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ANALYZING PROJECT MANAGEMENT METHODS IN SOFTWARE DEVELOPMENT

Aim. Software project success primarily depends on software project management practices, which ensure timely delivery, budget constraints, and quality goals. With the ever-changing nature of the software industry, project management must always be revised, improved, and re-evaluated in light of the changing landscape of the software industry.

Methodology. This research study examines project management approaches by conducting a literature review and comparing the state-of-the-art process models currently in use in the software industry. The processes compared in this research are waterfall models, agile (Srum, Kanaban), and hybrid approaches (Scrumban, Lean/Agile). The research study is designed to assess the strengths and weaknesses of the methods from multiple viewpoints of project management. The research study also investigates factors affecting the success of these methods, such as organizational culture, leadership frameworks, and the decision-making process. The modern trends in software project management are also considered in this research, along with modern software application paradigms like DevOps, cloud computing, containerization, artificial intelligence, and machine learning integration.

Results. The modern development trends in the software industry also require improved management practices and theories to handle the newness of these projects. The research study also proposes a model that helps the project managers identify a suitable process model as per the project needs. The proposed model also considers factors that affect the successful execution of a project, like team dynamics or organizational environments. The research study also includes modern project management practices like DevOps, cloud computing, artificial intelligence, machine learning integration, and containerization in comparison with classic management paradigms like waterfall, agile, and hybrid methods.

Scientific Novelty. The research study suggests organizational guidelines on the basis of this comparison between classic and modern methods. The guidelines help identify the best combination of management practices for a tailored approach to suitable methods for a particular software development project.

Conclusion. The identified methods of project management increase the success criteria for a software project and help to optimize the development process, which returns the satisfaction of market demands and delivers a high-quality software solution.

Key words: *Agile, DevOps, Hybrid-Agile, Project Management, Scrumban.*

Formulation of the problem. Due to the technological enhancement the software development has become an integral part of many sectors like, entertainment, finance and e-commerce among others. The need of project management strategies raises due to increasing complexity of software applications. The quality parameters as specification, cost and schedule are sensitive and requires ensured software development project management. To enhance productivity, re-distribute resources, improve communication and increase customer satisfaction, effective project management methodologies have been used as tools. Due to the dynamically changing nature of software, it is also important to evaluate the effectiveness and relevance of these practices.

With the arrival of emerging technologies, the software development sector is characterized by its dynamism, while old methodologies die off quickly.

The speedy change rise the challenges for project managers who must comply with evolving constraints and expectations. At the same time working on complex client requirements using heterogeneous teams which can be managed either through matrix or non-hierarchical structures. The market value affected if you do not plan out your activities efficiently from the beginning, which cause delays or cost overruns.

Conventionally, the structured approaches such as "Waterfall" model were often desired for development of software projects due to its linear sequential approach. With the evolving requirement conventional approaches had limitations. Agile methodologies became popular for evolving systems due to flexible nature towards evolution. These approaches also support collaboration between developers and other stakeholders throughout an iterative process. Agile approaches have proven particularly useful

in addressing some unique issues associated with software development projects, such as adaptability to changes in user constraints, promoting teamwork through face-to-face conversations, and providing deliverable modules in stages over short intervals. Nonetheless, successful implementation of agile concepts necessitates a total shift in organisational attitudes towards work processes, which can be challenging, particularly if workers have already become accustomed to regular operations.

Objectives of the article. Other project management frameworks, in addition to agile methodologies, can be utilized depending on the situation. To address the peculiarities of software development projects, hybrid models like Scrumban and Lean/Agile hybrids were developed. Additionally, the rise of distributed teams and remote collaboration has necessitated the development of methods and tools that facilitate cross-border communication, coordination, and knowledge sharing. Different strategies are polished today however they ought to be chosen after cautious thought of the specific undertaking's necessities, group structure and corporate culture. Methodologies for effective project management can ultimately result in the successful delivery of software projects by improving productivity, resource allocation, communication, and customer satisfaction.

However, the software development industry is not static, so project management methods must constantly change to keep up with new technologies and trends. New paradigms like DevOps, which emphasizes bringing software development and operations together, as well as the rise of cloud computing and containerization, have presented project management with new challenges and opportunities. In addition, they have to be incorporated into project management strategies because of the increased emphasis on user experience, security, and compliance requirements, among other things. Organizations must constantly evaluate and modify their project management practices in order to remain relevant and efficient in this environment that is rapidly changing. Organizations can optimize project delivery by utilizing the most recent methodologies, tools, and techniques, thereby improving software quality overall, by establishing a culture of continuous learning and improvement.

Software Development Projects' Complexities. Navigating the complexities of software development projects necessitates efficient project management strategies [1]. It is possible for businesses to achieve levels of productivity they had never imagined possible if they employ the appropriate strategies and continuously adjust to the prevalent trends in the industry. This will prompt better allotment of assets higher consumer loyalty further developed correspondences among different advantages. The purpose of this study is to learn about various project management approaches, including their advantages and disadvantages, as well as their suitability for various software development contexts. This concentrate accordingly tries to draw best practices, basic achievement factors (CSFs) as well as distinguish imaginative methodologies for directing associations in picking project the board techniques that are generally suitable.

An analysis of the latest research and publications. This research topic's literature review includes a wide range of studies on project management in software development environments from academic and business communities. According to [2], numerous authors have investigated a variety of approaches, frameworks, or models with the intention of increasing the efficiency or effectiveness of delivering such programs. As a result, this section provides an overview of previous research in this area.

Main Research Material

Methods Used by Traditional Project Management. The Waterfall model, one of the earliest and most well-known methodologies, has been extensively studied and criticized [3]. The method is linear in nature, but researchers report that it is inflexible. The report's causes of inflexibility are its inability to adapt to changing requirements

Agile Project Management

Modern-era methods like Agile family process models like Scrum, Kanban, and Extreme Programming (XP) were deployed to overcome the shortcomings of the classic methods. The main drawbacks reported for the classic methods were huge volumes of documentation, change adaptation methods, and delayed client feedback [4]. The agile methods were characterized by change management models, improved client communication, daily or weak client feedback, and delivering the projects in small, manageable iterations.

Hybrid or Customized Methods

Different hybrid methodologies that combine various frameworks have emerged to address the organization's need for greater flexibility and customization in project management. For example, Scrumban [5] combines elements of Kanban and Scrum. Lean/Agile hybrids on the other hand borrow from lean principles as well as agile methodologies like XP and Scrum which are mostly used in software development projects but tend to be more or less prescriptive depending on the situation of the project.

The potential advantages and drawbacks of these methodologies were investigated by this study [6].

Project management tools and techniques. The modern software project methods also gain popularity due to the rapidly growing support with tools and software's which facilitates the software development on each phase and cut short the total devilment time of a project. A reasonable share of research was focused on concepts and methods like team communication, project success factors, change management, configuration management, and continuous development methods [7].

Distributed and Remote Project Management

The de-centralized teams for software projects open the remote working, work from home or distributed software development. There were many portions of research dedicated to investigating domains like distributed project management, lean development, geographic diversity management, team communication for distributed projects, and knowledge sharing and management for distributed teams.

Emerging Trends and Future Directions

The new trends have also emerged in software project management, like DevOps, which integrates cloud services with software project management activities. There is also a need to investigate challenges like cloud data security, data engineering, cloud service availability, and user experience (UX) adjustments with these modern process management methods critical success factors and proposing a framework or guidelines for selecting and implementing the most suitable approaches based on project characteristics and organizational requirements.

Setting of Objectives. The main aim of this research is to evaluate the different software development methodologies used in project management. This will involve looking at traditional models such as Waterfall and modern agile frameworks like Scrum, Kanban, XP among others.

The hybrid models integrate different methods, e.g., Scrumban and Lean/Agile hybrids. The choice of these methods depends on the project requirements, budget, and team experience. The primary goal of these methods is to identify the major factors that contribute to a successful pest management solution. Team management, project complexity, organizational culture, change management, and user characteristics also need to be considered for a successful project management solution. These parameters will help the organization and project managers make informed decisions with realistic goals set for a project, which in turn increases the probability of project success.

Formulation of the goals of the article. The current research findings show many viewpoints under several themes that were considered during the data analysis of this study. The findings of this study provide assessment criteria for a project management method and guidelines for choosing an integrated solution for a particular software development project.

Evaluation of Project Management Methodologies. Traditional Methodologies

The traditional methods are ideal because of their stable requirements and documentation support for each step of the software development activities. The classic methods are change-reluctant, sequential in nature, and have limited client feedback options. These bottlenecks make them inappropriate for modern software development projects.

Agile Methodologies (e.g., Scrum, Kanban, XP). Strengths: Flexibility; iterative process; constant stakeholder involvement; adaptability to alterations in needs. Limitations: Possibility of scope creep; difficulties encountered when managing large projects; and reliance on experienced and highly skilled team members. Applicability: They are widely used in different software development scenarios with high levels of uncertainty and high customer involvement.

Hybrid Methodologies. Blends elements from different approaches and tailors them accordingly to the specific needs of a given project thus fostering continual improvement. Difficulties when implementing it, inconsistencies that may arise, therefore leading to cultural barriers within an organization. Designed for any organization that desires to overcome their unique challenges by coming up with a tailor made solution for them.

Outline of the main research material

Successful adoption of project management methodologies requires strong leadership commitment, and culture change which encourages collaboration, continuous learning, adaptability etc. Team Expertise and Competencies. Well informed team members who are highly skilled and experienced coupled with effective communication skills as well as collective knowledge about project management practices must be in place before one can talk of successful implementation.

Continuous engagement with various stakeholders like customers, users across functions help achieve desired project outcome in line with expectations. The size, complexity, team distribution and the nature of requirements (stable or rapidly changing) should be some factored into when choosing a project management methodology.

Table 1

Project Management Techniques

Category	Study	Authors	Key Findings	Limitations / Challenges
Traditional Project Management	The Waterfall Model	Royce (1970) [8]	Introduced a structured, sequential approach to software development.	Inflexibility and poor handling of changing requirements.
		Benington (1983) [9]	Early critique and evolution of Waterfall practices in real-world applications.	Similar limitations as Royce; noted practical issues.
	Critique of Waterfall Model	Stoica et al. (2016) [10]	Highlighted Waterfall's limitations in dynamic and complex environments.	Suggested alternatives but noted lack of empirical evidence in some areas.
Agile Project Management	Agile Manifesto	Highsmith & Cockburn (2001) [11]	Introduced principles focusing on iterative development, collaboration, and flexibility.	Broad principles with varying interpretations in practice.
	Agile Software Development	Fowler & Highsmith (2001) [12]	Emphasized adaptive planning, evolutionary development, and early delivery.	Theoretical basis with limited empirical evidence.
	Scrum	Schwaber & Beedle (2002) [13]	Popularized Scrum framework for managing agile projects; iterative and incremental.	Implementation challenges and need for strong Scrum master roles.
Hybrid and Tailored Methodologies	Scrumban	Reddy (2015) [14]	Combined Scrum's structure with Kanban's flexibility; aimed at continuous improvement.	Complexity in implementation and balancing both frameworks.
	Lean/Agile Hybrid	Rodríguez et al. (2012) [15]	Integration of Lean and Agile principles for efficiency and adaptability.	Challenges in cultural shift and maintaining balance.
Project Management Tools and Techniques	Impact of PM Tools on Project Success	Azanha et al. (2017) [16]	Empirical study showing positive effects of PM tools on project management outcomes.	Focus on tools rather than methodology.
	Modern PM Software and Tools	Kerzner (2017) [17]	Comprehensive overview of modern project management software and tools.	Need for better integration and customization features.
Distributed and Remote Project Management	Challenges of Distributed Teams	Herbsleb & Mockus (2003) [18]	Addressed key challenges in managing distributed software teams, such as communication and coordination.	Early study with evolving challenges due to technological advancements.

Source: author's own development

Continuous Improvement and Adaptation. Long-term success is rooted in regular retrospectives, lessons learned as well as adapting/refining the PM practices based on feedback-changing times.

Emerging Trends and Innovative Approaches. DevOps and Continuous Integration/Continuous Deployment (CI/CD):

Integrating software development with operations through DevOps practices as well as automated CI/CD pipelines can facilitate collaboration, hasten delivery, and enhance overall quality.

Containerization and Cloud Computing:

Docker, a containerization technology, and cloud computing platforms like AWS and Azure are changing software development which necessitates project management adaptations.
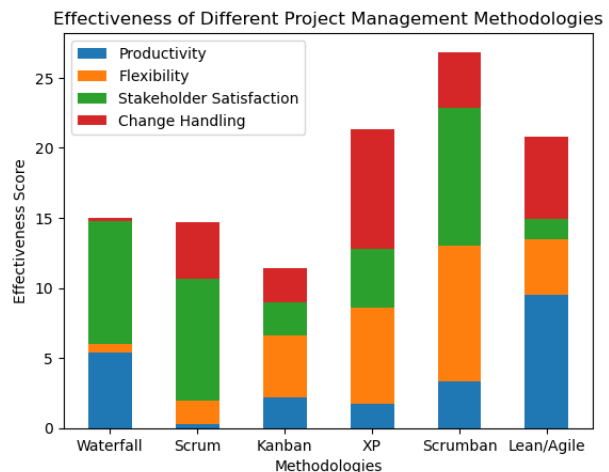

Fig. 1. Effectiveness Score of Methodologies

User Experience (UX) and Design Thinking:

The UX is a better insight for taking clients on board with software projects. It also incorporates a design thinking methodology that outperforms user-centric solutions and enhances customer satisfaction as well.

Agile at Scale and Distributed Agile:

Frameworks such as Scaled Agile Framework (SAFe) or Disciplined Agile Delivery (DAD) are the best choices for distributed team management, team communication, and cloud services integration with the software development cycles.

Artificial Intelligence (AI) and Machine Learning (ML):

Integration of AI and ML technologies with the software development processes will enhance intelligent decision-making, automated resource management, code repository management, configuration management, automated task distribution, and work-load management.

The research study investigates the parameters effecting software project management success rates and provides a comprehensive discussion about the strengths and weaknesses of the process models under study. Additionally, the study also identified the most important success factors. The study also investigates the emerging trends in software project management that are used to optimize software project management practices.

Conclusions from this study and further prospects. Software development is the most evolving and rapidly growing industry on the globe so far. There are many contributing factors as well as challenges to maintaining this tremendous growth. One way to maintain the growth and enhance the potential of this industry is through improved software project management. Accurate and optimized software project management will ensure successful delivery within time and budget constraints.

This research study provides a detailed analysis and insights for the classic software project management methods with novel and state-of-the-art methods for software project management. The study reveals that there is no single solution to fit-for-all software project management problems. The study also identifies that there is a need for integrated solutions from classic methods as well as modern methods to address the changes and requirements of new-era software development. The organizations should adopt a customized solution for their projects, keeping in mind success factors, user characteristics, and market requirements. The project leaders may combine the best elements of all methods to design an optimized software development process. The primary goal of a customized process model is to address the specific challenges faced by the organization. The process design must consider the organizational culture, team experience and expertise, and communication requirements. The stakeholder collaboration is a must-consider success criteria for all small- to large-scale software project management processes. Continuous development, continuous integration, and continuous adoption are the keys to success in modern software development.

Novel trends in software development like DevOps, containerization, cloud computing, and AI/ML integration also play an important role in upscaling the development process, adding business value, improving team management, team communication, and error-free, automated decision-making. Informed decision-making also supports robust and ready-to-welcome changes to processes, projects, and products. This research offers a baseline understanding of these key concepts and lists the important parameters for the process and project success. The research also provides a model to design a customized process model for a software project management context.

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Хамбір В.Р. АНАЛІЗ МЕТОДІВ УПРАВЛІННЯ ПРОЄКТАМИ В РОЗРОБЦІ ПРОГРАМНОГО ЗАБЕЗПЕЧЕННЯ

Мета. Успіх програмного проєкту в першу чергу залежить від методів управління програмними проектами, які забезпечують своєчасну доставку, дотримання бюджетних обмежень і досягнення цілей якості. Враховуючи мінливий характер індустрії програмного забезпечення, управління проектами повинно постійно переглядатися, вдосконалюватися та переоцінюватися у світлі мінливого ландшафту індустрії програмного забезпечення. Методологія. Це дослідження вивчає підходи до управління проектами шляхом проведення огляду літератури та порівняння найсучасніших моделей процесів, які наразі використовуються в індустрії програмного забезпечення. У цьому дослідженні порівнюються водоспадні моделі, гнучкі (Srum, Kanaban) та гібридні підходи (Scrumban, Lean/Agile). Мета дослідження - оцінити сильні та слабкі сторони методів з різних точок зору управління проектами. Дослідження також вивчає фактори, що впливають на успіх цих методів, такі як організаційна культура, структура лідерства та процес прийняття рішень. У цьому дослідженні також розглядаються сучасні тенденції в управлінні програмними проектами, а також сучасні парадигми застосування програмного забезпечення, такі як DevOps, хмарні обчислення, контейнеризація, штучний інтелект та інтеграція машинного навчання.

Результати. Сучасні тенденції розвитку індустрії програмного забезпечення також вимагають вдосконалення управлінських практик і теорій, щоб впоратися з новизною цих проектів. У дослідженні також запропоновано модель, яка допомагає менеджерам проектів визначити відповідну модель процесу відповідно до потреб проекту. Запропонована модель також враховує фактори, які впливають на успішне виконання проекту, такі як динаміка команди або організаційне середовище. Дослідження також включає сучасні практики управління проектами, такі як DevOps, хмарні обчислення, штучний інтелект, інтеграція машинного навчання та контейнеризація, у порівнянні з класичними парадигмами управління, такими як водоспад, гнучкі та гібридні методи. Наукова новизна. Дослідження пропонує організаційні рекомендації на основі цього порівняння між класичними та сучасними методами. Рекомендації допомагають визначити найкращу комбінацію управлінських практик для індивідуального підходу до підходящих методів для конкретного проекту з розробки програмного забезпечення.

Висновок. Визначені методи управління проектами підвищують критерії успіху програмного проекту та допомагають оптимізувати процес розробки, що повертає задоволення вимог ринку та забезпечує високоякісне програмне рішення.

***Ключові слова:** Agile, DevOps, Hybrid-Agile, управління проєктами, Scrumban.*