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SUBMIT YOUR ABSTRACT

Complete solution fulfilment for the manufacturing-based company – how intangible customization of personalization enhances the chances of success

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Abstract. There is a trending demand in the industry to provide customers with total solutions rather than mere products, and as a result, manufacturing-based companies, more than ever, face stiff challenges to deliver complete solutions successfully. To increase their chances of success, project life cycles are applied across solutions development. This study aims to enhance the chances of success through the personalization of project life cycles. It starts with developing a project life cycle upon which personalization can be achieved. A qualitative longitudinal study was conducted to gauge how well the personalization accomplished its aims. The intangible customization of personalization would allow researchers and practitioners to arrive at their own complete solutions that fulfil their customers' needs.

1. Introduction

In today's rapidly changing business environment, manufacturing-based companies are constantly under pressure to deliver complete solutions successfully [1-3,41]. They must deliver more value than they do through their standard product, system and services [4,5]. Hence, everything they sell is in some sense a "solution" to some kind of customer problem [6,1]. Project management serves as a vehicle that fuels the fulfilment of a complete solution as part of operational discipline [7]. However, delivering complete solutions successfully is a big challenge. Raja et al. [8] revealed some of the challenges, and indicated that a significant degree of customization could go a long way to secure success. There are numerous examples of manufacturing-based companies across diverse sectors that incline towards customization in their project life cycles, including studies reported by Schuh et al. [9] and Papazoglou et al. [10]. A literature review carried out on 33 papers between 2010 and 2017 by Orellano et al. [11] shows that complexity, uncertainty, and unpredictability of business can be reduced by the adaptation of customization in project life cycles.

Unfortunately, there is limited research on the customization of project life cycle for custom solution projects, hence the need for this study. For that purpose, an American based advanced analytical equipment company serves as a sample to explore the customization of project life cycle development. The projects investigated are worth \$30k to \$500k per custom solution, and they are developed for education, general electronics and healthcare segments. The authors anticipate that the methodology and outcomes of this study will be applicable in manufacturing-based companies similar to the sample company.

The question that underline this study is, "how should a project life cycle for custom solution projects look like?" In order to answer the underlying question, two separate studies are carried out,



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namely Study 1 and Study 2. Study 1 entails a literature review, whereas Study 2 is a qualitative longitudinal study to gauge the effectiveness of the intangible custom solution that is developed as a result of this research. The custom project life cycle is developed for the use of the sample company, but its principles are applicable to a wide range of similar manufacturing-based organizations.

For the sake of simplicity, the authors replace “intangible custom solution” and “tangible custom solution” with “the development work” and “custom solution” respectively. The former refers to the custom project life cycle that the authors develop, while the latter signifies “custom solution business”, which is the product (which is a solution) that the sample company delivers to its customer.

2. Literature review

Literature review starts by introducing the relationship between the development work and the solution. This is followed by the application of personalization theory, to which customization is the key result. Lastly, the authors cover the works of other researchers and practitioners of project life cycles.

2.1 Solution

Research papers on Product-Service Systems (PSS) has been on the rise in the past decade. Oliveira et al. [12] outlined the consistent growth of PSS research since 2009, especially in Europe and Asia. To that end, improvements in the quality of solutions provide competitive advantage [13]. With the growing trend of integrating product and service together, Kimita et al. [14] reported that guidance from the organization paves the way for solution realization. Muto et al. [15] proposed a design guideline to manage the design process in terms of their progress and health. Researchers and practitioners agree that service has been a part of the equation that completes the entire solution.

2.2 Personalization Theory

In 1986, Holman [16] studied personalization theory that focused on emotional ties between the customer and the product, while Rodin [17] explored the linkages between emotional responses and the control over one’s environment. Subsequently, Wells [18] expanded on the work by Rodin by analysing personalization theory on the physical work environment using the example of elderly residents in a nursing home. For Blom and Monk [19], personalization theory attempts to understand why people choose to personalize, their disposition, and the effects of personalization on customers. In 2006, Fan and Poole [20] distinguished four distinct types of personalization design philosophies, of which the authors applied one of it in this study.

2.3 Customization

Gilmore and Pine [21] saw customization of personalization as meeting specific needs of individual customers through the delivery of an incomparable set of solutions. To Nielsen [22] and Pine and Gilmore [23], it is all about completing a solution per customers’ driven requirements. In the past, manufacturers were stuck between being a leader in price and differentiation. They were forced to choose either one to gain advancement. Hence, customization of personalization came to the rescue because it is equipped with advantages from both sides of the coin. With this, manufacturers are able to price the first-to-market customized solution right by delivering the exact solution customers demand [24]. A study by Hubert [25] revealed that manufacturing-based companies need to carry out custom upgrades on existing designs to cover the entire life cycle from research and development to services in order to stay relevant in the market.

The sample company in this study shows its capability as a differentiator to its potential customers privately. In return, individual customers approach the sample company to obtain customized solutions for their specific needs.

2.4 Project Life Cycle

It is well accepted in the project management community that a project life cycle comprises a series of phases that a project passes through from start to finish. A project phase defined as a collection of suitable activities that contributes to the completion of the project's partial or complete outcomes. The phases are either sequential, iterative, or overlapping" ([26], p.547). In layman terms, project life cycle comprises patterns of phases and life cycles. Adams and Barndt [27] indicate that there are no rules to follow in terms of the number of phases in a project life cycle. Typically, it varies from three to six phases. According to Khan [28], the number of phases is determined by the company itself, while Papazoglou et al. [13] stated that the ability to transform equipment, process, production, human operation, product and service into an end-to-end connected manufacturing ecosystem should be the underlying factor that decides the number of phases the project is to be executed. To add, Pierre, et al. [29] believe that sharing progress and developing a common view of the project through a life cycle image in mind is important. All these works have motivated the authors to pursue the development work. The customization of project life cycle is also supported by PMI [26].

3. Methodology

The study begins with defining the research process, which outlines the research method, research approach, research design, data collection, data analysis, and presentation of findings. Then, Study 1 is carried out, followed by the development of a custom project life cycle, and lastly, Study 2, which is the verification of the development work.

3.1 Research Process

In research process, the research method is carefully selected, taking into account discussions by Yin [30], particularly on linear-analytic structures of research. An understanding of the phenomenon under study is made possible by a multi-method [31], whereby, the authors put together the results of Study 1 and Study 2 to yield the outcome of the entire study. Study 1 aims to locate relevant literatures, while Study 2 constitutes a verification process.

For research design, Study 1 becomes the foundation upon which the development work is based, similar to work done by Schaeken et al. [32]. Subsequently, the development work is tested in Study 2, which is carried out using longitudinal approach [30]. Case studies have a distinctive place in evaluation research and are particularly used to elaborate certain topics within an evaluation, as supported by many researchers [33-35].

A qualitative data collection method by Yin [30] is selected for exploration, which is done through a combination of Study 1 and Study 2. Literature review is one of the recommended options for observational data collection method. Petticrew [36] revealed that it is widely applied to examine real issues, while Tranfield et al. [37] stated that a good literature review should contain assessment on research aims, flexibility of the context, sampling strategy, data quality, theoretical adequacy and generalizability. To add, Harden et al. [38] recommended that classifying, comparing, contrasting and integrating literature content should be performed. To gauge the effectiveness of the development work, in Study 2, three different categories of custom solution are observed in a period of two years. Yin's [30] construct validity criteria is introduced during data collection in order to identify the correct operational measures to be used. In this sense, multiple sources of evidence are used, including data (evidence) from the sample company's restricted share drive and communication network.

In Study 2, the authors focus on the number of imperfections captured in the solution that the sample company is delivering to its customers. This becomes 'post' data, whereby 'pre' data is taken from past records. A comparison between 'pre' and 'post' data would indicate the effectiveness of the customization work developed in this research.

3.2 Custom Solution Development

The custom project life cycle, which is the outcome of this research, is designed with usability in mind, using a method similar to the one used by Schaeken et al. [32]. No doubt, Study 1 has prepared the authors for custom project life cycle development work well. The resultant intangible

customization of personalization is the integration of project life cycles found in the literature and project life cycles in use in the sample company.

3.3 Qualitative Longitudinal Study (Study 2)

The purpose of Study 2 is to assure that the development work is effective. Hence, a verification process is implemented, whereby the company’s Customer Acceptance Plan (CAP) is accessed as the source of data. CAP is where physical deployment is performed upon arrival at the customer’s facility, which is the designated location of the custom solution. The CAP is not intended to be an exhaustive test of the functionality of the custom solution. Rather, it verifies the key features of the custom solution when used in conjunction with the customer’s device. The custom solution is considered acceptable once the CAP is completed.

4. Results and Discussion

In this section, results from Study 1 is discussed, followed by custom solution development, and finally, the results of the verification of the development work is presented.

4.1 Results from Study 1

A study of the sample company’s in-house custom solution roadmap found five custom solution frameworks in place, namely standard project life cycle, major launch project life cycle, small project life cycle, agile project life cycle and third-party project life cycle. Third party project life cycle caters for Original Designer & Manufacturer and Contract Design. A key distinction among them is whether the supplier will or will not manufacture the resulting design while the sample company leverages technical capability from the supplier. As expected, no custom solution project life cycle is found. At the moment, the sample company is in the process of shifting from a hardware-centric approach to a solutions-centric one. Two of the projects investigated at the sample company are of the Hardware + Software Integration (HW+SW Int) category, while another two are of the Hardware Integration (HW Int) category. The last project is of the Bundling + Software Integration (BD+SW Int) category.

A study of available literature shows that there are 11 types of approaches in project life cycles, including the waterfall approach (see, for example, Thamhain and Wilemon [39]), the agile approach, the hybrid approach, and the “tailoring” approach, which is still in its infancy [26,40].

4.2 Results from Custom Solution Development

It is only logical that project management teams should not stick to a particular project life cycle when the nature of the project has changed and the existing project life cycle approach is no longer completely relevant [29]. After all, the goal of project management is to bring business value in the best conceivable way [26]. Hence, the most suitable project life cycle approach should be applied, and the agile approach is a likely candidate. Stakeholders who newly join the project team could be easily integrated into the project by pinpointing where they are and what are the deliverables to be completed in specific phases. For that, the authors have decided to apply a well-known flow-based agile project life cycle to serve as a base for further project life cycle customization work, alongside the sample company’s project life cycle approach.

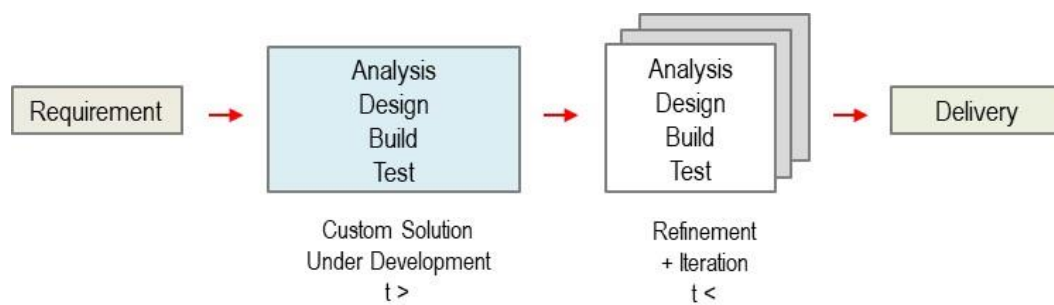


Figure 1. Custom Project Life Cycle for custom solution offering.

The custom project life cycle shown in Figure 1 is the integration of all of the sample company’s custom solution and regular project life cycles, plus eleven project life cycle approaches taken from the literature. While all the approaches are important, customization approaches are the key contributors to the custom project life cycle being developed. As can be seen in Figure 1, there are essentially four phases in the cycle – the first phase (Customer Requirement), the second phase (Analysis, Design, Build, Test under Custom Solution Under Development), the third phase (Analysis, Design, Build, Test under Refinement + Iteration) and the fourth phase (Delivery to Customer). The duration of execution, “t”, is the longest in the life cycle ($t >$), as represented by a rectangular box and in the Figure 1. A good output from the second phase would render a shorter period of time ($t <$) during the third phase, symbolized by a square box. The staggered square boxes in Figure 1 indicate the need for iteration in analysis, design, build and test until all of the customer’s requirements are met. Each cycle of refinement and iteration is expected to be shorter than the time in the second phase. The custom project life cycle ends with a single delivery, which is different from the iteration that appears in Agile Practice Guide by PMI [26], which is intended to provide multiple deliveries.

4.3 Results from Longitudinal Study

As stated earlier, Study 2 constitutes a validation exercise. A bar graph is used to present the data, as given in Figure 2.

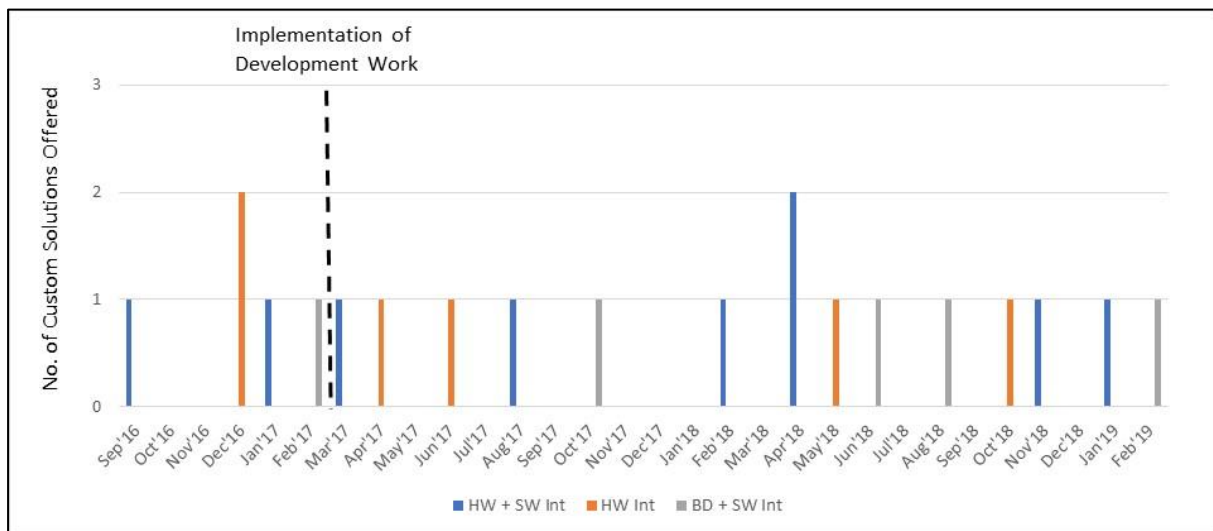


Figure 2. Longitudinal graph for three categories of custom solution offering.

As can be seen, there are thirty months of data of three categories of custom solutions used by the sample company, namely HW+SW Int, HW Int, and BD+SW Int. The sample company has delivered five custom solutions before the implementation of the development work, and fifteen custom solutions after the implementation of the development work in March 2017. For HW Int and BD+SW Int categories, the number of deliveries after the implementation of the development work is four, which is the minimum number for the data to be valid. Meanwhile, the HW+SW Int category has outnumbered the minimum criteria by three.

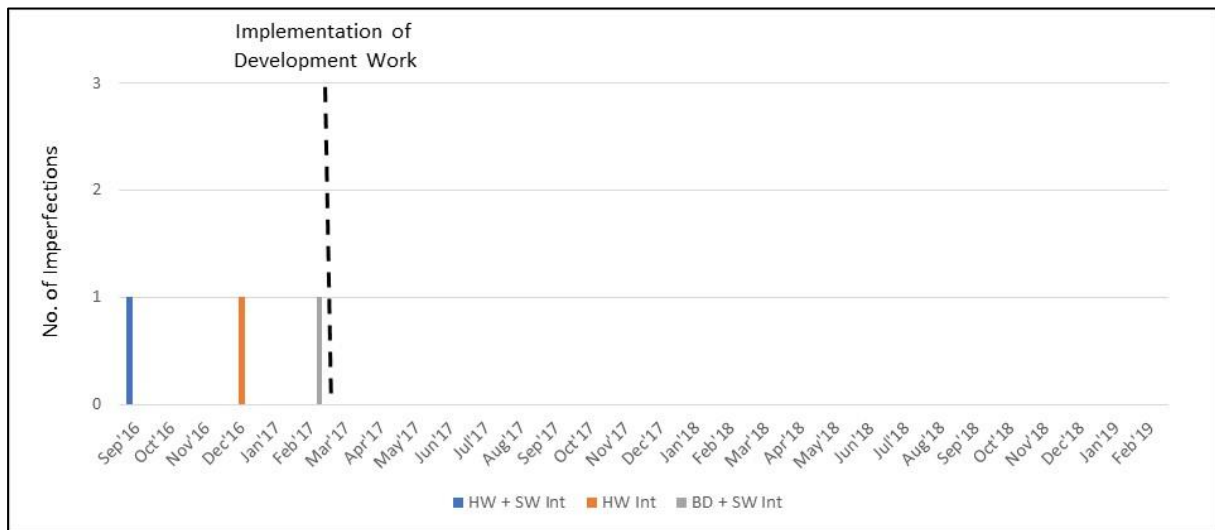


Figure 3. Longitudinal graph of imperfections of custom solutions before and after implementation

Figure 3 displays the number of imperfections from three different categories of custom solutions that are delivered within the first six months prior the implementation of the development work. As can be seen, the number of imperfections has decreased markedly, allowing the sample company to deliver another fifteen new custom solutions in the following two years without a single imperfection.

Hence, Study 2 has shown that the development work is effective. The two additional custom solution categories used on top of HW+SW Int represent extra evidence of this effectiveness. Thus, it can be safely stated that the application of the development work becomes an enabler for the transformation of a manufacturing-based company from hardware-centric to solution-centric.

5. Conclusion

This paper describes the development and implementation of a new project life cycle that can be used by manufacturing-based companies to deliver custom solutions. Three categories of custom solutions undertaken at a sample company have shown that zero imperfection is achieved for projects carried out in a period of two years. The authors believe that this study would serve as a reference for practitioners to fuel development work that will benefit their manufacturing-based companies, as implied by Yin [30], who believed that the results of implementation of a process in a case study manufacturing-based company is representative of others in the same industry. The encouraging results garnered from this study suggest that extending the work to include custom project governance, higher revenue projects, other market segments, and the use of quantitative methods should be looked into.

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