4PTRB Software Project Management Framework

Andre Price, Benyamain Yacoob, Eyiara Oladipo

Dept. of Electrical & Computer Engineering & Computer Science
University of Detroit Mercy
Detroit, MI, United States
(pricean2, yacoobby, oladipea) @udmercy.edu

***Abstract*—The people, process, product, project, technology, risk, and business framework (*4PTRB*), is a comprehensive framework for software project management that seeks to integrate existing standards from the project management body of knowledge (*PMBOK*), and capability maturity model integration development (*CMMI-Dev*). Putting into question the effectiveness of this framework, researchers conducted a web-based survey among software professionals, along with a case study involving twenty software projects. The researchers hoped to discover whether there is a more comprehensive or effective software project management technique by comparing *4PTRB* to widely used and accepted standards in the industry.**

***Index Terms*—Software project management, framework, *4PTRB*, *PMBOK*, *CMMI-Dev*, *3PR*, technology management, knowledge management**

I. Introduction

Expanding on the groundwork laid by previous researchers in software project management, our exploration delves into the people, process, product, project, technology, risk, and business framework (*4PTRB*). It offers a holistic and adaptive approach to the challenges inherent in software project management models [1].

Inspired by the *3PR* model, the *4PTRB* framework not only adapts to the ever-evolving demands of the software industry, but also introduces refinements to address specific nuances. In particular, the incorporation of project stakeholder management as a distinct knowledge area exemplifies the responsiveness of the framework to diverse industry needs [1].

In a broader academic context, the *4PTRB* framework emerges as a relevant and impactful subject for examination. Its comparison with established models such as *PMBOK* and *CMMI-Dev* sheds light on its unique attributes and potential contributions within an educational setting.

Beyond geographical boundaries, the study considers the applicability of the *4PTRB* framework in diverse contexts. Factors such as stakeholder theory, organizational maturity, and top management support, highlighted in various methodologies, highlight the global relevance of frameworks such as *4PTRB*.

The exploration extends to a comprehensive analysis of project management factors, drawing parallels with key performance indicators identified by researchers [1]. As the foundational article navigates through this study and uses a web-based survey and case study methodology, its objective is to unravel the intricacies of the *4PTRB* framework and evaluate its effectiveness compared to widely accepted industry standards. Through this examination, they aim to contribute substantively to the ongoing conversation on new software project management practices.

II. Literature Review

The foundation under which the proposed methodology was brought into fruition by Barghoth et al. [1]. The reason for creating this framework is to provide a system for planning and executing projects. The framework is introduced but integrates previous project management models [1]. Demir et al. [2] advocates for the *3PR* model, a framework that Barghoth et al. base on. Doing so points to the empirical nature of research and suggests that the project management approach is evolving to meet the different industries where it could be utilized. [2] illustrates this point by voicing the addition of project stakeholder management as a separate knowledge area. The catalyst for doing so was the accumulation of work experience from many project management professionals from different industries recognizing the importance of processes in system and software development. Chomal et al. [3] suggest *4PTRB* as its foundational framework for project management processes and investigate its differences concerning other model frameworks such as the body of knowledge (*PMBOK*), or the capability maturity model integration development (*CMMI-Dev*). Their reason for choosing *4PTRB* was the goal of looking at a model that has been used in the academic context. However, [3] omitted certain areas from the framework that were not appropriate to their goal, revising it to be more aligned within the academic domain. Taana et al. [4] provide a mode of analysis on existing project management methodologies to answer to the needs of Ghana pedagogy. The difficulty in all these frameworks is to find an evaluation metric that is valid and interpretable in the context where it is desired to be integrated. [4] evaluate *PRINCE2* and *PMBOK* by the success of those projects that used them. [4] want to create awareness of different factors such as notions of stakeholder theory, organizational maturity, top management support, etc. to consider when adopting a new project management model. Mir et al. [5] provide a deep analysis of evaluation of what project management factors to consider through box plots, linear regression, correlation analysis, and many others. From their findings, [5] saw

that key performance indicators of project management are what contribute the most to the success of any project.

III. Proposed Framework

Software project management is a vital and constantly evolving field, with multiple practices and standards emerging over time to address the complexities that can arise in projects. Good software project management has become critical to the success of projects of any size, and these standards aim to address the needs of the ever-growing business landscape. Guides and practices, like the ones found in the *PMBOK* and *CMMI-DEV* present software project management as a set of processes. Frameworks like the (3P's) model (Product, Project, and People), the (4P's) model (People, Product, Process, and Project), and the *3PR* model (People, Process, Product, and Risk) use the general principles of project management outlined by the existing standards to help provide structured approaches to project management [1].

These frameworks take different approaches to software project management, with the (3P's) model using a competency-based approach, while the (4P's) and *3PR* frameworks emphasize effective software project management practices [1]. Despite their success in leading software projects, these frameworks fail to account for various important aspects of successful project management. The (3P's) model does not provide sufficient guidance as it relates to the processes that need to happen for a successful project, while the (4P's) and (*3PR*) frameworks fail to account for the business and technological elements of a software project. Although no software project management framework claims to be perfect or to be the answer to every project's needs, these shortcomings can often have an impact on the success of a project, and the researchers of the original paper are seeking to overcome these shortcomings with a new framework [1].

To address this, the paper proposes an inclusive and comprehensive framework called *4PTRB* (People, Process, Product, Project, Technology, Risk and Business). The proposed framework seeks to integrate elements of previously established models for software project management while maintaining their strengths and addressing their shortcomings. In addition to these frameworks, the *4PTRB* framework adds the areas of "Technology" and "Business" to not only provide a more comprehensive approach to software project management but also to account for major areas and subareas that existing frameworks do not account for [1].

The proposed framework contains twenty-eight subareas. These subareas can be seen in Fig. 1.

The areas of "Technology" and "Business" will be the focus, and their corresponding subareas, as the other five main areas were integrated into existing software frameworks.

A. Technology

"Technology management is a set of management disciplines that enables organizations to manage their technological backbone to form competitive business advantage, improve software products and services" [1]. This

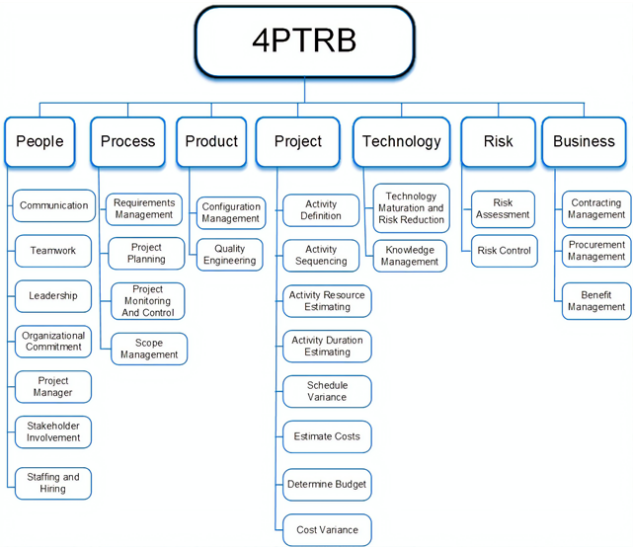

Fig. 1: Subareas of the *4PTRB* Framework

explains how current frameworks and standards do not accommodate, or consider the technological requirements of the project necessary to improve the project's outcome and create a competitive advantage. The subareas provide information to software project managers on how to safely incorporate and deal with the risks, integration, and skill gaps created when introducing technology into projects.

1) Technology Maturation and Risk Reduction (TMRR): This subarea allows software project managers to consider the risks involved in introducing new software to the project team. It reduces the likelihood of, and the risk associated with choosing new software that may not have proper support, may be prone to technical issues, or does not have a history of proven success or strong performance. This subarea also presents the idea of technology maturity as an important consideration in software project management. It views technology as a means to improve team productivity and output and seeks to reduce the time or money that may be spent on adjusting to faulty and unreliable software.

2) Knowledge Management: Knowledge management refers to the incorporation of the experiences, skills, and knowledge of each member of the project development process together to achieve a greater probability of project success. It considers the experiences of not only the project team but also the project stakeholders and allows software project managers to consider how to effectively share and utilize the vast body of knowledge available to them [1].

B. Business

The Business area deals with the management of financial and administrative operations. It accommodates the logistics of commerce as it relates to software products or services. This can involve the management of contracts and negotiation, methods of software procurement, and managing business outcomes and benefits [1]. These are addressed in the subareas of "Contracting Management", "Procurement Management" and "Benefit Management".

1) Contracting Management: Contracting Management deals with the processes related to managing the "creation,

negotiation, execution, alteration, and termination of contracts with various parties including customers, vendors, distributors, sub-contractors, and employees" [1]. A successful software project rarely exists in isolation, and its success is dependent on interactions with various stakeholders, vendors, and customers. An effective software project manager must consider the necessary contracts needed for successful collaboration with external services and contractors. This is especially significant, as existing frameworks and models often overlook its importance in a successful software project.

2) Procurement Management: This subarea involves the management of the acquisition of materials, products or services that the project needs, but cannot be provided by the internal team.

3) Benefit Management: The goal of this subarea is to "increase the business values of the implementation of software projects, maximize the financial impact on the organization, and [sustain] the benefits provided by a project" [1]. This involves understanding the benefits and worth of a project or business. It may also involve quantifying the benefit derived from a business or a project.

The project management effectiveness (PME) formula was used as a means to measure the effectiveness of software project management based on the seven areas included in the *4PTRB* framework.

IV. Framework Validation

To verify the proposed framework, a survey of one hundred and twenty-three software professionals from around the world was conducted [1]. Furthermore, the survey was followed by a case study on 20 software projects with different scopes, budgets, and periods. The results of this study will be discussed in the Results section. To provide information on how the research process was conducted, Fig. 2 precisely outlines it.

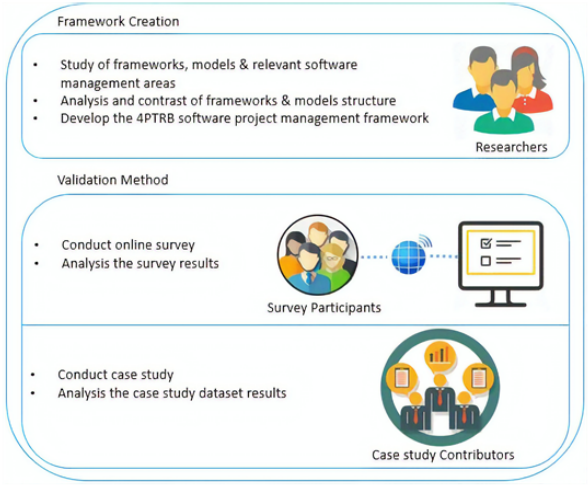

Fig. 2: Research Process for Validating Effectiveness of Framework

A. Survey

A web-based survey was conducted on one hundred and twenty-six professionals, but due to the lack of experience of three respondents, their responses were not considered in the final results, leading to a total of one hundred and twenty-three professionals [1]. The survey asked nineteen questions, with a set of questions asking about the importance of the different proposed management areas, another set asking questions about the importance of the proposed framework, with a third set of questions asking about the experience of the respondents.

An important part of the survey involved asking the professionals to rank the importance of the seven main areas of the proposed *4PTRB* frameworks. The importance ranking is as follows: Process, Product, Project, Technology, Risk and Business. These responses were the basis of naming the framework, as the first letters of the main areas correspond with the letters in the name of the framework [1].

Moreover, the respondent's responses were the basis of the PME formula, as the main areas were not equally weighted, but rated based on the ratings provided by the respondents. The formula is shown below:

$$PMEScore = PeopleS + ProcessS + ProductS + ProjectS + TechnologyS + RiskS + BusinessS \quad (1)$$

where:
PME Score: Software Project Management Effectiveness Score; PeopleS: People Main Area Score;
ProcessS: Process Main Area Score;
ProductS: Product Main Area Score;
ProjectS: Project Main Area Score;
TechnologyS: Technology-Main Area Score;
RiskS: Risk Main Area Score, and;
BusinessS: Business Main Area Score.

The PME formula was calculated based on the Demir and Cullen studies and the final formula is as follows:

$$PMEScore = PeopleS * 0.227 + ProcessS * 0.196 + ProductS * 0.172 + ProjectS * 0.153 + TechnologyS * 0.141 + RiskS * 0.074 + BusinessS * 0.037 \quad (2)$$

The formula can also be modeled by a pie chart, as noted in Fig. 3.

1) Distribution and Qualification of Survey Respondents: The majority of survey respondents lived in Egypt and the most common role was project manager. The respondents also have diverse experiences, with 9 years of experience making up the majority [1]. A good amount of them also have worked on multiple projects, thus being able to potentially provide more insight as to what methodologies work in certain projects and which do not. The range of projects completed by the respondents can be seen in Fig. 4. Lastly, most of the respondents worked in the commercial field, and web-based, mobile applications and database services were the most common types of software

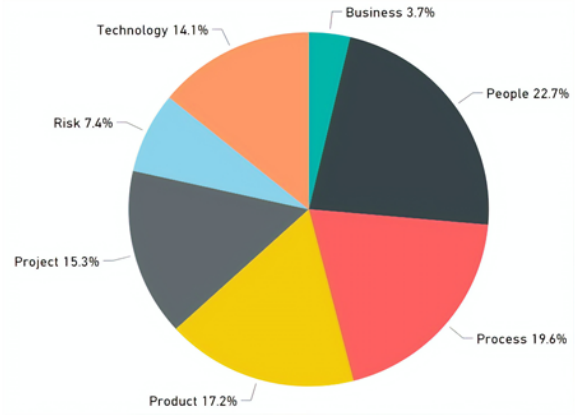

Fig. 3: Survey Rating of Core Project Management Factors

applications [1]. Find the supplementary graphics, Fig. 5 and Fig. 6, which highlight these findings.

2) Significance of the 4PTRB framework: 56.9% of survey respondents stated that the *4PTRB* was very important, while 29.3% stated that it was important.

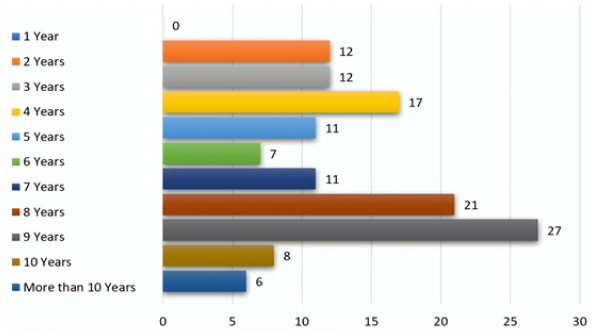

Fig. 4: Respondents Expertise

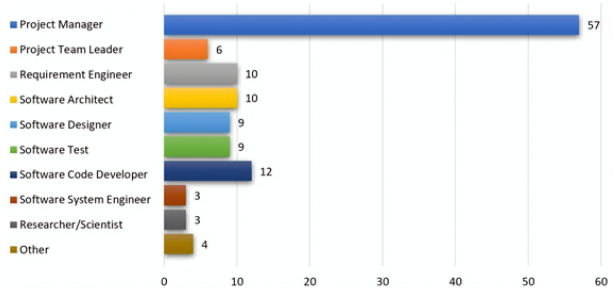

Fig. 5: Respondent Roles Within Software Projects

B. Case Study

Another means of framework validation was the conduct of a case study. This involved 20 software projects of varying sizes, budgets, and durations within the time frame of the year 2018. Eight project managers were involved, with software project managers "partaking in their project's data". In contrast, executive managers "asked to grant a project success score for every project based on scope, schedule, budget, customer satisfaction, and business value viewpoints [1].

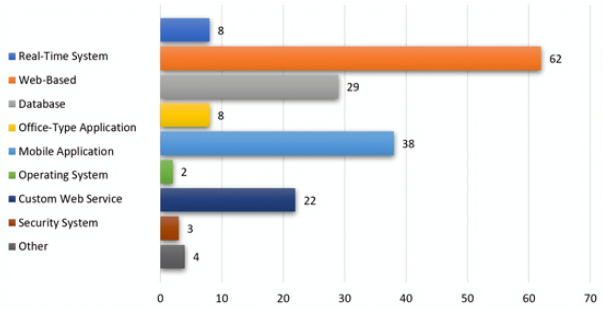

Fig. 6: Kinds of Software Applications

V. Results

Our findings draw inspiration from Barghoth et al.'s foundational work [1], where they introduced the *4PTRB* software project management framework. This comprehensive framework seamlessly integrates established project management models and frameworks, offering guiding principles derived from the *PMBOK* guide processes, CMMI for development (*CMMI-DEV*) processes, and essential management areas crucial for effective software project management.

The technology maturation & risk reduction (TMRR) subarea within the framework indicates the need to assess technology maturity, reduce risks, and gain a nuanced understanding of software solutions. Validating the *4PTRB* framework involved a global survey with software professionals, demonstrating its adaptability in diverse roles, experiences, organizations, and software applications [1].

In the empirical validation through a case study on twenty software projects in Egypt, participants, including software project managers and executive managers, utilized the software project management effectiveness evaluator (SPMEV) tool [1]. This real-world validation contributes significantly to the credibility of the framework.

Comparing the *4PTRB* framework with the established *3PR* framework, the results reveal a compelling positive correlation between the project success score and the software project management effectiveness (PME) score. Notably, the *4PTRB* framework exhibits a more robust positive correlation, boasting a Pearson coefficient of 0.9505, in contrast to the *3PR* framework's coefficient of 0.8276 [1]. This substantial difference signifies the superior effectiveness of the *4PTRB* approach, emphasizing its potential to drive successful project outcomes. The correlation of project effectiveness between the two frameworks can be seen in Fig. 7.

Delving into the process after its completion, we recognize the value of regular assessments of software project management effectiveness. Through these assessments, facilitated by the *4PTRB* framework, iterative best practices can be identified and applied, promoting continuous improvement in software project management throughout different project phases [1].

VI. Conclusion

The *4PTRB* framework offers a practical and comprehensive solution for software project management. Integrat-

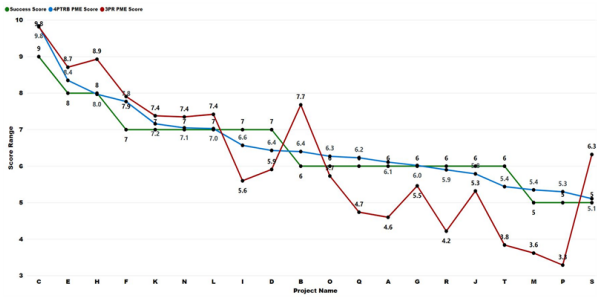

Fig. 7: Correlation Between the Project Success Score and the *4PTRB* PME as well as the *3PR* PME scores

ing key dimensions like people, process, product, project, technology, risk, and business, this framework draws from established standards.

Validation was carried out through a global survey and a diverse case study, including twenty software projects, effectively showing the *4PTRB* framework's capability [1]. Survey results indicate unanimous recognition of its importance among software professionals. Notably, the framework outperforms the *3PR* model in correlating positively with project success.

The inclusion of technology and business subareas enhances the framework's coverage, addressing important aspects often overlooked in other models [1]. The proposed PME formula incorporates weighted main areas and provides a quantitative measure for evaluating software project management effectiveness.

4PTRB emerges as a promising and practical approach for navigating the complexities of software project management. Its adaptability, empirical validation, and unique coverage make substantial contributions to advancing effective project management practices.

VII. Acknowledgments

We extend our gratitude to the individuals who contributed to the successful completion of this research. The collaborative efforts of the research team, including Andre Price, Benyamain Yacoob, and Eyiara Oladipo were instrumental in conducting the research, analyzing the results, and shaping the outcomes. We would also like to express our gratitude to the Department of Electrical and Computer Science at the University of Detroit Mercy for providing the essential resources and environment for this research. This project would not have been possible without the collective effort of these individuals and institutions, and we are thankful for their contributions.

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