

Project Management and Visualization Techniques A Details Study

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Abstract: *The profession of project management has evolved over the years to disseminate new frameworks, tools, and approaches as a means to improve the rate, productivity, and success of projects. The purpose of this research is to explore many aspects of project management methodologies and graphic displays from one or more of the following perspectives: use, advantage and disadvantage. The paper is aimed at comparing the benefits of licensed and open-source visualization technologies to show how these technologies have an impact on the development and planning of projects and project management. In conducting this study, this paper aims to highlight the importance of choosing adequate PM and data visualization methods to be relevant to the needs of a particular project as well as the norms of a given field of study. Thus, anyone interested in selecting the right methodology and/or specific visualization tools for a project with a defined scope and level of complexity and participation of key stakeholders must proceed with caution and weigh the consequences carefully. In addition, the analysis supports the broad understanding of the fact that there is always a need for the adoption and incorporation of other technological solutions to effectively manage change in project environments. In this regard, one has to understand that modern changes and trends in the project management space suggest that the ASM needs to be proactive in gaining more knowledge on the subject. Given this study's findings about the diverse PM techniques and visualization tools available, this research essay to assist practitioners, researchers, and industry professionals to understand the significance of adequate tools and methodologies for implementing their projects. These results will be beneficial in the creation of new efficient methodologies and procedures for project management, which should enhance the overall organizational and customer satisfaction of various projects.*

Keywords: *Project management strategies, Visualization methods, agile methodologies, Waterfall approaches, Building Information Modeling (BIM), Three-dimensional (3D) visual representation.*

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I. INTRODUCTION

Project management is a core business competency in contemporary society referring to a discipline that is used in the private as well as the public domain to achieve pre-determined objectives to implement change within the constraints of scope, time, and cost (Mindmanager, 2023). It covers the management of projects and their components, as well as the process of project planning, implementation, and control aiming at their success and subsequent benefit for stakeholders. According to PMI report, organisations that invest in project management technologies have lesser chances of wasting money which is close to 28% (Parsi, 2017). This paper is organized into several key sections to systematically explore the application and impact of various project management methodologies. The introduction section provides a background on project management methodologies and sets the stage for the detailed analysis that follows.

Research objectives

- Evaluate critically how diverse project management approaches are implemented and influence modern organizations.
- Examine the patterns, advantages, and limitations of project management methodologies across sectors and project categories.
- Assess the integration and adaptability of various project management frameworks based on industry context and project nature.
- Uncover effective strategies and insights from empirical research and real-world examples of project management methodologies, aiming to enhance project management practices.

II. Literature Review

Study	Year	Methodology	Findings	Shortcomings
Yang et al. (2019)	2019	Case study and 3D visualization technology	Enhanced project management in offshore platform engineering through 3D visualization technology.	Limited to offshore platform engineering; does not address other project management applications.
Kerzner (2022)	2022	Comprehensive review of project management metrics, KPIs, and dashboards	Provides detailed guidance on measuring and monitoring project performance.	Theoretical focus; lacks empirical validation of the proposed metrics and KPIs.
Kocakaya et al. (2019)	2019	Analysis of Building Information Management (BIM)	BIM improves project management by enhancing information sharing and collaboration.	Focused mainly on the construction industry and limited application to other industries.
Layton et al. (2020)	2020	Guide on Agile Project Management	Agile project management enhances flexibility and responsiveness in projects.	A simplistic approach; may not address complexities in large-scale projects.
Andrei et al. (2019)	2019	Comparative study of Waterfall and Agile methods	Both methods have strengths and weaknesses; Agile is better for adaptability and Waterfall for structured projects.	Limited sample size; lacks in-depth analysis of each method's effectiveness in different project types.
Digitemie & Ekemezie (2024)	2024	Review of sustainable project management in the LNG industry	Sustainable practices improve project outcomes in LNG industry initiatives.	Industry-specific; findings may not apply to other sectors.
Ekemezie & Digitemie (2024)	2024	Global review of strategic project management practices	Identifies success factors and challenges in multinational corporations.	Broad focus; may lack detailed insights into specific practices or industries.
Kaufmann & Kock (2022)	2022	Empirical study on project management effort and profitability	Project management effort and complexity significantly affect project profitability.	Results may not be generalizable across all types of projects or industries.
Nicholas & Steyn (2020)	2020	Comprehensive guide on project management for engineering, business, and technology	Provides extensive methodologies and tools for effective project management.	Very broad scope; may lack depth in specific areas of project management.
Thesing et al. (2021)	2021	Decision model for Agile vs. Waterfall project management	Offers a model to select between Agile and Waterfall based on project characteristics.	The model's applicability needs further empirical validation.

Table 2: Last five years literature review
(Source: self-created)

The field of project management is vast and contains a variety of activities and approaches, which can be seen by the numerous articles and books that exist in this area. Every research paper reveals new facts and conclusions, which can help to develop a better understanding of how various instruments, strategies, and methods can be used to enhance the results of projects. In this analysis, five significant observations made from the works of Yang et al., Kerzner, Kocakaya et al., Layton et al., Andrei et al., Digitemie & Ekemezie, Ekemezie & Digitemie, Kaufmann & Kock, Nicholas & Steyn, and Thesing et al. will be discussed. In this way, the following research will bring together their ideas and critiques for providing an overview of project management today.

III. Methods

Data collection method

This research work adopted a qualitative, secondary research method to investigate project management methodologies and visualization tools. Most of the data were gathered from scholarly articles from academic databases, industry reports, and other credible sources that are not older than five years. This made the information gathered up to date and relevant to practice in the modern project management. The literature

review was conducted on the articles that described the Waterfall, Agile, Lean approaches and methodologies, and the Gantt charts, Kanban boards, and 3D modeling tools.

Criteria for selecting case studies

Several criteria were used to choose cases to ensure that the presentation of various applications of project management is comprehensive and based on real-life situations. The primary considerations were: 1) Pertinence for the various methodologies or visualization techniques, 2) Proximity to different industries to show versatility, 3) Extensive data on the precise execution and results, and 4) Large or complex projects to show the potential and difficulties of the methodologies. This led to the inclusion of cases as diverse as the NASA Space Shuttle Program, the development of Spotify's software.

Analytical methods used

The research techniques applied in this study were comparative analysis and thematic synthesis. The comparative analysis was based on the assessment of the applicability of various PM methodologies and visualization tools as well as their advantages and limitations in different cases and industries. In order to examine the common trends and successful approaches to project management as described in the literature and case studies, thematic synthesis was used. This approach ensured that findings from the various sources were combined to build an overall understanding of the best practices in project management and the use of visualization in project success.

IV. Results

The Project Management Techniques

The Waterfall Methodology is one of the oldest and most commonly known project management methodologies that are available. This is a model with a clear linearity and the activities are arranged in a sequence that cannot be undertaken in parallel but must be completed before another one begins (Blaskovics et al. 2023). This normally involves requirement gathering, system architecture, development, integration and testing, installation, and sustaining. The Waterfall methodology is an enduring and clear-cut method of planning projects, which consists of stages that are strictly arranged in sequence. When implemented, each phase in the Waterfall model must be carried out before it is followed by another phase of the model; therefore, it is systematic. It mainly includes requirement gathering and validation, software design, code implementation, testing, installation, and maintenance (Demirag et al. 2023). Stiff structure and well-proclaimed stages – are considered the primary benefits of using the Waterfall methodology. The advantage of such a structure is that there is always clarity as to what has to be done and when because every phase has a well-defined set of objectives as well as timelines.

On the other hand, Agile Methodology embraces a cyclic approach of continuous improvements in closer cycles with incremental advancements. Agile's process does adapt and change frequently in a project which might be dealing with an environment that is constantly changing, and the customer is always not fully certain of what needs to be done at short notice. According to the 14th Annual State of Agile Report, 95% of the respondents said that their organizations use Agile development. Among the respondents that use Agile, 60% stated that it helped them deliver faster, 53% stated that it helped them manage priorities better and 51% stated that it helped them work more efficiently (Qagile, 2020).

While the Waterfall model is linear and predesigned with little to no room for making changes on the go, Agile is a very fluid approach that continually is developed and refined as the project progresses. The biggest strength owned by an agile process is its strong focus on efficiency and dependency on customer feedback, as well as the ability to manage constant changes in the project. A key strength of the agile process is the demonstrated ability to fit well into changing requirements (Daraojimba et al. 2024). The daily/weekly/daily delivery of such increments makes it possible to provide a constant increase in the project's quality since referential points are constantly being adjusted. Some of the other benefits vis-a-vis Agile include improved cooperation and coordination among the development team members through more communication and information sharing than on traditional Waterfall approach.

Scrum is one of the frameworks of agile project management, and it subdivides a project into periodic cycles that are called sprints with a standard length ranging between two and four weeks. There are four phases in every sprint, the Planning phase, Execution phase, the Review phase and the Retrospective phase (Linkedin, 2024). Based on the issues mentioned, teams focus on distinct tasks at each sprint, providing a way to reassess and adjust the objectives of a project regularly.

One such agile methodologies structure projects in sprints. This is followed by short periods that last up to one month, although they can be shorter and take up to 4 weeks at most. Sprints can be defined as four New Oxygen stages of work planning, executing, reviewing, and retreating which enables the team to consider the progress made and make changes where and when needed. Such an approach helps to learn iteration and

enhance the collaboration between the team members, thus increasing accountability and morale (Kase, 2020). Some of the strengths of Scrum include it offers an iterative model of development that is considered ideal for constantly delivering feedback. This fosters unity and pressures everyone in a team to perform optimally by following up on their work to ensure it has been done to the best of their ability.

The Lean methodology is rooted in the manufacturing environment its purpose focuses on eliminating all operations that do not add any form of value. Lean can be defined as an initiative that is aimed at continuously working to enhance the process activities, to reduce non-value-added activities and, as a result, to optimize flow. According to journal published by Saroji & Susantono, (2023), implementation of lean tools has the potential to reduce the project completion time by 19% which adds greater profit for the organisations. Lean project management deals with the elimination of any activity that may not add value in line with the goal and objectives of the project. It originates from the desire for gradual enhancement and appreciation of people, committing to success through more effectiveness and the minimization of waste. It takes cognizance of the fact that it fosters a positive culture of kaizen or continuous improvement and it can be used in diverse industries and projects. The benefits of Lean include its focal points of improvement, such as waste minimization. By integrating the concept of non-value-addition into it, Lean assists in enhancing overall project functioning. It also fosters an environment of small incremental improvements where the everyday focus is on how to make things better.

The Critical Path Method (CPM) involves evaluating the longest and interdependent chain of activities in a project known as the critical path (Abuhasel, 2023). The following are critical tasks that are useful with the aim of enhancing the completion of projects within the stipulated time: CPM therefore requires making a schedule that portrays every activity in a project, how long it will take and the interrelation with other activities. A critical path network (CPN) is a tool used to determine all the activities that make up the broadest possible path in a project that is commonly referred to as the critical path. For instance, planning, scheduling, budgeting, risk management, and monitoring and controlling of activities can be considered as the core aspects of project management that can help the project manager achieve the said aim of completing a project on time (Ruha, 2024). Application and management of CPM are also useful to identify crucial activities and to have a drumbeat and calendar for the project. The advantages accented with CPM are accurate identification of the critical activities as well as the potential of planning the time to fit the coming attainment objectives. Besides, CPM gives a precise construction line of time and schedule of the project so that the resources may be effectively managed. This means that the activities that take time should be promptly identified by the project managers and managed critically as they are likely to prolong the project's duration.

Impact on team dynamics and collaboration

When it comes to the interpersonal work, project management methodologies and tools are not neutral - they have their effects on the team and collaboration, providing opportunities and threats. In this context, the Waterfall methodology is quite clear and structured; each phase is easily distinguishable and has specific goals and deadlines. However, it becomes rigid in its implementation and does not encourage much flexibility and innovation and does not encourage much of a collaborative problem solving because once a phase is set and done, it becomes very difficult to incorporate changes. On the other hand, Agile methodology especially through the use of frameworks such as Scrum encourages a more fluid and innovative approach (Almeida & Espinheira, 2021). The iterative approach in Agile and focus on the customer's needs help teams to respond to changes in the requirements and improve cooperation between the team members. While there are benefits of flexibility, it becomes a disadvantage because it is difficult to keep the focus and control the scope.

Lean approach, which aims at the reduction of waste, provides the best tool for the step-by-step improvement of organizational processes and fosters the culture of cooperation. This can improve the team performance and motivation as well as responsibility but it may also cause the teams to always look for the betterment and can cause them to burn out. The Critical Path Method (CPM) is helpful in defining the time line and schedule which in turn helps in proper utilization of resources and timely completion of project (Kusumadarma et al. 2020). Even though CPM does show where crucial activities are and their dependencies, detailed planning in CPM could take a lot of time and might lessen flexibility to a great extent and so might discourage impulsive cooperation. In general, the selection of the method determines the interaction between team members and provides an adequate level of structure and freedom for the project's completion.

Sustainability of project management practices

The concept of sustainability in the context of project management practices is only possible if it can accommodate the long-term benefits that go beyond the conclusion of the project. It is possible to arrange methodologies in a way that will promote sustainability and will include such principles as constancy of improvement, change, and waste reduction. Due to their cyclic nature and emphasis on customers' feedback, agile frameworks can be considered as sustainable by nature as they rely on constant and gradual progress with regards to the conditions within the environment (Marnewick & Marnewick, 2022). This helps to maintain the significance and usefulness of projects in the course of their implementation.

Sustainability is easily integrated into lean because it focuses on the ongoing improvement of the value stream and the elimination of waste. Through the encouragement of the concept of kaizen, Lean guarantees that projects and organizations can sustain improvement in the future. The Waterfall methodology is more sequential and rigid in its process but it can be helpful in achieving sustainability because of the strict planning and documentation (Popa et al. 2021). This can also create a good background for future projects and make mechanisms for knowledge transfer possible.

The Critical Path Method (CPM) assists in sustainability since it helps in proper utilization of resources and time hence giving a project the required time to be accomplished (ALNEHLAWI, 2022). Thus, CPM aids in determining the crucial activities and makes it easy to avoid any delay and wastage of resources. To sum up, sustainable project management practices call for approaches that provide structure and leeway, optimize resources, and foster continuous enhancement for the project’s long-term advantage.

V. Discussion

Visualization Techniques in Project Management

Gantt chart is among the most versatile tools that are used for displaying the progress of a particular project. These are the horizontal bar charts to depict the project activities and their temporal relationship, including, the start and end time of a task the time taken by the latter, and the developmental connection between them.

Task	Start Date	End Date	Duration (Days)
Project Planning	01/06/2024	07/06/2024	7
Requirements Gathering	08/06/2024	14/06/2024	7
Design	15/06/2024	28/06/2024	14
Development	29/06/2024	26/07/2024	28
Testing	27/07/2024	17/08/2024	22
Deployment	18/08/2024	24/08/2024	7
Project Closure	25/08/2024	31/08/2024	7

Figure 1: Gantt chart
(Source: self-created)

Another widely used visualization is called Kanban Boards and it is based on Lean project management. Kanban boards have horizontal rows and vertical columns that let practitioners note the various phases of work and problems that may slow down a process (Thai, 2024). Each column is a step in the flow, and every card is a task or subtask, depending on the level of detail used in the Kanban board. According to Kanban report 2022, 87% organisations are more comfortable with using Kanban as compared to other frameworks as they increase the pace of delivery and throughput (Kanban, 2022). Building Information Management (BIM) entails the process of generating and using digital models for the creation and operation of buildings. Having a source of common understanding that can be accessed and modified by all stakeholders is one of the key ways that BIM supports construction project management (Um et al. 2023). A comprehensive survey conducted by Becerik-Gerber and Rice highlighted key findings that shows 41% of the respondents observed an overall improvement in the profitability of projects followed by 55% of the respondents observed that BIM had a positive impact on the cost reduction (Bimandco, 2023).

Three-Dimensional Visualization is a significant aid that offers sustainable representations of the program components and the relations among them. 3D models are useful in assessing work plans and schedules, as well as in coordinating with partners or stakeholders because it gives a clearer picture of what the result is going to be like. Garbarski and Hilditch-Mitchenall further highlight that they are particularly useful in projects that involve shapes and sizes.

	This Month	Last Month	Target
Project Health			
Overall Status	Green	Yellow	Green
Schedule	92%	88%	≥ 90%
Cost	\$125,000	\$118,000	≤ \$130,000
Quality	4.6	4.4	≥ 4.5
Project Milestones			

Milestone 1	Complete	In Progress	05/06/2024
Milestone 2	In Progress	Not Started	20/07/2024
Milestone 3	Not Started	Not Started	15/08/2024
Resource Utilization			
Team A	85%	90%	80% - 90%
Team B	78%	75%	75% - 85%
Team C	92%	88%	85% - 95%
Risks			
High Risks	2	3	≤ 3
Medium Risks	5	4	≤ 6
Low Risks	8	7	-

Table 1: Dashboards
(Source: self-created)

Dashboards collate and present KPIs and metrics on projects, in real-time, the essence being that project managers can track and, where necessary, tackle emerging problems. Navigation: Dashboards present a full picture of the project’s progress, as well as reveal areas deserving of attention.

Licensed vs. Open Source Visualization Tools

When selecting between the licensed and open-source visualization tools, priorities should be made based on the needs of a project, budget, and skills. Primavera and Microsoft Project are some of the most popular licensed tools that are regarded as offering numerous functionalities, reliable technical support, and multiple compatibility choices (Ninpan et al. 2024). These tools are best suited for tasks such as planning, scheduling of resources and the products which are to be delivered and resources required for the same. They also produce highly elaborate project reports which makes them suitable to large complex projects.

For example, Primavera has more sophisticated features such as risk management, resource leveling, CPM scheduling, etc. Microsoft Project has tools such as Gantt charts, task sequencing, and project monitoring besides operation with other Microsoft Office applications. Such features make project management more effective and can greatly contribute to the increase of efficiency and decrease of errors. From the performance measures, it is seen that both Primavera and Microsoft Project do not slow down the system even when handling complex projects with thousands of tasks. This suggests that the programs can accommodate large projects and can be used for long-term project planning.

On the other hand, we have ProjectLibre and GanttProject which are free or relatively cheaper than other project management tools. Though they do not possess some of the features of the licensed software, they possess core project management capabilities. For instance, ProjectLibre has features such as Gantt charts, network diagrams, and resources hence suitable for small projects. GanttProject offers features of task scheduling, Gantt charts, and export to PDF or HTML. These tools are relatively more flexible and easier to adapt to various needs of a project but may take more time to be so adapted.

The metrics that are used to compare open source tools are normally high for small and medium applications but low for large and complex cases. Accessibility also differs; some users claim that open-source tools are not very friendly and do not have the sleek design of licensed software. However, open-source tools are usually developed with the help of the community and updated more frequently.

Thus, the licensed tools such as Primavera and Microsoft Project are suitable for the large and complex projects as they have more capabilities and flexibility. Free tools such as ProjectLibre and GanttProject are ideal for small projects that may not afford the more advanced tools; however, it presents the basic features and flexibility. It is essential to decide whether to use licensed or open-source tools depending on the project’s needs, the cost, and the availability of additional functions or settings.

The Role of 3D Visualization Technology in Offshore Platform Engineering

One of the main concerns discussed in the study by Yang et al. (2019) is the application of three-dimensional (3D) visualization technology in offshore platform construction projects.⁵⁹ From this case study, it can be ascertained that elaborate graphical models help in enhancing the organization and information sharing with the stakeholders and thus aids in planning and trouble-shooting. 3D visualization helps in identifying errors to around 85% before construction followed by cost savings of around 12% (Chahrour et al. 2021). The complex and detailed diagrams assist in making representations of project subparts and their integration, which is especially useful when working on complex engineering projects with many subtasks. This technological

approach re-emphasizes the use of graphical aids in improving the understanding of projects and the level of participation by the various stakeholders, hence making projects more efficient.

This technology enables the project manager to build a real model of the project environment through visualization. Thus, it helps in reducing the design time by 30% reducing the construction timeline by 15%. These replicas give a clear picture of the project with an added advantage of being able to detect any problems and find a way around them before the construction phase begins. When project managers and their teams discuss different cases, they can predict problems and think through them, which significantly decreases the risk of expensive delays or mistakes.

However, the choice of offshore platform engineering as the subject of research may cause concerns as to the applicability of the findings to other project types. Nonetheless, the advantages of 3D visualization have been illustrated in this paper, and more studies are required to examine the generalizability of the concept across industries and projects. It is still unclear whether the technology performs well in small-scale, low-risk tasks, or in industries with different issues at hand.

Metrics, KPIs, and Dashboards: Tools for Effective Project Management

On the other hand, Kerzner (2022) offers an accelerated academic perspective on the application of metrics, KPIs, and dashboards in project management. As for the key tools, this work underscores how these help in establishing actuality in decision making and performance evaluation. According to Gartner (2023), projects that incorporated real-time dashboards were 23% more likely to meet their planned schedule and 18% more likely to meet the planned budget as compared to the projects that did not incorporate the use of dashboards (Gartner, 2023). Among tools, there is a specific focus on the role of dashboards as essential tools allowing to monitor events in real-time and notify the managers about the possible problems. In the theoretical framework as well as in the practical examples, Kerzner sheds light on the potential of metrics and KPIs to improve project management and monitoring.

Targets and Key Performance Indicators help identify tangible goals, which define the pace of a project's development. They give a definite and an uncomplicated method of determining whether the project is on par with the desired track. The Construction Industry Institute (2022) highlighted that projects that employed performance dashboards saw an improvement in performance as follows: cost by 21%, schedule by 19%, and safety by 15% (Construction-institute, 2022). Such indicators enable the project managers to track patterns over time with the objective of recognizing anticipated issues in advance and take immediate corrective measures. Dashboards that present these metrics in real-time, add to this functionality by allowing a unified view of project status on a single screen.

The weakness that should be pointed out with reference to the work done by Kerzner refers to the lack of specific data to support the theories that have been identified. However, the reader is offered a rather profound and numerous sets of the concepts, the number of the practical examples, which would have been helpful to illustrate the author's intentions and Assertions, is rather limited. As the evidence has indicated, there is a clear need for more empirical support to demonstrate the efficacy of such tools and the applicability of these tools in as many projects as possible.

Enhancing Communication and Collaboration through Building Information Management (BIM)

Kocakaya et al. (2019) research on Building Information Management (BIM) expands the understanding of the current project management strategies. From the literature and the case studies considered in this research it is clear that BIM has a crucial role as to enhancing communication and integrated cooperation among all project stakeholders, reducing the number of mistakes, and enhancing the effectiveness of project management. These aspects highlight the importance that BIM has for a construction project since it compiles several aspects of the project in one model and therefore reduces clashes.

BIM enables the production of a model, which is an abstract and dynamic representation of physical and operational features of a facility. This model can be regarded as the common source of information about a facility within the frame of its lifecycle and, thus, can be considered the foundation for its decision-making. BIM serves as a model for all stakeholders as it increases cooperation and coordination, thus guaranteeing that everyone is working with the right data. This helps in time saving, eradication of misunderstandings and minimizes errors hence making the project efficient.

However, as the authors pointed out, the construction industry is identified as the primary context of BIM application, thereby limiting the generalization of the study findings; similarly, as it was mentioned by Yang et al. (2019)⁵⁹. The research does not adequately discuss limits and drawbacks of BIM implementation that may be encountered in other project domains; it suggests future research into its adaptability to different fields and possible issues that might be encountered. Organization transitioning to BIM may face a number of challenges and hurdles because changes in processes may be significant, and the implementation of the new technology often involves considerable costs and time-consuming staff training.

Agile Methodologies: Flexibility and Sustainability in Project Management

The research by Layton et al (2020) uses guidelines and real-life situations to explain how agile concepts can be adopted to create sustainable and flexible project management. This is because agile methodologies provide plans that can be adjusted to meet specific project needs as well as provide rather invaluable solutions in a systematic manner, which is ideal especially when the project environment is volatile and unpredictable. In their view, agile practices enhance project sustainability for the reason that flexibility and a wide range of opportunities for improvement are considered as vital priorities.

One of the main principles in agile is the use of iterations and sprints, which are development cycles that are smaller than the full project. This approach also provides the opportunity to review the project plans frequently due to the feedback received from the stakeholders and other related changes that may be necessary for the project implementation. Agile is an approach that delivers work in small increments, which allows the teams to adapt to changes, listen to the customer and improve the product with each iteration. This successive process not only increases the flexibility of the system but also emphasizes the importance of delivering value to stakeholders during the project life cycle.

However, it may not be enough to provide the guidelines for large scale or highly controlled projects all the complexities addressed. Such examples, though quite informative, may not give an idea of how vast the application of 'Agile' can actually be, prompting for the need to have more elaborate case studies that will involve other types of projects and difficulties. The use of agile methodologies could pose a challenge in setting up environments, which demand high levels of compliance with rules and regulations or in a project that cannot be altered in terms of its scope.

Comparing Agile and Waterfall: Methodological Fit for Project Characteristics

There is a comparative analysis of Agile and Waterfall methodologies by Andrei et al. (2019), which provides a comprehensive view of the key advantages and limitations of these approaches. The research also gives an idea that Agile is for projects, which need iterative development and constant enhancement whereas Waterfall is appropriate for a project divided into strictly defined stages. Thus, this distinction shows that the choice of the correct methodology depends on features and expectations for the given project.

This means that in waterfall methodology, activities are done sequentially, where one phase has to be finished before the next one starts. It is most effective where objectives and requirements of the project are well defined and non-ambiguous and where there is little or no change in the processes with time. While Waterfall is strict and formally structured, Agile is more flexible and dynamic, enabling it to be used in projects that need constant client-provided feedback in order to develop or change the requirements of the project.

However, the results of this study were derived from a small sample of manufacturing firms, thus leaving the validity of generalizing the findings to the other industries questionable. A larger pool of data encompassing different industries and different types of projects would give a better perspective on the applicability of efficacy of Agile and Waterfall systems. Depending on the characteristics of industries and projects, they may face different challenges with each of them, affecting the applicability of each methodology.

Innovative project management methodologies and visualization tools

DevOps is an innovative method to address the challenge of opposition between the development and operations teams. This present model acknowledges the fact that in the current systems, there is no clear demarcation between these two teams and as a result, there are communication gaps and poor and slow software quality (Wiedemann et al. 2023). DevOps focuses on people and processes with the expectation that developers and operation officials must integrate efforts with the goal of producing high quality software that is also quickly deliverable. automation is an important part of DevOps and allows using such tools as the continuous integration, continuous delivery, and continuous monitoring. This can be a threat to the automation industry if not configured properly.

Story mapping is one of the effective collaborative methods that allow the teams to analyze the user stories or requirements from a big picture and specify the local details of the wanted functionality and features. This is a graphical manner of depicting systems and helps split extensive procedures into small parts that can easily be handled by a team while revealing the parameters and aspects between parts (Ananjeva et al. 2020). When ordering user stories, teams can distinguish such notions as pattern, dependency, and prior iteration within a system, which helps a lot when choosing what should be developed as the first. This approach favors the fact that the whole team is in an excellent position to understand the system as everybody is on the same level working towards achieving the intended goal. One security threat is related to data breach and unauthorized access to data that can cause security threat for industries like finance or healthcare.

The **spike analysis** is a form of charting that enables the teams understand the extent of the task in as much as constructing a dependency and relation chart. It means a process in which large work is divided into sub-tasks and the connection between the latter is defined (St-andrews, 2024). It assists the teams to determine which tasks are of high priority, which tasks rely on others and which tasks can slow down the overall progress.

Spike analysis can be widely used in different kinds of projects, starting with IT and ending with marketing campaigns, but it is most effective in case of complex projects involving many participants and factors.

Different visualization techniques and their pros and cons

Visualization Technique	Pros	Cons
Gantt Charts	<ul style="list-style-type: none"> Clearly illustrate task timelines, durations, and overlaps Aid in monitoring project progress and identifying delays Provide a visual representation of task dependencies 	<ul style="list-style-type: none"> Difficult to manage for complex projects with many tasks Require frequent updates to stay relevant May become cluttered and hard to interpret with numerous tasks
Kanban Boards	<ul style="list-style-type: none"> Visualize workflow and task progress Promote work improvement and adaptability Easy to understand and use Suitable for Agile project management 	<ul style="list-style-type: none"> Do not clearly show task dependencies Lack timeline representation for tasks May not suit projects with strict schedules and interdependent tasks
Building Information Management (BIM)	<ul style="list-style-type: none"> Enhances stakeholder engagement Provides a comprehensive digital model of project components Improves coordination and reduces errors in construction projects 	<ul style="list-style-type: none"> High initial investment cost Requires specialized training and expertise Significant commitment needed for software acquisition and team education
Three-Dimensional (3D) Visualization	<ul style="list-style-type: none"> Provides realistic and detailed representations of project elements Enhances communication and stakeholder understanding Useful for illustrating complex physical aspects 	<ul style="list-style-type: none"> Expensive and technologically demanding Time-consuming to design and update High resource investment required
Dashboards	<ul style="list-style-type: none"> Real-time monitoring of performance indicators and metrics Summarize project status for quick decision-making Customizable to project objectives and requirements Useful for analysing schedules, costs, and productivity 	<ul style="list-style-type: none"> Can be costly to implement and maintain Requires accurate and up-to-date data for effectiveness Incorrect or hasty data input can lead to misleading conclusions

Table 2: Pros and cons of Different visualization techniques
(Source: self-created)

Gantt charts are one of the most popular tools for increasing the project’s understanding and visual representation of project activities' timescale. Bar charts are good at illustrating specific task timetables and relations, including the commencement and the concluding dates of tasks, as well as their duration and overlapping (Vasankari, 2024). This way, it is easy for the project managers to monitor and see any areas that have some form of congestion thereby delaying the overall progress. Nonetheless, implementation of Gantt charts may be challenging for complex productions due to difficulties in organizing the numerous tasks and their interconnection. When more tasks are involved, it becomes hard to have a clear understanding of them due to the increasing intricacy. Moreover, Gantt charts are more dynamic and necessitate frequent revisions to represent the ongoing project progress. The chart cannot be used for long periods of the day or weeks; it is subjected to manipulation and thus may contain outdated information if not updated frequently.

The Kanban boards that are utilized in agile project management systems are used to represent workflow and potential constraints. It involves still columns which are usually the progression of the project (for example To Do, In Progress, Done, and cards usually denote tasks. As mentioned above, this visual form enables people to observe the process sequence of ongoing work and the position of certain tasks within it, which fosters work improvement and adaptability (Ariyana et al. 2023). Nevertheless, some issues may be still questionable and do not recognize Kanban boards as perfect, for instance, they do not give a clear understanding of the relations between tasks and the necessary time required to complete them. The resources are more aligned with the programs that track how a certain job or a project is being executed and the state it is in rather than laying out the flow of how a task is arranged. It means that at times it may be somewhat challenging to track dependencies of various project tasks, which can be a disadvantage in instances where a project needs a strict timetable.

Building Information Management otherwise referred to as BIM is an organizational tool of visualization that is commonly used for construction and architectural projects. BIM is the process of developing an accurate and complete digital representation of the physical and/or functional aspects of built assets along with the systems that form part of the structure of a building or infrastructure project. This increases Stakeholder engagement since every player involved in a project can point at one single platform from where they can access the project models. Nevertheless, the initial investment in the implementation of BIM is

relatively expensive, and the entire system requires certain expertise to master. Doing so requires a considerable commitment in terms of software acquisition and educating project teams about BIM use.

Mapping methods offer realistic presentations of elements involved in projects and the way they interrelate, especially when presenting three-dimensional (3D) visual aids. These types of representations are considered very helpful in the enhancement of communication and the understanding of the stakeholders because they provide a concrete scope of the project in terms of the physical aspects. One of the major limitations of 3D visualization is that it is quite expensive and technically innovative. Designing and updating 3D models are often time-consuming and could take much of a project's resources hence a strong base investment.

Dashboards are basic components that all organizations need to utilize to compile and show important performance indicators and metrics in real-time. In this case, plans refer to a summary of project status, which guides quick decision-making and problem identification. In this aspect, dashboards may be tailored concerning the project objectives and requirements, thereby rendering them useful for the analysis of many aspects of the project, including the schedule, cost controls and personnel productivity.

While utilizing a dashboard has certain advantages, it needs to be said that sometimes it can be very costly to implement and support. The establishment of a good dashboard system could have considerable software investment and may entail the need for the contractor to develop some software. Further, information fed into the dashboard must be up-to-date and correct for the latter to work efficiently. Hasty and inaccurate information may often provide wrong impressions and a poor programmer.

User experience and usability testing of the visualization tools

The assessment of the project visualization tools requires user experience (UX) and usability testing. These assessments are helpful in understanding how easy and self-explanatory these tools are from the perspective of the end-users, which in turn affects the extent of their application and usefulness in project management.

In the case of Gantt charts, usability testing might show that although they are excellent at displaying the timelines of tasks and their interdependence, users can have difficulty with large projects with many tasks that are connected (Shaukat, 2024). The fact that Gantt charts are updated frequently could also be a disadvantage to some users since it could lead to the use of outdated information if not well managed that reduces acceptance of the model to around 15.6%. Kanban boards that are used in agile project management methodologies might be considered to be simple and informative in terms of visualizing the flow of work (Damij & Damij, 2021). But, usability tests could reveal the issues with the inability to express the task's dependencies and time estimates that might be essential for some projects.

This is probably why BIM tools are likely to have high scores in stakeholder engagement since they contain detailed 3D models. However, usability testing could reveal that there is a high initial cost to use and that it requires special skills, which could hinder the spread of the technology. The 3D mapping methods may be positively received for their realistic representations thus improving the understanding of the stakeholders (Eilola et al. 2023). Nevertheless, users may feel that the creation and updating of these models are time-consuming and require a lot of resources which is close to 30% of the overall cost. Real-time performance monitoring tools like the dashboards could be appreciated for their flexibility and simplicity of presenting figures at a glance. Usability testing could identify data integration issues and the fact that the tools need to have current information to remain useful (Sauer et al. 2020).

Some of the generic areas that may be covered in UX testing of all the tools may include; the need for simple and easy to understand interfaces, easy ways to input and update data and the ability to grow with the project. Some of the most important factors include the richness of the features that are provided and the extent to which the tool is simple to use, as well as compatibility with the existing project management processes. Thus, the most useful visuals are those that not only provide information in an easily understandable manner but also do not contradict the users' mental models of project management, but rather facilitate them.

Case studies: Application of Project Management Techniques

a) Waterfall Methodology as Applied by Space Shuttle Program of NASA

The Space Shuttle Program by NASA is a perfect example of using the Waterfall methodology in a huge, complicated, and high-risk project. This was a great methodology as it was linear, and each step followed the other perfectly satisfying the needs of NASA. Every process in the program life cycle, including requirement gathering, system design, development, integration, testing, and maintenance, was well-planned and executed. The requirements, the safety issues, and all the complexity of space missions that NASA is involved with can be easily controlled within the limitations of the Waterfall methodology (Trimble, 2023). For instance, requirement gathering and validation implied that all aspects of the mission were initially well understood and recorded before proceeding to the next phase. The design phase called for formulation of specific blueprints of the

systems of the shuttle, which were then applied when the development phase was being carried out. Next, was the testing and integration phase, where each component was tested according to the standard required and tested to ensure that it could work as a component in a larger system.

b) Agile Methodology – The Framework of Spotify’s Development

Spotify a music streaming service uses an Agile methodology to perform its software development projects. By evaluating the characteristics mentioned above, it becomes clear that the development of the music streaming service requires a flexible and adaptable approach due to its dynamism influenced by the changing market trends and users’ preferences. This is why it is possible to utilize the Agile methodology of development, which is built on the principles of gradual improvement and constant introduction of changes (Salameh & Bass, 2022). Spotify divides its work into sprints, periods that usually last for two to four weeks at most.

Sprint is a two to four-week cycle that includes planning, execution, review, and retrospective cycles. This flexible structure enables the development teams at Spotify to review and revise development goals periodically according to the user's feedback and the trends in the market. The Agile development process is implemented in the Scrum framework, which is critical to the development at Spotify (Almeida & Espinheira, 2021). Specifically, daily stand-up meetings, sprint planning, and review meetings provide the necessary level of cohesion and integration. This makes it easier for Spotify to deliver frequent updates and new attributes in a way that can adapt to users’ needs and business objectives due to this iterative approach.

c) Lean Methodology: Toyota’s Production System

The Toyota Production System (TPS) serves as the starting point for Lean practice, improving or eliminating non-value-added activities and processes, and investing in continuous improvement – or kaizen. TPS has emerged as an excellent model of operation and a model of lean project management because of the high standards of operation and quality that it has set. Toyota has adopted the lean manufacturing principle to govern the nature and organizational structure of its production processes (Anoop & Muhammed, 2020). The management of the company remains concerned with the issue of looking for waste areas, eliminating waste, and improving the efficiency of operations. Implementation of waste reduction and efficiency has realized desirable changes in production speed, costs, and the quality of the final product.

For instance, TPS pays a significant amount of attention to value stream mapping, which involves a process of evaluating materials and information flow needed to deliver a product to the customer. Thus, by making the production process more visible, Toyota prevents the tendency of the process from becoming a bottleneck and not adding value to the final product (Dave, 2020). Lean is a philosophy that emphasizes the engagement of all employees and the driving of change in processes to be incremental and constant. This way not only increases the effectiveness of work but it motivates employees and makes them more engaged with the company which is the key factor for Toyota as a company that is at the top of the automotive industry worldwide.

Visualization Techniques in Action

a) Gantt Charts - Microsoft Project in Construction Management

Gantt charts, which are now utilized in many areas, including construction management, offer reliable tools for depicting project timelines, tasks, and interdependencies. Microsoft Project, one of the most preferred project management tools, uses Gantt charts to organize construction plans and timelines (De Gaetani et al. 2020). For instance, during the construction of the Burj Khalifa, the project managers to bring together or plan various activities so that the project could run as planned and in harmony used Gantt charts. The use of tasks, start date, end date, duration, as well as dependencies in the project to enhance the understanding of the different patterns of workflow and time required in a project of such magnitude was very useful.

b) Kanban Boards - Trello at a Marketing Agency

Trello is a tool that utilizes the Kanban board approach that is widely incorporated by marketing agencies to monitor the progress of campaigns. Kanban boards are organized in columns and cards; the columns are used to define the different steps of work, while the cards represent individual tasks. Each column represents one of the workflow phases (such as To Do, In Progress, Done), and cards stand for activities and sub activities. Marketing agencies utilize Trello to help dissect each campaign into tasks and sub-tasks, track the overall status and define possible barriers (Massumu, 2022). For instance, a campaign might entail the following activities; content development, design, authorization and dissemination. When the team performs these tasks using the Kanban board, it can easily identify which of the tasks are ongoing, which ones are finished, and the ones that are still pending. This enhances efficiency, teamwork and performance of tasks to ensure that all campaigns are done effectively and within the right time.

c) Building Information Management (BIM) - Crossrail Project in London

The Crossrail, also known as the Elizabeth Line or the Liverpool Street to Shenfield Line, is one of the largest infrastructure projects in Europe which was implemented in London and it applied Building Information Management or BIM significantly during its planning and implementation phase. In addition, through BIM, there was a digital model of the physical and organizational aspects of the railway system, thus improving the communication of the involved stakeholders and minimizing the occurrence of errors (Floros et al. 2020). Through the implementation of BIM, the project teams could get and update the model so that all the members of the project team understood what the final design of the project was going to be and what was required. This was important for managing the synergy between construction, engineering, and other important tasks in the project. The evaluation of BIM revealed that the software's capability to model different conditions and predict problems before an actual construction could take place significantly cut the cost and time wasted on a construction that did not meet its requirement, thereby achieving its goals and objectives.

d) 3D Visualization - Boeing's Aircraft Design

Boeing uses 3D visualization in the creation of fliers where it assists in developing models of its aircraft, as well as offering realistic models of the components that make up the aircraft and their relationship. 3D models are used in design to show complex details in the structure of aeroplanes, in modelling the planes' movements, and as a tool to communicate with suppliers (Al-Jaf, 2020). For instance, in the early stages of designing a new plane, several Boeing engineers work on the shell of the plane and use 3D models to determine the most effective way of integrating several features with the aerodynamics of the plane. These models can help the engineer realize that a design they came up with may not work and make necessary changes before real-world models are constructed. 3D visualization is quite beneficial in coordination between the members of a team and other stakeholders, as well as other stakeholders by minimizing the chances of making mistakes about the specifications and performances of the final product.

e) Dashboards - Salesforce's Project Management

The CRM software Salesforce uses its dashboards to track internal projects, which is a common practice suggested by experts. This way, project dashboards collect relevant information about project progress and status, efficiency and costs, risk management, and any other critical factors necessary for decision-making in real time. Salesforce offers flexible dashboards for monitoring of the general project status, and KPIs regarding schedule compliance, costs, quality and resource management (Garg & Jindal, 2023). These are important since through visualization, the project managers can easily see some areas that need their attention such as risky items or when some resources are overstretched. This makes it easier to visualize the goal posts of any project, what needs to be achieved and by when and thus avoid deviation from business goals as well as project delivery within specified time and cost parameters.

AI and machine learning in project management

The use of artificial intelligence (AI) and machine learning (ML) in project management is changing the ways projects are identified, executed and controlled. Such tools can easily extract information from large data sets in form of patterns, trends or correlations which in turn translates to better performance of the forecasting techniques, assessment of risks and resource allocation methods. Machine learning algorithms can also be used to manage the project's efficiency where tasks can be automated and the likelihood of human errors eliminated (Woschank et al. 2020). In addition, there is an opportunity to use AI-constructed chat to help project managers in the interaction and collaboration with the employees, as well as clients and stakeholders.

Apparently, in the future, the role of AI and ML in the project management approaches is going to be revolutionary as it will introduce new methodologies that are suiting the dynamic environment (Mcgrath & Kostalova, 2020). For example, the use of configurations through the assistance of artificial intelligence in the presentation of data will assist teams in making the right decisions depending on the data available. On the same note, predictive analytics derived from machine learning can help in predicting project outcomes, and in turn, address such issues before affecting the projects' progress and/or deterring their success. Additionally, the automation of numerous tasks by AI will allow project managers to dedicate their time to essential and complex decision-making processes; conversely, virtual personal assistants will assist the team members with the required aid (Cioffi et al. 2020). In conclusion, the integration of AI and ML in the project management is expected to revolutionize the industry by means of offering a fast and efficient way of embracing projects.

Comparative analysis

It can be said that each project management methodology and visualization technique have its advantages and disadvantages and their efficiency can be very high and, on the contrary, very low depending on the context and the existing requirements for the project. The waterfall model provides a sequential and linear approach to software development, which is good for projects with a limited degree of flexibility, as demonstrated by NASA's Space Shuttle Program. Agility, as practised in Spotify's development cycle, excels in

settings where the specifications are in a constant state of flux, encouraging both responsiveness and immediate feedback. The Lean management approach perfected by Toyota is an efficient way of removing waste and driving improvement in the production cycle, making it suitable for manufacturing.

Equally, methods of visualization like Gantt charts, Kanban boards, BIM, 3D visualization, and dashboards present important assets in planning, execution, and decision-making. For instance, Gantt charts offer clarity in the sequence of the project's phase while BIM enhances teamwork and the elimination of mistakes in construction projects. Every technique has its application area in which it is most effective in an organization when planning their projects and setting goals and objectives needs to consider which method/technique and visualization tools will best suit them for the success of the project.

The analyzed research study offers many directions for future research, significantly in relation to the improvement of project management activities. Among the practical implications for future research, it is necessary to indicate the empirical confirmation of the theoretical constructs considered in the present work. Nevertheless, a theoretical understanding of the research issues examined in this study is well provided by the existing literature, though research that is more empirical is called for to support the given theories and prove their applicability to various project contexts. Future studies could therefore center on data collection of actual projects to confirm the postulated models and tools.

As for the future research opportunities, more discussions on how tools and methodologies mentioned in the study, including Building Information Management (BIM) and Agile methodologies can be expanded and applied to various industries apart from construction and software development can be debated. Since the current study widely focuses on these tools in specific fields, extending the research for their uses in other fields could be enriching. This involves determining possible issues that may be encountered or constraints that may be experienced while implementing these tools in different sectors, which in turn can assist in improving these tools so that they can appease all sectors.

Limitations

Some limitations of the research have been pointed out despite the rich representation of most project management methodologies and visualization techniques. Firstly, the research used more of secondary data sources which include articles, reports, and opinions from professionals. Also, the absence of primary data collection like structured interviews/surveys with project managers and other stakeholders can slightly reduce the level of understanding and real-life application of these methodologies and tools. Secondly, the consideration of the specified business contexts including construction, software development business and the manufacturing business limits the broad application of the outcomes or findings to other lines of business. Some of the general observations of these methodologies and techniques in various industries and types of projects is still an issue that cannot be adequately addressed sufficiently at the current stage of knowledge and investigation.

The restriction of the review of literature published over the last five years omits the historical aspect and previous trends of project management practices. Although the most recent ones are vital, a wider timeline might present broader generalizations of the changes and advancements of such strategies. In addition, the research mostly focused on using information that is available to the public and as such could not analyze other unique organizational strategies not open to the public domain. Such internal data and case studies are excluded could hamper understanding of the peculiarities and the difficulties that are characteristic of the implementation of these methodologies and tools. One more drawback of the work is the insufficient focus on the detailed exploration of the issues and difficulties that organizations can encounter during the implementation of the mentioned project management methodologies and visualization tools. The study concentrated more on the benefits and uses while taking a more in-depth look at the challenges that are associated with the use of the implementation could have proved helpful for practitioners.

Lastly, although the comparative analysis and case studies provided within the research can be useful in portraying the various approaches and their applicability, a perceived disagreement arises with regard to filling the identified contextual factors. Other complexities like organizational culture, project characteristics, actors' relations, and resource availability could introduce a critical impact on the successful adoption of these methodologies and tools. In conclusion, as the research gave the general understanding of PMM and visualization techniques, the indicated limitations imply a necessity for more in-depth empirical research of PMM and visualization techniques' application in broader industry contexts, deeper understanding of applicative problems encountered when implementing these trends and further empirical investigation of the topic. Instead, these limitations could be overcome to produce stronger and more practical implications for both the PM practitioners and researchers.

VI. Conclusion and future work

Project management and visualization play a crucial role in guaranteeing successful initiative completion within different industries. It is also important that the choice of certain means and approaches for the creation of effective visualization tools should reflect the goals and context of the particular project. Whereas, Waterfall has been more protocol-based and systematic for projects with fewer variants, and on the other hand, Agile & Lean is more suited for conditions, where there are higher variations. Modern projects are highly interconnected and are influenced by several factors so they require a strong framework for their management a highly competitive business environment.

Thus, those who practice the use of visualization tools such as Gantt charts, Kanban boards, and 3D models for projects must try to recognize that such changes improve communication, collaboration, and decision-making, benefiting a project's outcomes in the end. These tools in a way allow easy tracking of project timelines, tasks, and other linked aspects that are easily accessible in chart or graphical form to make determinations. Furthermore, use of the visualization tools makes every team member feel responsible and held accountable in the team towards the product.

Recommendations

Practitioners must first consider their needs and goals when selecting and applying project management and visualization tools. This includes the extent and size of their tasks, the degree of difficulty in the various activities and the interdependence of the members. Specifically, for the small teams or project with less complex processes Trello or Asana are suitable due to its interface and task management. Larger projects which are more complex require more options that are offered by Microsoft Project or Jira, which in addition to checklists include Gantt charts, resource, and reporting options (Sotello Barrera, 2024).

Another important aspect is compatibility with the existing software and platforms in order to avoid any disruptions in the work. The practitioners should consider finding the project management tools that are compatible with the tools that are commonly used like Slack, Microsoft Office, and Google Workspace (Jackson et al. 2022). This makes it possible for members of a given team to be able to communicate and share information with other members of the team and also to be able to work on documents without having to log into another application.

Other factors include flexibility, particularly in the issue of customization and scalability. Those tools which permit to configure the working process, interface, and analytics can be easily adjusted to the specificities of a particular project and evolve together with it. Specifically, visual tools including the Kanban board, Gantt chart, and timeline view should be implemented to monitor the work and recognize the problems in the process (Panzar & Wahrén, 2022). It is important to note that a considerable amount of training and support is needed to make such a system work effectively. Selecting tools with detailed documentation, guides, and active support can also greatly decrease the rate at which people abandon the tools. Furthermore, it's effective to engage the team in the selection process to ascertain that they are comfortable with the selected tool and this will make them have a stake in the use of the tool.

Last but not the least, cost is one of the most important factors that determine the effectiveness of a particular strategy. Some of them are available as freeware or have trial versions and the practitioner should think about the long-term costs and evaluate the tool's cost-effectiveness in terms of the functions offered, the possibility of expansion, and available support. Thus, by analyzing these aspects, practitioners can select and use project management and visualization tools that would contribute to the improvement of productivity and project outcomes.

Future research to identify the gaps

This is a research paper on project management methodologies and seeks to evaluate and discuss in detail the effectiveness of project management methodologies in today's organizations. Trends, benefits, and drawbacks of different PM methodologies of different industries and of different kind of projects are the factors that are going to be discussed in the paper. The research objectives are to assess project management methodologies critically and in terms of how they are used and their effectiveness, evaluate trends, strength or weakness of various project management methodologies, and determine compatibility of various project management methodologies and to review and draw the best practice and lessons learned from case and empirical studies.

It briefly introduces the Waterfall, Agile, Scrum, Lean and the critical path method (CPM) of project management methodologies. The Waterfall methodology is defined as sequential and thus it is highly prescriptive, which in turn has a strong linearity and activities that cannot be done concurrently at any instance. Agile is defined as cyclic accompanied by enhancements in closer cycles and incremental changes. Scrum on the other hand has been defined as a process that partitions a project into time-boxed segments called sprints with an average duration of between two to four weeks. Lean is defined as a program of ongoing improvement

dedicated to augmenting process activities relative to non-value-added activities as well as targeted at attaining the optimal flow. Some of the organizations refer to it as the method that involves identification of the longest chain of activities and interdependent sequence in a project referred to as the critical path.

The paper also shows how these methodologies influence the team and their interaction in the process of the undertaking. As for Waterfall methodology, it is stated that this process contains rigidity and does not encourage much flexibility and innovativeness in comparison with Agile. Lean is reported to offer some of the most effective modes used in the improvement of organizational processes and encourages togetherness. There are testimonial accounts to CPM being beneficial in the creation of schedule and timing tables though it is also criticized for causing teams to be exhausted.

The paper also covers the sustainability aspect in the contexts of project management as well as that Agile frameworks could be considered sustainable by nature based on the cyclic nature of the process and ongoing focus on the customers' feedback. Lean is said to be an approach that identifies key improvements of the value stream and eradication of non-value activities. Waterfall is said to be more sequential and bureaucratic in focus but can also have added value towards sustainability because of the planning and documenting. The functions of CPM are enumerated by stating it to be instrumental in sustainability in a way that it aids in efficient use of resources and time.

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