQ	Research Question
SE	Systems Engineering
SOW	Statement of Work
SOX	Sarbanes-Oxley Act
TPS	Toyota Production System

LIST OF SYMBOLS

r	Pearson Correlation Coefficient
n	number of the pairs of the stock
$\sum xy$	sum of products of the paired stocks
$\sum x$	sum of the x scores
$\sum y$	sum of the y scores
$\sum x^2$	sum of the squared x scores
$\sum y^2$	sum of the squared y scores

Kajian Integrasi Gabungan Kitaran Hayat Projek Unik Dengan Kerangka Tadbir Urus Projek Unik Dalam Industri Campuran Tinggi, Kuantiti Rendah

ABSTRAK

Permintaan terhadap pembekal solusi kian meningkat, menyebabkan organisasi pembuatan tercabar untuk menjalani transformasi dari menjadi pembekal berpusatkan-perkakasan kepada pembekal berpusatkan-solusi. Kegagalan melaksanakannya boleh mengakibatkan masalah besar. Banyak organisasi pembuatan telah memulakan transformasi ini untuk mempertahankan perniagaan dan mengembangkan pertumbuhan perniagaan masing-masing. Namun, proses transformasi ini penuh cabaran. Oleh sebab itu, pihak organisasi mula menerapkan kustomisasi ke atas kitaran hayat projek atau tadbir urus projek untuk meningkatkan peluang kejayaan. Amalan terbaik dibangunkan berdasarkan banyak faktor, termasuk faktor fungsi, kegunaan, reka bentuk, penyediaan, penggunaan, keberkesanan dan faktor-faktor lain yang mungkin timbul. Walaubagaimanapun, nilai keseluruhan tidak diketahui. Tidak banyak kajian dilakukan ke atas ciri kitaran hayat projek unik. Pelaksanaan kustomisasi bagi kitaran hayat projek adalah sukar sekiranya ciri kitaran hayat projek unik tidak diintegrasikan ke dalam kerja yang dibangunkan. Di samping itu, kajian keberkesanan kitar hayat projek unik yang digandingkan dengan kerangka tadbir urus projek unik kurang dijalankan, terutama bagi organisasi pembuatan industri campuran tinggi, bilangan rendah. Oleh itu, kajian kualitatif pelbagai kaedah berdasarkan data bukan-numerik ini dijalankan untuk meningkatkan pemahaman tentang nilai gandingan kitaran hayat projek unik dengan kerangka tadbir urus projek unik bagi organisasi pembuatan, serta untuk menguji perspektif instrumental teori pemperibadian. Penyelidikan ini bergantung kepada kajian kes membujur dan merentas untuk menghasilkan gambaran yang lebih terperinci mengenai fenomena yang dikaji. Kajian kes membujur melibatkan Organisasi Pembuatan A. Kajian kes ini telah mengenalpasti ciri-ciri kitaran hayat projek unik. Kerja-kerja pembangunan turut dilaksanakan sebelum mengumpul data sekunder dan menjalankan analisis padanan corak. Kajian kes merentas pula melibatkan Organisasi Pembuatan B, C dan D. Kajian ini menggunakan teknik pensampelan heterogen untuk memberikan variasi maksimum dalam data yang dikumpul. Wawancara bersemuka dijalankan untuk memperincikan keberkesanannya, diikuti analisis tematik. Seterusnya, hubungan antara pemboleh ubah diuji. Analisis keseluruhan disahkan secara triangulasi. Hasil kajian menunjukkan kitaran hayat projek unik yang digandingkan dengan kerangka tadbir urus projek unik meningkatkan peluang kejayaan transformasi sesebuah organisasi dalam industri campuran tinggi, kuantiti rendah. Hasil kajian ini juga memungkinkan penyelidik dan pengamal membangunkan kustomisasi pemperibadian tidak-ketara mereka sendiri, yang sesuai dengan keperluan masing-masing. Adalah dicadangkan di masa hadapan agar projek yang lebih tinggi kosnya di segmen pembuatan perniagaan lain diteroka, termasuk aspek sokongan pasca-pemasangan dan penggunaan ukuran statistik untuk mengesahkan hubungkait tambahan antara pemboleh ubah di dalam proses yang berkenaan.

Integration Studies of Coupling Custom Project Life Cycle with Custom Project Governance Framework in High Mix, Low Volume Industry

ABSTRACT

The demand for solution providers is trending, and as a result, manufacturing organizations, more than ever, are being challenged to transform from hardware-centric to solution-centric. Failure to do so could be catastrophic. Many manufacturing organizations have started the transformation in order to stay in business and for enhancement of growth prospects. However, transforming from hardware-centric to solution-centric has faced tough challenges. To overcome this, they have started to apply customization on either project life cycle or project governance to enhance the chances of success. Formulating the best practices depends on many factors which includes functionality, usability, design, provision, utilization, effectiveness and other factors which may crop up. Yet, the overall value is unknown. Conversely, there is a lack of custom project life cycle characteristics that can be located. The customization work for project life cycle would be challenging by not integrating the custom project life cycle characteristics into the development work. Similarly, limited research has been conducted to gauge the effectiveness of custom project life cycle coupling with custom project governance framework especially for manufacturing organization in the high mix, low volume businesses. Hence, a multi-method qualitative study for this non-numerical data driven research is initiated, aiming to improve understanding of the value of custom project life cycle coupling with custom project governance framework for manufacturing organization as well as to test the instrumental perspective of personalization theory. This research relied on both longitudinal and cross-sectional case studies to yield a more detailed picture of the phenomenon under study. The longitudinal case study that involved manufacturing organization A enabled the identification of custom project life cycle characteristics and a series of development works prior to secondary data collection and pattern matching analysis. For cross-sectional case studies that involved manufacturing organizations B, C and D, the research depended on heterogenous purposive sampling technique to provide the maximum variation possible in the data collected through face-to-face interviews to detail picture of its effectiveness, prior to themes searching via thematic analysis. Subsequently, relationships among variables were tested. The overall analysis was validated via triangulation. The findings suggest that custom project life cycle that coupled with custom project governance framework would enhance chances of success for manufacturing organization transformation in the high mix, low volume industry. In addition, this would allow researchers and practitioners to develop their own intangible customization of personalization that suits and fulfils their needs. It is recommended that in future, solution projects with higher deal sizes in other manufacturing business segments are investigated, alongside post deployment support and the use of statistical measures to confirm the additional relationships between the variables be explored.

CHAPTER 1 : INTRODUCTION

1.1 Introduction

In this chapter, the research outline of the study is presented. The chapter begins with an overview of manufacturing organization transformation from hardware-centric to solution-centric. Successively, intangible customization of personalization is introduced to enhance the chances of success. The chapter also states the problem statement, research questions, research objectives, research scope and limitations and research deliverables of the research. Lastly, a brief research methodology of the study and theoretical framework is also highlighted.

1.2 Research Background

The predominant view in the literature is that a solution is an integration of goods and services to meet a customer's business needs (Davies, Brady, & Hobday, 2006; Sawhney, 2006; Tuli, Kohli, & Bharadwaj, 2007). Consistent with extant literature, manufacturing organizations tend to view a solution as a customized, bundle of products and services (Galbraith, 2002; Sawhney, Wolcott, & Arroniz, 2006). In contrast, customers tend to view a solution more broadly as a set of customer–supplier relational processes comprising customer requirements definition, customization and integration of goods and/or services and their deployment. The difference in the two perspectives sheds light on why many manufacturing organizations underemphasize relational processes that customers consider crucial. Manufacturing organizations' inattention to these processes arguably results in lost sales opportunities, dissatisfied customers, and lower profitability.

These studies suggest that manufacturing organizations could benefit from supplanting their view of solutions with a relational process view by high-value solutions beyond the manufacturing organization views (Foote, Galbraith, Hope, & Miller, 2001; Johansson, Krishnamurthy, & Schlissberg, 2003; Jacob, & Ulaga, 2008; Bettencourt, Blocker, Houston, & Flint, 2015; Ferreira, Cova, Spencer, & Proença, 2016; Rymaszewska, Helo, & Gunasekaran, 2017).

To manufacturing organizations, solution offering literally means business model transformation from a hardware-centric to solution-centric. For this, manufacturing organizations start to offer custom solutions under one-to-one condition to test the waters in which manufacturing organizations approach their potential customers one at a time to demonstrate their capability in specific technology. Manufacturing organizations in diverse industries, such as metal, machinery, energy utilities, construction, engineering and learning are seen to be heading towards this direction (Rabetino, Kohtamäki, & Gebauer, 2017; Lütjen, Tietze, & Schultz, 2017; Clegg, Little, Govette, & Logue, 2017; Martinez, Neely, Velu, Leinster-Evans, & Bisessar, 2019).

However, delivering a solution successfully faces tough challenges. Raja, Frandsen, and Mouritsen (2017) have revealed extending analytical capabilities for research and development while scaling the capabilities for a production context were the challenges faced by the three manufacturing organizations based in Denmark during the transformation in which the four sample manufacturing organizations in this study are in the customization businesses, together with the High Mix, Low Volume (HMLV) businesses. In HMLV, the industry focuses on custom solutions that optimally fulfil customer requirements that come with high level of flexibility.

In a nutshell, project management serves as a means that fuels the fulfilment of a solution as part of operational discipline (Di Muro & Turner, 2018). Out of which, either custom project life cycle or custom project governance under project management are used by manufacturing organizations across diverse sectors. Project life cycle or project governance has become the popular choice of manufacturing organizations transformation since they incur no additional investment in the implementation unlike the Enterprise Resource Planning by Oracle which incurs additional investment. Project life cycle is a series of phases that a project passes through from the start to the end. In most manufacturing organizations, Microsoft Project or Microsoft Excel are already in use with existing project life cycle for schedule developing, assigning resources to tasks, progress tracking, budget managing, and analyzing workloads. Project governance, on the other hand, includes roles and responsibility, policies and processes and they are common examples of project governance implementation to govern custom solution projects efficiently and confidently (Müller, 2009), especially in the case of International Organization for Standardization certified manufacturing organizations.

To name a few, Schuh, Dölle, Kantelberg, and Menges (2018) and Papazoglou, Elgammal, and Krämer (2018) have applied project life cycle to increase the chances of success. Along the line, a literature review on 33 papers between 2010 and 2017 by Orellano, Lambey-Checchin, Medini, and Neubert (2018) indicates that complexity, uncertainty, and unpredictability of business can be reduced by project life cycle adaptation. In PMBOK Guide 6th Edition, “A project life cycle is the series of phases that a project passes through from its start to its completion. A project phase is a collection of logically related project activities that culminates in the completion of one or more deliverables. The phases can be sequential, iterative, or overlapping” (PMI, 2017, p.547).

In layman terms, project life cycle comprises patterns of phase, life cycle and number of phases. Pierre, Didier, and Germain (2002) illustrates that major life cycles have existed in the past three decades and they are straightforward, control-oriented, quality-oriented, risk-oriented and fractal. To them, each life cycle represents a specific aspect of a project. Fifteen years later, PMBOK Guide 6th Edition has released predictive, iterative, incremental, agile and hybrid as their version of the life cycles (PMI, 2017). Some similarities among life cycles presented by PMBOK Guide 6th Edition and Pierre et al. (2002) were observed. These life cycles are the outputs for sequential, iterative, or overlapping patterns of phase.

Thamhain and Wilemon (1975) introduced the waterfall approach, which is also known as predictive approach. This was followed by other approaches: agile was suggested in mid 1990s. Subsequently, another distinctive approach named as hybrid was shared by PMI (2017) and also in PMI & Agile (2017) before "tailoring" approach. To them, "tailoring" an approach on project life cycle is about applying the most adequate project life cycle on a specific project by using demand pattern, rate of process improvement and more as consideration factors, and the examples given are in the agile domain. With this limited knowledge found in PMI and in general literatures, this suggests that the "tailoring" approach is still at the infancy (PMI, 2017; PMI & Agile, 2017).

No tailoring of project life cycle can be accomplished without knowing the project life cycle characteristics. Ee (2005) outlined seven characteristics of project life cycle in which adding value and production of information are the distinctive ones and the other remaining five characteristics of project life cycle were supported by other researchers

and practitioners. Ee (2005) explained, the chances of value adding by cost control are highest during the first phase and lowest during the last phase. He also emphasized that communication and retention of the information developed in the first two phases are vital for the subsequent phases and they enhance the chances for project success. Speaking of probability of project success, Pradeep (2010) had the same view with Ee (2005). For uncertainty and financial commitment, risk and uncertainty levels are greatest during the first two phases and will be gradually reduced when more information is made available throughout the project (Ee, 2005). This opinion is supported by Invensis Learning (2018) where most of the researchers and practitioners are concurring with the project life cycle characteristics mentioned above. PMI & Agile (2017) came up with a breakthrough, in which project life cycle characteristics for predictive, iterative, incremental, agile and hybrid are outlined and compared under four careful considerations namely requirements, activities, delivery and goal. On the other side of the coin, no project life cycle characteristics for customization can be found.

Similarly, Too and Weaver (2014), Ahola, Ruuska, Artto, and Kujala (2014) and ul Musawir, Serra, Zwikael, and Ali (2017) applied project governance to increase their chances of success. Others are uncertain about which project governance to be applied when needed (Müller, Shao, & Pemsel, 2016). The identified project governance literature sample consists of a heterogenous group as the articles show different definitions. The definitions offered for project governance vary from very narrow to broad. For example, Turner and Simister (2001) adopted an economics-based perspective on project governance which defines the concept as a contract type used in the project (such as fixed price), whereas other researchers have broader definitions for the concept. Take for example, Ruuska, Artto, Aaltonen, and Lehtonen (2009) believe that a company

must be able to meet its project stakeholder demands, documentation procedures, communication and contractual arrangements. Different views regarding the temporality of project governance have also been advanced.

Walker, Segon, and Rowlinson (2008)'s model on project governance distinguishes between the hard and soft aspects in project governance. The hard aspect of this model refers to structural and regulatory elements, designs, policies and legal requirements. The soft aspects of governance will complement the hard aspects in the way people interact with the governance structure, in light of their responsibilities and accountabilities which include the impact of relationships on the behaviour of individuals. The main objective of the model is to achieve equilibrium of trust and control to balance the hard and soft elements in governance.

The terminology used to define and describe central concepts in project governance literature shows that there is a lack of shared and universally accepted view on what project governance is. This is especially evident when project governance addresses individual projects, which is limited in its scope as it is related to governance of projects which in turn is under the purview of corporate governance. As Müller (2009) puts it: Project governance is closest to the management of a project, interacts with it, and is typically exercised by groups, owners, PMOs, or combinations of thereof.

A study by Ahola et al. (2014) has identified two distinct and relatively independent streams of literature. One stream reveals that project governance is an activity that is externally and specifically imposed by the project-based firm on the focal project. With this in mind, project governance aims to define standards and rules which

individual projects are expected to comply with and it is also used to monitor the fulfillment of these rules. The other stream of literature labelled as “project governance internal to a specific project” requires project governance be customized as opposed to standardized. There should be project governance arrangements that define shared practices for safeguarding, coordinating, and adapting the numerous exchanges that take place between project-based and non-project-based firms taking part in the project.

On the contrary, limited studies have been empirically conducted on the customization of project life cycle coupling with project governance framework for solution projects. Certainly, deeper research into the coupling effect of project life cycle and project governance shall offer the intangible custom solutions for the problem statement at the high mix, low volume businesses.

Prior to that, instrumental perspective of personalization theory and its three aspects namely design, provision, and utilization should be applied into the customization of project life cycle and project governance framework to enhance chances of success. Functionality and usability that highlight the importance of the customers situated needs are the main focus of instrumental personalization while design, provision, and utilization are there to ensure a smoother execution of the concept. All start with the design for functionality and usability, followed by the availability of the platform to keep and maintain all the customization work. Lastly, the concept was tested in utilization to enhance the chances of success for the transformation.

1.3 Problem Statement

Manufacturing industry is trending towards customer-oriented practices. Within this context, custom solution emerges as an alternative to enhance sustainable business models whereby manufacturing organizations are increasingly moving away from their existing business model for solution offering (Herterich, Uebernickel, & Brenner, 2015). However, transforming from hardware-centric to solution-centric faces constant pressure to perform well (Elfving, Lindahl, & Sundin, 2015). For this, manufacturing organizations start to offer custom solutions under one-to-one condition to test the waters. To overcome the challenges, some manufacturing organizations have started to applied customization on either project life cycle or project governance to enhance the chances of success (Too & Weaver, 2014; ul Musawir et al., 2017; Schuh et al., 2018 and Papazoglou et al., 2018). Conversely, there is a lack of custom project life cycle characteristics study that can be located. The customization work for project life cycle would be challenging by not knowing and integrating the project life cycle characteristics into the development work (PMI & Agile, 2017). Likewise, limited research has been conducted to gauge the effectiveness of custom project life cycle coupling with project governance framework especially for manufacturing organization in high mix, low volume businesses.

1.4 Research Questions

This research attempts to answer the following questions:

1) What are the characteristics for a typical custom project life cycle?

2) How should a custom project life cycle for custom solution projects look like?

3) What are the relevant sets of project governance for a range of custom solution projects?

4) How well does customization of project life cycle coupled with project governance framework enhance the chances of success in manufacturing organization transformation?

1.5 Research Objectives

The objectives of the research are stated below.

RO1: To identify the project life cycle characteristics in four careful considerations namely requirements, activities, delivery and goal that reflects the nature of custom solution. The outcome would be one of the prudent predecessors for the development of custom project life cycle.

RO2: To develop a project life cycle in four phases (requirement, development, refinement + iteration and delivery) that suits the pattern of phase for custom solution projects. The output from this development aims to become the new member for the family pattern of phase: predictive, iterative, incremental, agile and hybrid.

RO3: To develop a project governance framework that allows the selection of optimum set of project governance to be used for specific categories of custom solution.