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EXPLORING CURRENT PROJECT MANAGEMENT METHODOLOGIES IN THE CONTEXT OF THEIR BEST APPLICATIONS

Olena Volovyk, Oleh Harmash. "Exploring Current Project Management Methodologies in the Context of their Best Applications". *The article is devoted to the study of the main project management methodologies, their origins and authorships, advantages and disadvantages in terms of their implementation. The published scientific resources on the project management evolution are processed and analysed. The modern concepts in formulating project objectives towards "faster-efficient-effective" were traced. The three perspectives of evaluating project success which involve project stakeholders, project managers and project end users are introduced. The main categories of the project management methodologies are outlined and diagrammed; the characteristics of every category are specified; the examples of the most established methodologies recognised in the business community are given. Brief conceptual explanation of each methodology is outlined together with its pros and cons and the most suitable areas of implementation are explored. The comparison of CPM and CCM is presented in a graphical manner. The latest statistics on the current trends in the methods' usage is presented and analysed. It was revealed that there is a strong tendency in preferring and applying hybrid methodologies and a strong decline in consistent usage of traditional methodologies. Scrum as the most popular agile methodology at team level has been identified followed by Kanban and others. The extension of using agile methodologies beyond IT-related and software development applications has been detected. Basic diagrams demonstrating logical structure and principles of some methods are shown. Recommendations for considering specific project features in the context of its scope, collaborating team characteristics, level of certainty and predictability of affecting factors coming from external and internal environments, customer and stakeholder involvement, objectives and project success evaluation criteria are developed.*

Keywords*:* project management, project management methodologies, traditional project management, agile project management, hybrid project management methodologies, project management application, PMBOK®, PRINCE2, Spiral, Crystal.

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Олена Воловик, Олег Гармаш. «Дослідження сучасних методологій управління проектами в контексті їх найкращих застосувань». *Стаття присвячена дослідженню основних методологій управління проектами, їх виникненню та авторству, перевагам і недолікам у частині їх реалізації. Опрацьовано та проаналізовано наукові публікації з еволюції управління проектами. Простежено сучасні концепції у формулюванні цілей проекту в напрямку «швидше-рентабельно-ефективно». Представлені три точки зору оцінки успіху проекту, які включають зацікавлені сторони проекту, менеджерів проекту та кінцевих користувачів проекту. Окреслено та наведено схеми основних категорій методологій управління проектами; вказуються характеристики кожної категорії; наведено приклади найбільш усталених підходів, визнаних бізнес-спільнотою. Стисле концептуальне пояснення кожної методології викладено разом із її перевагами та недоліками, а також досліджено найбільш прийнятні сфери впровадження. Порівняння CPM і CCM представлено в графічному вигляді. Наведено та проаналізовано останні статистичні дані про сучасні тенденції використання методів. Було виявлено, що існує сильна тенденція віддавати перевагу та застосовувати гібридні методології та значне зниження використання обмеженного тількі традиційними методологіями. Scrum як найпопулярніша гнучка методологія для командної роботи була визначена. Друге місце по популярності віддається методолгії Kanban. Було виявлено розширення використання гнучких методологій за межі проектів, пов'язаних з інформаційними технологіями та розробкою програмного забезпечення. Наведено основні схеми, що демонструють логічну структуру та принципи деяких методів. Розроблено рекомендації щодо розгляду конкретних особливостей проекту в контексті його обсягу, характеристик команди, що співпрацює, рівня визначеності та передбачуваності впливаючих факторів зовнішнього та внутрішнього середовища, залученості замовника та зацікавлених сторін, цілей та критеріїв оцінки успіху проекту.*

Ключові слова: управління проектами, методології управління проектами, традиційне управління проектами, гнучке управління проектами, методології гібридного управління проектами, застосування управління проектами, PMBOK, PRINCE2, Spiral, Crystal.

Елена Воловик, Олег Гармаш. «Исследование современных методологий управления проектами в контексте их наиболее эффективных применений». *Статья посвящена изучению основных методологий управления проектами, их происхождению и авторству, преимуществам и недостаткам с точки зрения их внедрения и применения. Научные публикации по развитию управления проектами обработаны и проанализированы. Прослежены современные концепции в формулировании целей проекта по направлению к «быстрее-рентабельнее-эффективнее». Представлены три точки зрения на оценку успеха проекта, в которых участвуют заинтересованные стороны проекта, менеджеры проекта и конечные пользователи проекта. Основные категории методологий управления проектами описаны и представлены в виде диаграмм; указаны характеристики каждой категории; приведены примеры наиболее устоявшихся и используемых методологий, признанных в бизнес-сообществе. Приводится краткое концептуальное объяснение каждой методологии вместе с ее преимуществами и недостатками, а также исследуются наиболее подходящие области применения. Сравнение CPM и CCM подходов представлено в графическом виде. Представлены и проанализированы последние статистические данные о текущих тенденциях использования методов. Выявлено, что наблюдается устойчивая тенденция предпочтения и применения гибридных методологий и резкое снижение использования традиционных методологий в чистом виде на постоянной основе. Scrum была определена как самая популярная методология Agile на командном уровне, за которой следуют Kanban и другие. Было обнаружено расширение использования гибких методологий за пределы проектов, связанных с информационными технологиями и разработкой программного обеспечения. Показаны базовые*

диаграммы, демонстрирующие логическую структуру и принципы некоторых методов. Разработаны рекомендации по учету особенностей проекта в контексте его масштаба, характеристик взаимодействующих команд, уровня определенности и предсказуемости влияющих факторов, исходящих из внешней и внутренней среды, вовлеченности заказчиков и заинтересованных сторон, целей и критериев оценки успешности проекта.

Ключевые слова: управление проектами, методологии управления проектами, традиционное управление проектами, гибкое управление проектами, методологии гибридного управление проектами, применение управление проектами, PMBOK, PRINCE2, Spiral, Crystal.

Introduction. The current stage of economic, social and technological development demonstrates that project management has proved to be more and more common because this approach has shown a high practical efficiency in solving complex problems in various areas of economic and business activities. Nowadays, the project management methodology has found application in many areas: construction, investment, IT-sphere, logistics, supply-chain-management and many others.

Modern concepts of project management formulate the implementation objectives towards "faster-efficient-effective", which makes it particularly challenging in the reality of a large number of restrictions and continually changing business, social and technological environment. In the process of shifting from one stage of economic and business development to the next one, the project management required new approaches in formulating project objectives, task framing and task sequence execution, time-management and activity evaluation techniques including the duration of every activity and the project as a whole, human resource management and resource management methodologies, budgeting etc.

While the first scientific approaches in project management were oriented on physical product development or construction of large-scale objects requiring long time and a great number of interrelated activities, the shift from product-oriented methodologies towards client-oriented methodologies resulted in establishing a new philosophy in management which has received the name of agile. The number of approaches continually grows resulting in a great variety of modifications of traditional (classical) methodologies, agile methodologies and hybrid ones representing a diversity of combinations of the both. Therefore, there is a strong necessity to realize the advantages and disadvantages of the suggested methods, identify the project characteristics which would justify the methodology application and choose the most suitable for it.

Analysis of the latest researches and publications. Project management has been developed, extended and modified for decades. The major distinguished contributors to this trend of scientific management are Henry Gantt, O. Taiichi, W.W.Royce, James E. Kelly, Morgan R. Walker, Eliyahu M. Goldratt, H. Takeuchi, I. Nonaka, J. Sutherland and K. Schwaber, K. Beck, L. Corey, Harry, Mikel J, B. Smith, Alistar Cockburn, B. Boehm and many others. [1-16] who introduced a variety of project management methodologies while adapting them to ever changing economic and business environment. In general, their finding were mostly industry and task oriented though further they were extended beyond the initial framework. The modern tendency in assessing critical success factors of project performance were explored by Shamim, D. M [18] , Jitpaiboon, T., Smith, S. M., & Gu.[19] and others who outlined that project success is evaluated from the perspectives of the three parts involved into the project- the project sponsor, the project manager and the project user. Taking into account the complexity of success perception, the selected project methodology needs to meet specific evaluation criteria including technological success; efficacy of project delivery;

management and organization implications; corporate efficiency and customer happiness. [18]

In 2020 Komus, A., & Kuberg, M [20] compiled an official report project management approaches applications. The results demonstrate major tendencies in preferences on different project management methodologies applications. For traditional, or classical/ sequential, approaches only 8% of the respondents stated that they use consistently traditional project management among which 23% apply PMBOK ®, 19% do no pursue standard methodologies at all and 13% apply PRINCE2. In general, there is a steady decline in consistent usage of traditional methods from 22% in 2012 to 8% in 2019. Interestingly that there is a strong tendency of preferring agile and hybrid approaches to traditional ones in project management. The same report claims that the users who prefer hybrid methods constitute 43% versus 28% of those who prefer selective agile approaches. Scrum (84%) is the most used agile approach at team level, followed by Kanban and others. Even though Agile approaches are primarily used by IT developers, there is an extensive trend of their adoption in fields without an IT connection and include physical product development, logistics, supply chain management, marketing, strategic organizational restructure, etc.

Despite a great number of researches in the field of project management, there have been insufficient efforts done towards identifying clear distinctions in methodologies' classification, determining and systemizing major advantages and disadvantages of most popular methods as well as the specific projects' features justifying application of a methodology type.

Objectives statement. The purpose of the research is to explore the development of project management methodologies, outline the categorisation in their variety applied in the contemporary business and scientific environment, give basic characteristic of different approaches in project management, analyses their advantages and disadvantages, and determine the most beneficial areas of their implementation.

Method (methodology). To achieve the goal, general scientific methods were used, in particular, literature review, methods of analysis and synthesis, system approach, tabular and graphical methods.

Basic material and results. Project management approaches can be organized into three main groups: sequential (traditional/classical), iterative (flexible/agile) and hybrid (a mixture of traditional and iterative approaches or a combination of the both) (Fig. 1)..

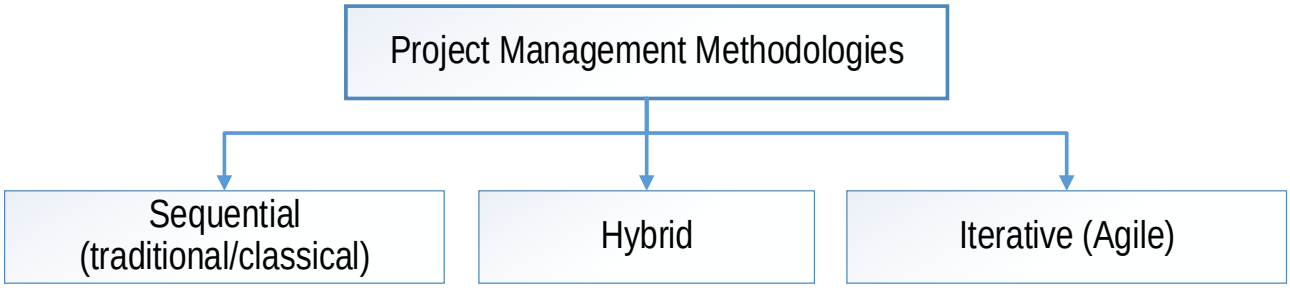

Figure 1 – Figure1 Project Management Methodologies Classification

Source: compiled by the authors

Each of the approaches has its advantages and disadvantages as well as implementation benefits. The articles gives brief conceptual explanation of each methodology together with its pros and cons and explores the areas of implementation which every methodology may suite the most.

Sequential, or traditional/classical, approach emphasizes linear processes where phases have precise starting and ending points and progress straight from one phase

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to another. Such methods have clearly defined objectives, well-controllable processes within the project, detailed documentation and high level of accountability. More advanced methodologies of the sequential approach are introduced by the Waterfall method, the Critical Path Method (CPM) with its extension PERT (Program Evaluation and Review Technique) which represents the algorithm for scheduling project activities, and The Critical Chain Method (CCM). (Fig. 2).

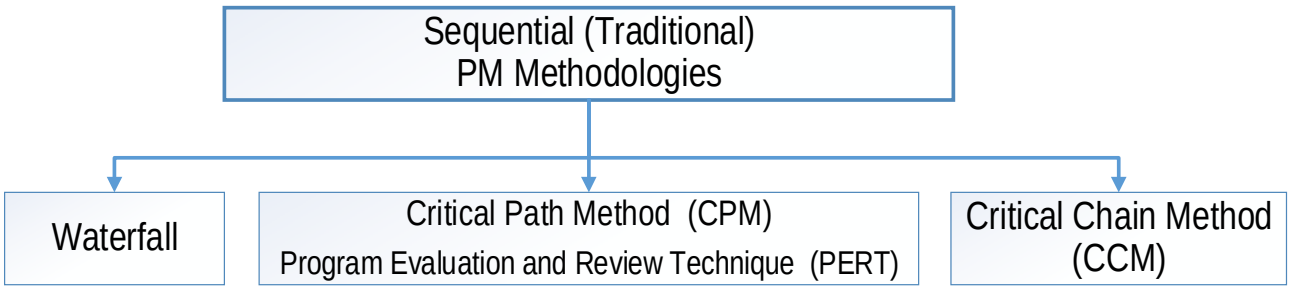

Figure 2 – Sequential Project Management Methodologies

Source: compiled by the authors

The Waterfall method was first introduced and established in 1970 by Winston W. Royce [2], a computer scientist, for manufacturing and construction businesses, though later it was successfully adopted by service-oriented industries. The main idea underlying this method is to build a system comprising static phases Requirements Determination, Design, Implementation, Verification, and Maintenance executed in a linear order. There have been several modifications to the Waterfall method, but all of them use the system approach suggested by Winston Royce. Stakeholders and customer prepare the requirements jointly and carefully document them. Interestingly that the Gantt charts which were originated in 1910 – 1915 by Henry Gantt is the most preferred tool for the Waterfall which visualizes subtasks, dependencies and project phases through the project life cycle. Gantt charts and WBS (work breakdown structure) are easy-to-use and well-visualizing tools for the sequential methodologies.

The advantages of the Waterfall methodology include clear structure of the project phases; clearly defined end goals; simplicity to use and understand; low work-in-process as the model phases are processed and completed one at a time; easiness to manage; non-overlapping project activities. Though the limitations of this methodology imply lack of flexibility and complexity to customize; the client/end user interaction is excluded during the project execution; high cost to maintain for users and extensive training for project staff. Therefore, the Waterfall methodology works poorly for long, on-going and multiple-module projects. On the other hand, it is best for the projects with well-defined end goal that have careful planning, detailed documentation, and consecutive execution.

The Critical Path Method (CPM) arises from the theory of graphs and represents an algorithm for scheduling the project activities. It is commonly used in conjunction with the Project Evaluation and Review Technique (PERT). This methodology was developed in the late 1950s by Morgan R. Walker of DuPont and and James E. Kelley Jr. of Remington Rand [3]. The critical path represents the longest (in terms of duration) sequence of essential project activities that must be completed on time. Calculating the critical path is key to determining the total duration of a project, its milestones, deadlines and essential activities which need to be completed on time. The advantages of this methodology involve clear and logical vision of the project as a whole; quantification of timelines and tasks; flexibility in shifting resources from non-critical to critical activities and vice versa; ability to spot the details, etc. The limitations

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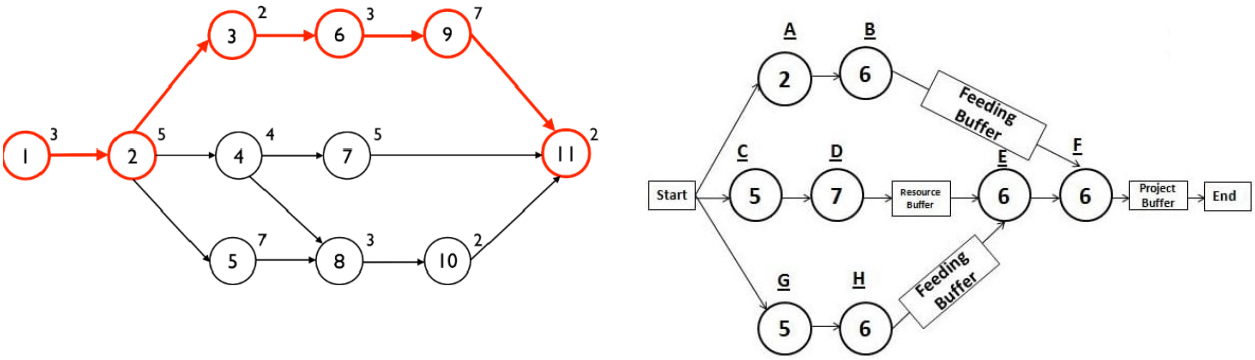
of this methodology include high complexity of the network diagram for large projects, which makes it difficult to track, and low flexibility when the information on every activity is incomplete.

The Critical Path Analysis is commonly used with all forms of projects, including construction, aerospace and defense, software development, research projects, product development, engineering, and plant maintenance, among others. Any project with interdependent activities can apply this method of mathematical analysis.

The Critical Chain Method (CCM), which was developed and introduced by the Israeli physicist Eliyahu M. Goldratt in 1997 [4], extends the theory of constraints which focuses on identifying constraints and bottlenecks in the system to improve the throughput. The CCM is defined as "the longest path in the network diagram considering activity interdependence and resource constraints." [4] It is the sequence of activities with the shortest time advance which takes into account the constraints of resources (workforce, equipment, etc.) and shifts a part of the stocks into so-called buffer activities – project feeding buffer, feeding buffer and resource buffer. Figure 3 depicts distinctive differences and similarities between the CPM and CCM.



Critical Path Methods diagram (*Source [21]*) Critical Chain Method Diagram (*Source [21]*)

Figure 3 – Comparison of Critical Path Methods and Critical Chain Method diagram

This method emphasizes prioritization, dependencies analysis, and optimization of resources and is best for complex projects with limited resources.

Table 1 summaries the project characteristics for the most suitable applications of the sequential (traditional) project management methodologies.

Table 1. Summary of the suitable project characteristics for sequential methodologies

Method	Suitable project characteristics
Waterfall	Smaller projects with easy identifiable deliverables during the planning stage
Critical Path/PERT	Mainly non-research projects and some research projects with independent activities which durations easy to predict where delivery terms and deadlines are critical
Critical Chain	Complex projects with limited resources

Source: compiled by the authors

The given methodologies are mostly suitable for projects with clear tasks to perform and lack flexibility and adaptability to uncertain conditions in the environment.

Agile project management is an iterative approach to delivering a project throughout its life cycle. Originally, it was developed for software development projects, but now it has other applications too. Formally, Agile was launched in 2001 when 17 technologists drafted the Agile manifesto [15]. They wrote four basic principles for Agile project management, intended to guide teams on developing effective software projects. However, in practice the roots of agile philosophy dates back to the late 40s early 50s of the last century. In general, this approach is structured, iterative, and adaptive to business planning and managing project process which, unlike the traditional approach, suggests simultaneous execution of non-dependable activities which can be done in parallel providing flexibility to the project execution and ability to change processes while the project development is in progress. At the core, agile projects exhibit trust, flexibility, empowerment and collaboration. Major Agile project management methodologies include Kanban, Scrum, Scrumban, Lean, Six Sigma, Extreme Programming (XP), Crystal and others. (Fig. 4)

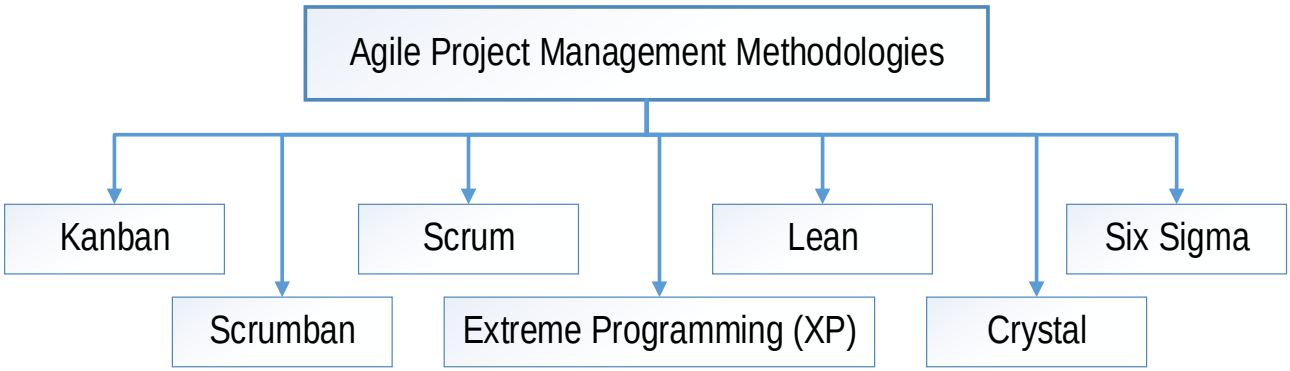


Figure 4 – Agile project management methodologies
Source: compiled by the authors

Kanban is a visual means to design, manage, and improve flow systems for knowledge work which uses Kanban boards depicting the workflow by splitting it into three stages: requested, in progress, done. It was developed by Taiichi Ohno, a Japanese industrial engineer, in 1953 for effective inventory management and later extended on other industries including IT-development [1]. This method does not have a strictly designed process rather focused on the most significant tasks. The major advantage of the method is its simplicity and transparency to implement. Other advantages may include improved predictability, customer satisfaction, and quality management. However, the method is not suitable for dynamic settings, as it does not show the timeframes for individual activities. In addition, failure to keep the Kanban board up-to-date may cause serious miscommunication within the team resulted in further failure in the project execution. This methodology works best for the small project teams collaborating remotely, having many incoming requests that vary in priority and size.

The term Scrum ,as related to project management, was introduced by Hirotaka Takeuchi and Ikujiro Nonaka in 1986 [5].Then in the early 1990s Ken Schwaber and Jeff Sutherland developed it further to help organisations struggling with complex projects [6]. Scrum methodology emphasises empirical observations and formulates six basic principles : control over the empirical process, self-organisation, collaboration, value-based prioritization, time-boxing and iterative development.

The Scrum methodology involves the use of short "sprints" from which the project cycle is formed. These intervals last from one to two weeks and are designed for teams of 10 people at most. This is the main difference from the Waterfall methodology, where individual tasks are linked to each other by dependencies. The advantages for the method involve its high adaptability and flexibility, encouraging creative working environment, reduced documentation, and improved quality work and customer satisfaction. The disadvantages of the method lie in its focus on individual tasks rather than on the overall project deadline making it difficult to integrate with the traditional project management approach, and requires extensive training of the personnel. The Scrum methodology works best for a wide variety of environments and situations that do not initially have clearly identifiable requirements and require a flexible approach.

Scrumban merges the structure and predictable routine of Scrum with Kanban's flexibility and represents an effective tool for handling large projects by splitting them into smaller chunks. It was first introduced by Corey Ladas in 2008. The advantages of this method is that it enforces transparency, provides effective handling of bottlenecks, implies less control from team managers and reduces the volume of documentation. However, elimination of daily meetings from the routine schedule complicates evaluation of individual efforts and contribution. The Scrumban methodology is a great solution for teams that are looking to structure to their Kanban project management, or for teams looking for a slow transition from Scrum to Kanban.

Lean agile methodology is aimed at eliminating waste and creating a simple project structure. Ultimately, this means being able to do more with fewer resources to improve the efficiency and quality of teamwork. . Lean manufacturing principles were first established and developed by Toyota in the 1950s and applied in the 1970s to combat the energy crisis. Waste reduction was originally applied to physical products. This idea was further extended to project management by James P. Womack and Daniel T. Jones , who introduced five principles which can be used to apply the lean concept to project management in their book "Lean Thinking" published in 1996 [9]. Nowadays this term implies to wasteful ways of doing work. The goal of lean project management is to maximize value while minimizing waste. It is based on three fundamental principles: delivering value as defined by the customer, eliminating waste, and continuous improvement. The concept of Lean was targeted on eliminating three types of deviations that demonstrate inefficient allocation of resources represented by three letters Ms referring to the Japanese words Muda (waste), Mura (unevenness), Muri (overburden). The advantages of the Lean methodologies represent cost reduction, customer interaction enforcement and increased quality. However, it may lead to inventory problems due to low amount of stocks, high implementation costs, and challenges during the transition period of shifting to Lean management. It is recommended for teams experiencing efficiency problems. In general, projects teams of different sizes can benefit from this method.

The Six Sigma, introduced by Bill Smith and Mikel Harry in 1986, focuses on understanding customers' requirements, continuous improvement and eliminating defects and waste [11]. These objectives can be achieved through profound knowledge of statistics, engineering and scientific management. It is often referred to as a philosophy rather than a methodology. The main advantage of Six Sigma is that it is customer driven and considers the entire process of the project from the raw materials to the final product rather than just final product. The disadvantages may include a requirement for extensive training for employees, processing large amounts of data resulting in increased overall costs. Six Sigma perfectly suits large organizations with

hundreds of employees where the need to complete projects without waste becomes an important factor for the organization.

Crystal is an agile framework concentrated on individuals and their interactions rather than processes and tools. It is a direct outgrowth of some values outlined in the Agile Manifesto. It was developed by Alistair Cockburn for IBM in 1991 and included guidelines for team collaboration and communication [12]. The Crystal framework is based on two beliefs:1) teams can find ways on their own to improve and optimizes the workflow, and 2) every project is unique and continually changing so the project's team is the best to decide how to cope with it. The advantages of this approach include the following: teams are free in making decisions; teams may respond well to the changing environment; facilitates direct team communication, transparency and accountability. However, lack of pre-defined plans may lead to scope slow down, and lack of documentation may cause confusion in understanding. This method is ideal for experienced and autonomous development teams.

Extreme programming (XP), introduced by Kent Beck in the 1990s, is a people driven approach rather than process driven approach which allows changing the project plan, budgets and final outcome at any stage of the project development in order to fit the changing needs [7]. This method is widely applied in IT-development industry. The main advantage is that XP significantly saves costs and time required for project realization because project teams do not use much documentation rather come to solutions through discussions within the team. Other advantages of this methodology involve its simplicity as developers use very simple quickly updatable solutions; visibility and accountability of the whole process during the project; improved employees' contribution and satisfaction.

Table 2 summaries the features of the most suitable projects of the given Agile methodologies in project management.

Table 2 – Summary of suitable project characteristics for Agile methodologies

Method	Suitable project characteristics
Kanban	Projects require quick changes , requirements vary in priority and size; projects are developed for both service and industry by collaborative teams
Scrum	Medium or large size complex projects with changing requirements; the projects can be developed by a collaborative cross-functional small project teams; effective for remote collaborative teams
Scrumban	Projects where difficult to predict the amount of work to be performed; ongoing project chores in uncertain environment; effective for remote collaborative teams
Lean	Complex projects within large organizations where efficiency issues are critical
Six Sigma	Complex projects for large organizations employing hundreds of people where waste free performance is critical.
Crystal	Short-term projects that require rapid delivery of the projects; long-term projects with frequent testing and feedback; project teams of highly experienced professionals
Extreme programming (XP)	Complex projects with uncertain and unpredictable factors and tight deadlines.

Source: compiled by the authors

The disadvantage of this methodology is that it assumes high speed of work and stressful environment that may result in employees' exhaustion; less attention to processes may result in defects and quality requirements violation; lack of

documentation may lead to unexpected untraceable failures in the future.

The XP method is used for dynamic projects with tight deadlines; work is carried out within short development cycles with many releases. This approach results in high productivity and short lead times.

The variety of the current agile methodologies and their continual growth demonstrate the demand for high level of adaptability of project execution to both changing environments and changing project requirements in on-going projects. Every methodology has very specific areas of application which are limited by project scale, time restrictions, proficiency level of collaborating teams, resource management requirements, desired productivity level, industry type etc.

Hybrid project management methodologies benefit from the rigid structure of the sequential (traditional) approach and the flexibility of the Agile approaches. PMBOK®, PRINCE2 and Spiral represent some of the most popular hybrid approaches in project management. (Fig. 5)

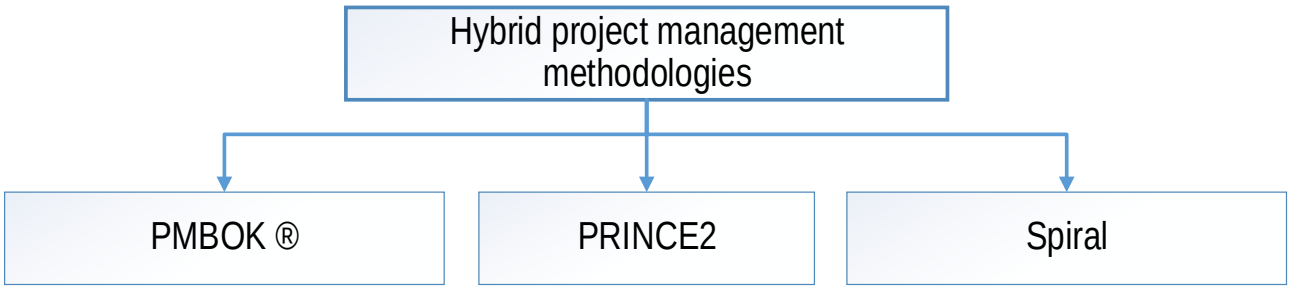


Figure 5. Hybrid project management methodologies
Source: compiled by the authors

In general there are many more approaches which can be classified as hybrid, but this research is limited to the ones listed above.

The Project Management Body of Knowledge (PMBOK®) methodology represents a modification of a traditional approach enhanced by agile insertions. It is a document containing standard terminology, best practices and process guidelines around project management as defined by the Project Management Institute (PMI). It dates back to 1969 when the Project Management Institute (PMI) was founded. In 2021 the organisation published the seventh edition, the latest version, of the guide. While the traditional approach follows the PDCA (Plan-DO-Check-Act) workflow management processes developed by M. Porter, PMBOK involves five processes that include Initiating-Planning- Executing – Controlling and Monitoring – Closing. Figure 5 depicts the workflow process with implied PMBOK® methodology.

Unlike the traditional approach, the five processes in PMBOK® may overlap and interact throughout the project. In addition, PMBOK® implies three main categories on key aspects of the project: core areas, facilitating areas and coordination areas which facilitate managing the five processes effectively. The main advantage of PMBOK® is that it is a guide prepared by management professionals which introduces the best insights and practices in a standardised manner; it is regularly updated and suits for any team with disregard of the organisation size of industry. The PMBOK® Guide can be used as a basis for developing an own approach to project management.

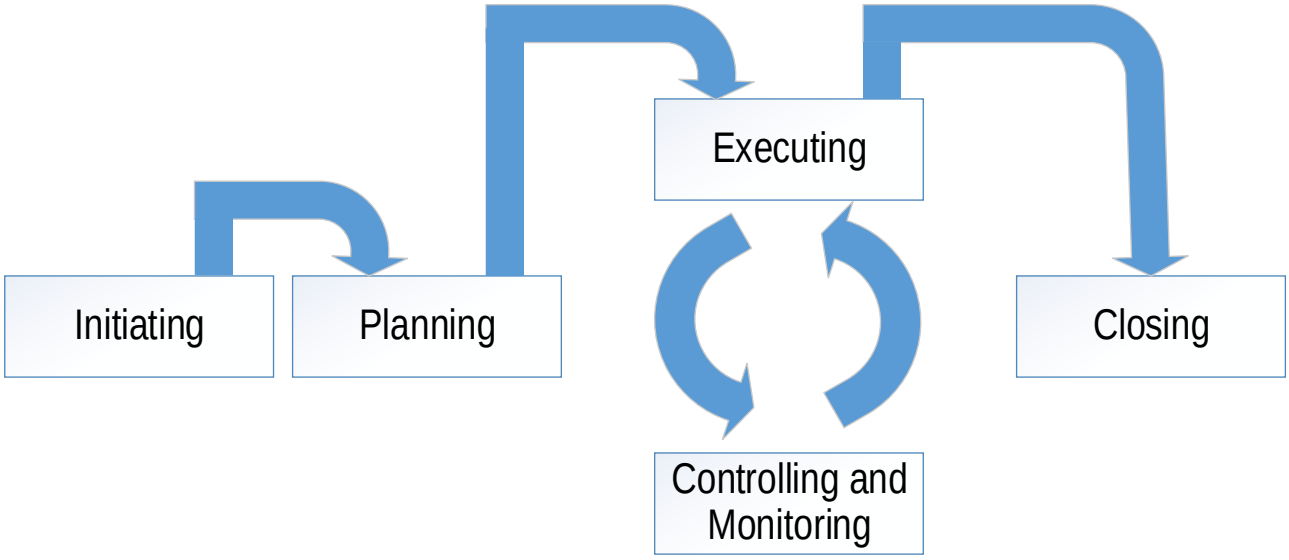


Figure 5 – The core project management processes defined by PMBOK®
Source: updated from [14]

PRINCE2 (the acronym stands for "PRojects IN Controlled Environments") is one of the most widely practiced project management methodology worldwide. Initially it was developed in the late1980s by the UK Government in order to manage IT-teams and was named PRINCE. It was reviewed in 1996 and received the current name of PRINCE2. The methodology emphasises organisation and control and represents a linear and process-based framework, focusing on moving initiatives through predefined stages [16]. Like in the traditional methodology, the records from every stage are documented into six reports to the project board and help to stay organized and on track. Like in the Scrum Agile approach, the project people are assigned three main roles, six supplementary roles and uses both qualitative and quantitative measures of performance. The controlled performance targets comprise the following variables: Time, Cost, Quality, Scope, Benefits, Risks which form a comprehensive project management process with clearly defines roles. This is an effective methodology for implementation of corporate projects, individual project tasks including milestone control, product transfer management and project initiation and closure. The advantages of this methodology involve its worldwide recognition; completeness as it combines agile and traditional approaches; principles are universal and applicable to projects of any scale; adaptable, enables effective communication with stakeholders and teammates. The disadvantages include its limitation to technical skills and neglecting soft skills; unlike PMBOK® which introduces over 100 project management techniques, it is limited to two techniques; the method assumes a lot of documentation to maintain and adapt. This method works best for large enterprises with a great number of stakeholders.

Spiral, introduced by Barry Boehm in 1986, is the most preferred SDLC (Systems Development Lifecycle) model for long-term and high-risk software development projects [13]. It combines prototyping and architecture in phases and functions as a synergy of the Waterfall and Agile models because shifting to the next phase is performed according to the initial plan even if the previous phase has not been completed yet. The model involves a repetitive cycle which executes the phases repeatedly until the project is fully completed. Figure 6 visualises the iterative implementation process of the Spiral model.

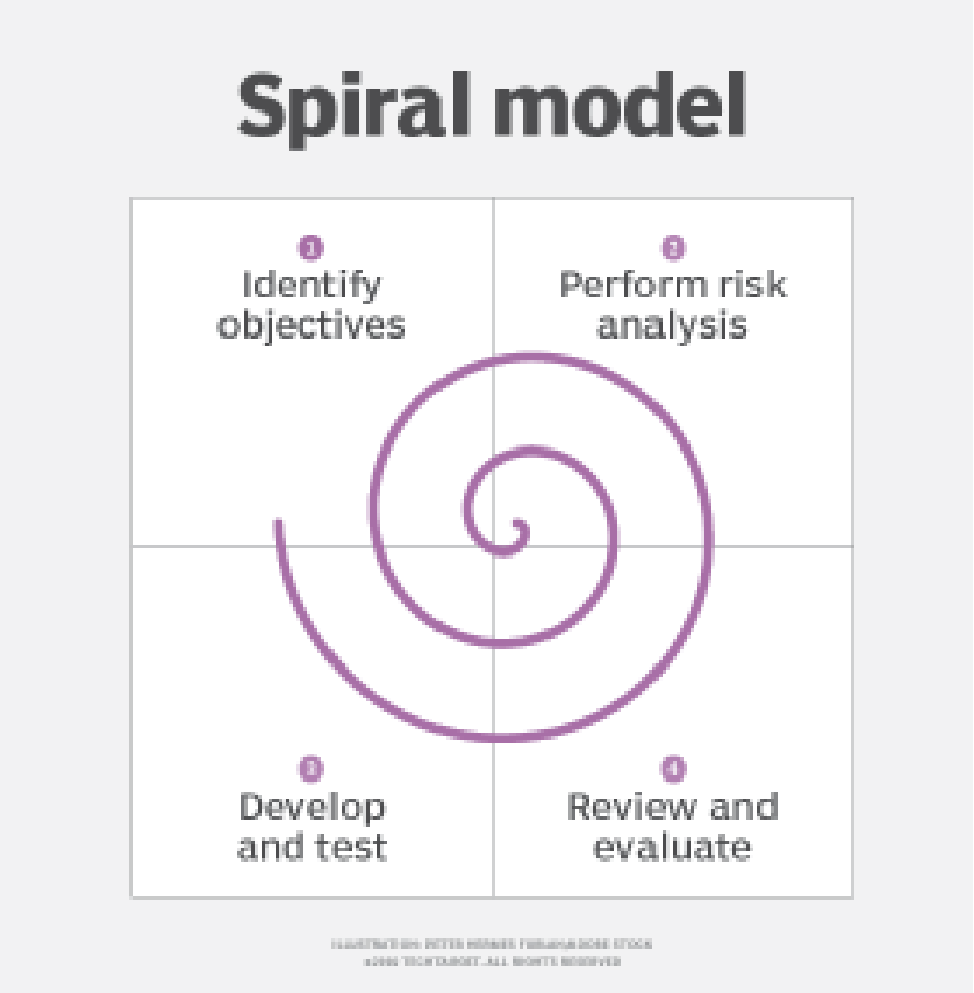


Figure 6. Spiral model diagram
Source: [22]

The obvious advantage of the model is its flexibility to possible changes followed by risk handling at every phase and increased customer satisfaction as the model facilitated customer feedback. The disadvantages may include high costs, which makes it unfavorable for small projects, dependence on risk analysis, complexity and inefficient time management.

Table 3 summarizes the features of the most suitable projects of the given Hybrid methodologies in project management.

Table 3 – Summary of suitable project characteristics for Hybrid methodologies

Method	Suitable project characteristics
PMBOK®	Standard projects with small teams; large projects in combination with other PM methods
PRINCE2	Large and complex enterprise projects with a great number of stakeholders and initially well-defined goals; avoid for small projects
Spiral	Perfect for large expensive and complicated projects in IT industry

Source: compiled by the authors

The research shows that hybrid approaches in project management are applicable to large-scale complex projects which incorporate high costs and consider a

variety of stakeholders, the feature deemphasized while applying consistently traditional or agile approaches.

Conclusions. Project management methodologies do not represent an established permanent know-how tool rather a flexible and continually modified and updated framework which success is assessed from three perspectives – stakeholder, project team and end user. The most used methodologies can be categorized as sequential/traditional/classical and iterative/flexible/agile. The traditional approaches (Waterfall, Critical Path/PERT Methods, Critical Chain Method) were established for product-oriented projects and did not involve stakeholders and end users during the development and implementation phases as they had clearly stated objectives, task wordings and stable precedence of activities. These methods are vulnerable to uncertain and unexpected factors as they lack flexibility during the development and implementation stage. These methods work effectively for projects with easy identifiable deliverables during the planning stage, complex projects with limited resources or projects with independent activities which durations easy to predict where delivery terms and deadlines are critical. Agile project management methodologies gain more and more popularity for both IT-related and non-IT-related industries as they are more client oriented, satisfy the interests of the three parties of the project and allow flexible and changes in on-going projects. They work best in applications related to projects requiring quick changes, which vary in priority and size; complex projects influenced by uncertain and unpredictable factors and involving cross-functional collaborative teams working remotely. The major popular Agile methodologies are represented by Scrum, Kanban, Scrumban, Lean, Six Sigma, etc. Nowadays, there is a steady trend of implementing hybrid methodologies which combine the benefits and transparency of traditional approaches and flexibility of agile approaches. They are represented by PMBOK®, PRINCE2, Spiral and others. The latest statistical data demonstrate a growing popularity of the latter ones as they can be used for large complex projects with a great number of stakeholders. Generally, the selection of the most suitable project management methodology depends not only on the industry type rather on the project features, size and priorities.

References

1. Ohno, Taiichi, Toyota Production System: Beyond Large-Scale Production, Productivity Press; Philadelphia, USA – 1988 – 176 p.

2. Royce, W.W. Managing the Development of Large Software Systems. Proceedings of IEEE WESCON, 26,-1970, pp. 328-388

3. James E. Kelly, Morgan R. Walker, Critical-path planning and scheduling, Association for Computing Machinery, IRE-AIEE-ACM'59 (Eastern), New York, NY, USA – 1959, pp. 160-173. (doi.org/10.1145/1460299.1460318)

4. Eliyahu M. Goldratt. Critical Chain : A Business Novel, Taylor&Francis Ltd., Oxford, Unitied Kingdom, 1997, 260 p.

5. H. Takeuchi, I. Nonaka. The New Product Development Game, Harvard Business Review 64(1),1986, pp. 137-146

6. J. Sutherland and K. Schwaber, The Scrum Papers: Nuts, Bolts, and Origins of an Agile Method. Boston: Scrum, Inc., 2007

7. K. Beck, Extreme Programming Explained: Embrace Change. Boston: Addison-Wesley, 1999.

8. L. Corey, "Scrum-ban". Lean Software Engineering. Modus Cooperandi Press, Seatle, WA, USA – 2009

9. J.P. Womack, D.T. Jones. Lean Thinking: Banish Waste and Create Value in Your Corporation. Journal of Operational Research Society. Nov. 1, 48(11) 1997, pp. 1148

10. Harry, Mikel J. (1988). The Nature of six sigma quality. Rolling Meadows, Illinois: Motorola University Press. p.25

11. B. Smith, "Six-sigma design (quality control)," in IEEE Spectrum, vol. 30, no. 9, pp. 43-47, Sept. 1993, doi: 10.1109/6.275174

12. Alistar Cockburn. Crystal Clear: A Human-Powered Methodology for Small Teams: A Human-Powered Methodology for Small Teams, Addison-Wesley Professional; 1st edition (October 19, 2004)

13. B. Boehm. A Spiral model of software development and enhancement. ACM SIGSOFT Software Engineering Notes, vol. 11, Issue 4, August 1986, pp. 14-24 (doi.org/10.1145/12944.12948)

14. Project Management Institute. A Guide to the Project Management Body of Knowledge (PMBOK Guide). 7th ed., Project Management Institute, 2021.

15. Beck, K., et al. The Agile Manifesto. Agile Alliance. - References - Scientific Research Publishing- 2001

16. Colin Bentley. PRINCE2 Practical Handbook. Book, 3rd edition, Elsevier Ltd-2009

17. What Is Prince2? PRINCE2 Definition, Retrieved from http://prince2.com/what-is-prince.asp. July 12, 2022

18. Shamim, D. M. . (2022). Exploring the Success Factors of Project Management. American Journal of Economics and Business Management, 5(7), 64–72. Retrieved from https://www.grnjournals.us/index.php/ajebm/article/view/1314 on July 25, 2022

19. Jitpaiboon, T., Smith, S. M., & Gu., Q. (2019). Critical Success Factors Affecting Project Performance: An Analysis of Tools, Practices, and Managerial Support. Project Management Journal, 50(3),pp. 271-287. doi:10.1177/8756972819833545

20. Komus, A., & Kuberg, M. (2020): Result Report: Status Quo (Scaled) Agile 2019/20, 4th International Survey–Benefits and Challenges of (Scaled) Agile Approaches, Koblenz, Retrieved from https://scrumorg-website-prod.s3.amazonaws.com/drupal/2020-02/Result%20Report-SQA-public-v1.0%20%281%29.pdf on July 25th, 2022

21. Ushmani F. Critical Chain Method in Projects. Oct.3, 2021. Retrieved from https://pmstudycircle.com/critical-chain-method-ccm-in-project-management/ on July 25th 2022.

22. Search Software Quality: Spiral Model. TechTarget. Retrieved from https://www.techtarget.com/searchsoftwarequality/definition/spiral-model on July 29, 2022.