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Ανάπτυξη Ψηφιακής Πλατφόρμας Διαχείρισης Έργων με Χρήση Earned Value Management για Μικρομεσαίες Επιχειρήσεις

ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ

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DEVELOPMENT OF A DIGITAL PROJECT MANAGEMENT PLATFORM USING EARNED VALUE MANAGEMENT FOR SMALL AND MEDIUM-SIZED ENTERPRISES

MASTER THESIS

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<u>Υπεύθυνη Δήλωση</u> *: Βεβαιώνω ότι είμαι συγγραφέας αυτής της διπλωματικής εργασίας και ότι κάθε βοήθεια την οποία είχα για την προετοιμασία της, είναι πλήρως αναγνωρισμένη και αναφέρεται στη διπλωματική εργασία. Επίσης έχω αναφέρει τις όποιες πηγές από τις οποίες έκανα χρήση δεδομένων, ιδεών ή λέξεων, είτε αυτές αναφέρονται ακριβώς είτε παραφρασμένες. Επίσης βεβαιώνω ότι αυτή η διπλωματική εργασία προετοιμάστηκε από εμένα προσωπικά ειδικά για τις απαιτήσεις του Μεταπτυχιακού Προγράμματος Σπουδών Διοίκηση και Ψηφιακός Μετασχηματισμός του Τμήματος Διοικητικής Επιστήμης και Τεχνολογίας του ΕΛΜΕΠΑ.*

Περίληψη

Η παρούσα διπλωματική εργασία εξετάζει την ανάπτυξη μιας ψηφιακής πλατφόρμας διαχείρισης έργων για μικρές και μεσαίες επιχειρήσεις (ΜΜΕ), η οποία ενσωματώνει βασικές λειτουργίες του Earned Value Management (EVM). Σκοπός της εργασίας είναι η δημιουργία μιας προσβάσιμης, χαμηλού κόστους και εύχρηστης λύσης που υποστηρίζει την οργάνωση έργων, την παρακολούθηση εργασιών και προθεσμιών, την καταγραφή κόστους και την αξιολόγηση της απόδοσης έργων ως προς το κόστος και το χρονοδιάγραμμα.

Αρχικά, παρουσιάζονται οι βασικές αρχές της διοίκησης έργων και της μεθόδου Earned Value Management. Το EVM επιτρέπει την ταυτόχρονη παρακολούθηση της προγραμματισμένης αξίας εργασίας (Planned Value – PV), της κερδισμένης αξίας (Earned Value – EV) και του πραγματικού κόστους (Actual Cost – AC). Με βάση αυτά τα δεδομένα υπολογίζονται οι δείκτες Schedule Performance Index (SPI) και Cost Performance Index (CPI), οι οποίοι χρησιμοποιούνται για την εκτίμηση της αποδοτικότητας κόστους και της τήρησης του χρονοδιαγράμματος.

Για την πρακτική εφαρμογή αναπτύχθηκε ένα no-code πρωτότυπο στην πλατφόρμα Airtable. Το prototype οργανώνει τα δεδομένα σε τρεις συνδεδεμένες οντότητες: Projects, Milestones και Tasks. Επιτρέπει την καταχώριση έργων, οροσήμων, εργασιών, ποσοστού προόδου, προγραμματισμένου κόστους, πραγματικού κόστους και προθεσμιών. Επιπλέον, περιλαμβάνει προβολές για την παρακολούθηση της κατάστασης των εργασιών, των καθυστερήσεων και των εργασιών που υπερβαίνουν τον προϋπολογισμό, καθώς και μια διεπαφή EVM Review για την αυτόματη παρουσίαση των δεικτών PV, EV, AC, CPI και SPI.

Η λειτουργική αξιολόγηση έδειξε ότι η πλατφόρμα μπορεί να μετατρέπει ενημερώσεις σε επίπεδο εργασίας σε αυτόματα ανανεωμένη πληροφόρηση σε επίπεδο έργου. Συμπερασματικά, το Airtable μπορεί να αποτελέσει μια πρακτική και οικονομική λύση για ΜΜΕ που επιθυμούν βασική παρακολούθηση κόστους, προόδου και χρονοδιαγράμματος, χωρίς την πολυπλοκότητα εξειδικευμένων εταιρικών συστημάτων.

Λέξεις Κλειδιά : Διοίκηση Έργων, Earned Value Management, Airtable, Μικρές και Μεσαίες Επιχειρήσεις, No-Code Πλατφόρμα, Παρακολούθηση Κόστους, Παρακολούθηση Χρονοδιαγράμματος, Δείκτες CPI και SPI

Abstract

This dissertation examines the development of a digital project management platform for small and medium-sized enterprises (SMEs) that integrates core Earned Value Management (EVM) functions. The aim of the study is to create an accessible, low-cost and user-friendly solution that supports project organization, task and deadline monitoring, cost recording, and project performance assessment in relation to cost and schedule.

Initially, the study presents the fundamental principles of project management and Earned Value Management. EVM enables the simultaneous monitoring of Planned Value (PV), Earned Value (EV) and Actual Cost (AC). Based on these data, the Cost Performance Index (CPI) and the Schedule Performance Index (SPI) are calculated in order to assess cost efficiency and adherence to the project schedule.

For the practical implementation, a no-code prototype was developed using Airtable. The prototype organizes data into three connected entities: Projects, Milestones and Tasks. It enables users to record projects, milestones, tasks, progress percentages, planned costs, actual costs and deadlines. In addition, it includes views for monitoring task status, delays and tasks that exceed their planned budget, as well as an EVM Review interface for the automatic presentation of PV, EV, AC, CPI and SPI indicators.

The functional evaluation showed that the platform can transform task-level updates into automatically updated information at project level. In conclusion, Airtable can provide a practical and cost-effective solution for SMEs seeking basic monitoring of cost, progress and schedule performance without the complexity of specialized enterprise project management systems.

Key Words: Project Management, Earned Value Management, Airtable, Small and Medium-Sized Enterprises, No-Code Platform, Cost Monitoring, Schedule Monitoring, CPI and SPI Indicator

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Συντομογραφίες

- AC – Actual Cost
- BAC – Budget at Completion
- CPI – Cost Performance Index
- CV – Cost Variance
- EAC – Estimate at Completion
- ETC – Estimate to Complete
- ERP – Enterprise Resource Planning
- EV – Earned Value
- EVM – Earned Value Management
- PV – Planned Value
- SME – Small and Medium-sized Enterprise
- SMEs – Small and Medium-sized Enterprises
- SPI – Schedule Performance Index
- SV – Schedule Variance

Chapter 1: Project Management: Concepts, Methodologies and Control Practices

Introduction

Project management supports the planning, coordination and control of activities that are undertaken to achieve defined project objectives. In practice, project managers must monitor progress, costs, deadlines, resources and risks in order to identify deviations from the approved plan and take corrective action when necessary. This need is particularly important for small and medium-sized enterprises (SMEs), which often operate with limited resources and may not have access to specialised project-control systems.

The existing literature examines project management from several perspectives. Studies on project management discuss traditional, Agile and hybrid methodologies, planning and scheduling techniques, project-manager competencies and risk management. A further body of literature focuses on Earned Value Management (EVM) as a method for integrating scope, schedule and cost information in order to measure project performance. EVM research commonly examines its core variables, performance indicators, forecasting capabilities and limitations. In addition, recent studies consider the use of digital and no-code platforms as accessible solutions that can support the organisation, monitoring and control of projects, particularly in organisations with limited technical and financial resources.

However, SMEs may face practical difficulties when applying EVM through manual calculations or multiple spreadsheets. The collection of task-level cost and progress data, the calculation of performance indicators and the preparation of project-level reports can be time-consuming and may create risks of inconsistency or data-entry errors. Therefore, there is a need for practical digital solutions that can combine basic project-management functions with accessible EVM-based monitoring.

The aim of this dissertation is to design, implement and functionally evaluate an Airtable-based no-code project management prototype that incorporates core Earned Value Management principles for SMEs. The prototype uses linked Projects, Milestones and Tasks records to support project organisation, task management, deadline monitoring, cost recording and progress tracking. Task-level information is aggregated at project level in order to calculate and present Planned Value (PV), Earned Value (EV), Actual Cost (AC), Schedule Performance Index (SPI) and Cost Performance Index (CPI). The platform also includes operational views that assist users in identifying delayed or over-budget tasks.

The dissertation is organised into five chapters. Chapter 1 presents the main concepts, methodologies, tools and risk-management practices of project management. Chapter 2 examines the principles, variables, indicators, limitations and digital application of Earned Value Management. Chapter 3 describes the requirements, design and Airtable configuration of the proposed prototype. Chapter 4 presents the implementation and functional evaluation of the platform through operational views, EVM calculations and a dynamic update scenario.

Finally, Chapter 5 summarises the main findings, contribution, limitations and potential future development of the study.

1.1 PM Definition

Project management is the application of knowledge, skills, tools, and techniques to projects. A project is described as " a temporary endeavor undertaken to create a unique product, service, or result ." It consists of work that has "a unique set of processes, which have start and finish dates, undertaken to achieve an objective ." It involves applying a range of knowledge, skills, tools, and techniques to manage project activities, with the aim of achieving the defined objectives while working within constraints of time, cost, scope, quality, and risk (Čabarkapa, 2019).

Expanding on this fundamental principle, PMBOK suggests a framework through which the project management life cycle can be managed. This framework comprises five project process groups that provide guidelines within which any given project can be managed by an organization (Varajão et al., 2017).

1.Initiating	defines and authorizes a project or a specific project phase
2. Planning	objectives are established and the actions needed to accomplish them and deliver the required scope are identified
3. Executing	implements the project management plan by assembling resources and people
4. Monitoring and Controlling	identifies variances, and facilitates corrective actions to achieve project objectives
5. Closing	accepts the project deliverables and brings the project or phase to an orderly conclusion

Table 1 Five Process Groups (Abdullah et al.,2021)

These five process groups operate across ten knowledge areas-integration, scope, time, cost, quality, human resources, communications, risk, procurement, and stakeholders-thereby providing comprehensive guidance for effective project management (Cardona-Meza & Olivar-Tost, 2017).
There are different stages through which a project passes during its life cycle. Traditionally, these stages have been classified into four phases: starting, organizing, executing, and closing. However, according to the Comprehensive Project Life Cycle (CPLC), two additional stages can be included to address project complexity: Project Incubation/Feasibility and Post-Project Evaluation. While the incubation stage examines feasibility and strategic fit, the post-project stage evaluates success against several parameters. By adopting this broader life cycle approach, organizations can improve predictability and success through the standardization and control of project processes (Archibald et al., 2012).

It would be misleading to assume that the primary aim for project management is the effective execution of a project. In reality, project management also ensures alignment between projects and business strategy, thereby supporting broader organizational objectives through portfolio management and benefits realization. Strategic project management gives organizations a competitive advantage in the execution of business strategies and long-term

initiatives (Petrović et al., 2014). To manage organizational complexity effectively, project managers must adopt dynamic planning methods that incorporate major determinants of project success (San Cristóbal et al., 2018). Integrating benefits management frameworks further enhances project success because it enables project managers to focus on actual business value rather than only on project outputs (Gomes & Romão, 2016).
Having clarified how projects are defined and structured across their life cycle, the next step is to examine which project management approaches can be applied in practice to manage them

1.2 Project Management Methodologies: Traditional, Agile & Hybrid Approaches

Traditional methodology: The Waterfall model

One of the oldest and historically most influential software development frameworks is the Waterfall model. As noted by Saravanos (2025a), the origins of the Waterfall model predate Royce's well-known 1970 paper and can be traced to Herbert D. Benington's 1983 presentation Production of Large Computer Programs, which described a nine-step linear process inspired by the SAGE defense program. Royce's 1970 paper later became the dominant point of reference in the literature. Importantly, Saravanos (2025a) argues that Royce's original model was later oversimplified and misquoted, since Royce himself warned that a purely sequential model was risky and invited failure. The rigid single-pass model commonly called "Waterfall" was later reinforced by U.S. Department of Defense standardization. A second review by Saravanos (2025b) shows that later empirical studies often rely on simplified versions of the model rather than Royce's original sequence.

The Waterfall model is most suitable for projects whose specifications are clearly specified, stable, and remained same during development. Based on empirical studies and practitioner experience, this approach is particularly appropriate for the following situations:

- Projects with fixed contractual commitments, such as government, aerospace, or defense systems.
- Projects that can be completed in a relatively short period , where the administrative cost of phase management remains proportionate.
- Projects characterized by strict sequencing and strong dependencies among deliverables.

Advantages

The following are some of the structural benefits of the Waterfall model due to its planning orientation:

- Predictability and controllability: Because scope, cost, and time are defined at the initial stages, management can monitor project progress against predetermined milestones
- Documentation: Formal documentation is created throughout each phase of the project
- Minimal dependency on the client: When requirements are approved, the rest of the work can proceed with minimal client input (Reiff & Schlegel, 2022)

- Accountability: Clearly defined roles, deliverables, and end-of-phase criteria facilitate communication with stakeholders (Dybå & Dingsøyr, 2008)

Disadvantages

The rigidity that makes the Waterfall model controllable is also its main limitation:

- Limited adaptability to change: Requirement changes often require formal change-control procedures, which may increase both cost and schedule overruns
- Late defect detection: Testing usually occurs after implementation, so errors introduced in earlier phases may be discovered only at the end
- Limited feedback: End users typically gain access to the product only at the end of the project cycle
- Assumption of stable requirements: The model is based on the assumption that requirements can be fully identified at the start of the project, which is not always realistic (Dybå & Dingsøyr, 2008)

Agile methodologies: Scrum and Kanban

Foundations of Agile. Agile project management introduces a more flexible alternative to conventional plan-driven approaches. It developed in response to the limitations of highly structured, documentation-heavy approaches in fast-changing and complex project environments. In February 2001, the seventeen signatories of the Manifesto for Agile Software Development "They introduced four core values:

1. Focusing more on people and collaboration than on formal processes and tools
2. giving priority to functional software rather than extensive documentation
3. emphasizing customer collaboration rather than contract negotiation
4. quickly adapt to change instead of rigidly following a plan.

These values are supported by twelve principles, including the continuous delivery of valuable software and a clear openness to changing requirements.", frequent releases through short iterations, close collaboration with business stakeholders, and a strong emphasis on technical excellence (Beck et al., 2001).

Based on a systematic review of research published between 2001 and 2021, Pacagnella Junior and da Silva (2023) identify the main benefits of agility as greater customer satisfaction, higher team productivity, better product quality, and increased adaptability. They also note that the effects of agile adoption depend heavily on contextual factors such as team size, project type, and organizational culture. In a more recent systematic literature review, Dong et al. (2024) define agile project management as an iterative, team-based approach characterized by flexibility, stakeholder collaboration, and adaptive planning.

Scrum: Roles and ceremonies

Scrum is one of the most widely used Agile frameworks in practice. It organizes work into iterative and time-boxed sprints, usually lasting from two to four weeks, during which a cross-functional and self-organizing team develops potentially releasable product increments. Scrum typically includes the following roles:

- Product Owner manages and prioritises the Product Backlog, ensuring that backlog items are clearly specified, readily accessible, and oriented towards maximizing the return on investment of the development effort.

- Scrum Master acts as a servant leader who supports adherence to Scrum principles, coaches team members, and helps to remove organizational impediments. An empirical study involving 5000 developers and 2000 Scrum teams found that team autonomy and continuous improvement are key indicators of Scrum team effectiveness (Stray et al., 2023).
- Development Team: A self-organizing and cross-functional group, usually consisting of 3 to 9 members, responsible for developing the product increment.

There are five main ceremonies in Scrum:

1. Sprint Planning Meeting: User stories are selected from the product backlog by the team for the next sprint and a sprint goal is defined.
2. Daily Stand-up Meeting (Daily Scrum): A 15-minute meeting held every day, where the team members discuss their progress and impediments.
3. Sprint Review Meeting: At the end of the sprint, the work done by the team is presented to the stakeholders.
4. Sprint Retrospective Meeting: The team reviews its process of work and makes improvements for the next sprint.
5. Backlog Refinement: The Product Owner and the team clarify, estimate, and prioritize backlog items.

Kanban

Kanban is an Agile-lean approach whose origins lie in the Toyota Production System and whose application to knowledge work was articulated by David J. Anderson. Unlike Scrum, Kanban does not prescribe iterations, formal roles, or fixed ceremonies. Instead, it emphasizes the visualization and optimization of workflow. Based on prior synthesis studies, the core practices of Kanban include the following:

- Visualizing the workflow on a board
- Limiting the work in progress at each step of the workflow
- Managing and measuring flow
- Clear communication of process policies
- Creating feedback loops
- Continuous improvement in a collaborative way by experimenting with small steps

Empirical evidence on Kanban is promising. Leal et al. (2018) identify four benefits with the strongest empirical support: work visibility, control of project activities and tasks, flowefficiency, and reduced time-to-market. However, resistance to transparency and the discipline required by WIP limits remain major cultural challenges. Al-Baik and Miller (2015) likewise conclude that Kanban combines agile practices and lean principles, but its success depends on organizational commitment to continuous improvement.

Hybrid approaches: Combining traditional and agile methods

Concept and rational

Hybrid Project Management (HPM) combines conventional, plan-driven methods with adaptive project management approaches. The underlying assumption is that no single methodology is optimal in every situation. By combining Waterfall and Agile

approaches, organizations can benefit from the predictability and governance of Waterfall while also retaining the flexibility and adaptability of Agile. In many cases, Waterfall is used for planning, design, and deployment, whereas development and testing are carried out through Agile sprints.

This view is supported by empirical evidence. According to a global survey of 1,168 project professionals, 89% of respondents reported using a mix of project management methodologies, indicating a shift away from reliance on a single approach. The principal reasons for adopting hybrid project management were improved resource management (88%) and greater flexibility (84%). Waterfall and Agile–Scrum/Kanban were the methodologies most commonly integrated in hybrid approaches (Nieto-Rodriguez, 2024).

Empirical studies also suggest that hybrid approaches can improve project outcomes. Krupa and Hájek (2024) identify methodological, project-related, team-related, customer-related, and organizational benefits in their systematic literature review. Survey evidence further indicates that 48% of respondents reported significant improvements in project success after adopting hybrid methods. In addition, 89% reported at least moderate improvements in team productivity, comprising 33% reporting moderate improvement, 41% significant improvement, and 15% exceptional improvement. At the same time, the principal implementation barriers were resistance to change from team members (58%) and difficulty in synchronizing different methodologies (43%) (Nieto-Rodriguez, 2024). Overall, the literature supports a contingency perspective: hybrid project management is not universally superior, but it may be especially useful in contexts of moderate to high complexity (Mitchell & Mitchell, 2024).

These methodological choices place specific demands on the people who lead projects, which makes it necessary to understand the role and competencies of the project manager.

1.3 PM Role and Skills

Project management plays a central role in delivering projects successfully, as the project manager connects project planning, team coordination, and the resolution of issues across the entire project life cycle (Alvarenga et al., 2020). In contemporary project environments, a project manager is not only responsible for administrative oversight but also for aligning project goals with execution, coordinating interdependent activities, and mitigating risks (Affandi & Nainggolan, 2026). Planning, coordination, and problem-solving can therefore be regarded as core managerial responsibilities.

In terms of competencies, research suggests that successful project delivery requires a balanced mix of technical expertise and interpersonal skills (Alvarenga et al., 2020; Sampaio et al., 2022). Hard skills include technical competence, budgeting, and scheduling, all of which are necessary to translate project requirements into feasible plans, allocate resources effectively, and monitor performance in financial and time-related terms (Alvarenga et al., 2020). These capabilities help project managers maintain control over implementation and make corrective adjustments when deviations occur.

However, the literature also shows that soft skills are critical, especially in projects characterized by complexity and collaboration (Rehan et al., 2024; Sampaio et al., 2022). Leadership enables project managers to provide direction, sustain motivation, and foster commitment under conditions of uncertainty and interdependence (Sampaio et al., 2022). Communication is equally important because it supports information sharing, stakeholder alignment, and the reduction of misunderstandings or implementation failure (Affandi & Nainggolan, 2026; Alvarenga et al., 2020). Negotiation and conflict management are likewise essential interpersonal skills in projects shaped by competing objectives, limited resources, and multiple stakeholder demands (Affandi & Nainggolan, 2026). Overall, the role of the project manager extends beyond technical control to include behavioral competence and relational leadership (Affandi & Nainggolan, 2026; Rehan et al., 2024).

Once the expectations regarding the project manager's role and skills have been clarified, it becomes important to consider the concrete tools and techniques that support them in planning, coordinating, and controlling project work.

1.4 Tools and Techniques for Project Management

Project management uses a range of systematic tools and techniques designed to facilitate project planning, coordination, and control. Common examples include the Work Breakdown Structure (WBS), scheduling techniques such as the Gantt chart and the Critical Path Method (CPM), and digital project management software used to support task coordination and control. Together, these tools contribute to clearer scope definition, better time management, more effective resource allocation, and improved communication (Kelley, 1961; Project Management Institute, 2019).

The Work Breakdown Structure (WBS) is one of the fundamental techniques used for planning where the overall project scope is broken down into smaller, more manageable parts. According to the existing literature, it is described as "a deliverable-oriented decomposition of the total project scope," which enables better project management (Project Management Institute, 2019; Tausworthe, 1980). This decomposition improves cost estimation accuracy, facilitates responsibility allocation, and supports progress control because each work package becomes more identifiable, assignable, and measurable (Tausworthe, 1980; Project Management Institute, 2019).

Scheduling is another critical element of project management because it defines the sequence of activities and their interrelationships. One of the most common scheduling tools is the Gantt chart , which presents activities on a timeline and helps managers track task durations and overlap. However, in the case of interrelated projects, the Critical Path Method (CPM) provides a better foundation for analysis in determining the order of tasks that defines the total duration of the project (Kelley, 1961). As Kelley explains, CPM was developed as a mathematical technique enabling managers to evaluate activity sequence, duration, and the effects of potential delays. In this sense, CPM helps distinguish critical from non-critical activities and supports schedule control (Kelley, 1961).

In practice, Gantt charts and CPM can be used together. The Gantt chart functions as a visual representation of the project schedule , whereas CPM helps managers understand activity

interdependencies and identify tasks that require close monitoring to avoid delays (Kelley, 1961). In addition to traditional planning tools, modern project management increasingly relies on digital platforms such as Trello, Asana , Jira, and Microsoft Project for coordination, task allocation, monitoring, scheduling, dependency identification, and resource management (Project Management Institute, 2019; Kelley, 1961).

However, even the most structured planning and scheduling techniques cannot fully eliminate uncertainty, which is why risk management has become a core component of contemporary project management practice.

1.5 Risk Management

Risk management is one of the key dimensions of project management because uncertainties can significantly affect project scope, time, cost, quality, and performance (Sanchez-Cazorla et al., 2016; Michelberger & Pató, 2021). Within this process, risk identification is a crucial first step, since risks cannot be evaluated or managed effectively if they have not first been recognized (Sanchez-Cazorla et al., 2016). Identifying potential risks usually involves a combination of structured methods and expert judgment. Common approaches include brainstorming, document review, stakeholder consultation, checklists, and risk categories that help teams identify threats from different sources and project domains (Sanchez-Cazorla et al., 2016; Ward, 1999).

Research also suggests that risk identification may be undermined by time pressure, poor communication, insufficient stakeholder involvement, and cognitive or organizational limitations that prevent key risks from being recognized (Dicks & Molenaar, 2025). For this reason, effective identification requires not only methodology but also participation from stakeholders with relevant technical and managerial knowledge (Sanchez-Cazorla et al., 2016; Dicks & Molenaar, 2025).

Once the risks have been identified, they need to be reviewed to decide which ones could have the greatest effect on the project and should be dealt with first. This is usually done by considering how likely each risk is to occur and how much it could affect the project's objectives (Ward, 1999; Michelberger & Pató, 2021). However, Ward argues that a sound assessment should also consider the timing of the risk and the feasibility of possible responses, since these factors influence how manageable the risk really is (Ward, 1999). Risk evaluation therefore supports the rational allocation of managerial attention by distinguishing tolerable risks from those that may threaten project success (Ward, 1999; Michelberger & Pató, 2021).

After prioritization, suitable responses should be developed. The literature identifies four broad response strategies: avoidance, transfer, mitigation, and acceptance (Michelberger & Pató, 2021). Avoidance tries to address the source of the risk directly or alter the project plan; transfer tries to transfer the responsibility of any adverse effects to someone else, usually through contracts and insurance; mitigation tries to minimize either the probability or impact of the risk; and acceptance is the response when the risk is insignificant, inevitable, or expensive to manage (Michelberger & Pató, 2021; Ward, 1999). Overall, effective risk management depends on the integration of risk identification, evaluation, and response

planning within a coherent decision-making framework (Sanchez-Cazorla et al., 2016; Michelberger & Pató, 2021).

In parallel with managing risks, project managers must also ensure that resources and costs are controlled in a way that supports timely and efficient project delivery.

1.6 Resource and Cost Management

Resource and cost management are essential aspects of project governance because they affect work efficiency, schedule reliability, and overall project performance (Chilton, 2014; Khesal et al., 2019). With respect to human resources, effective team allocation depends on matching personnel to job demands, skills, and availability (Chilton, 2014). Uneven allocation may lead to delays and reduced efficiency, making resource planning a central managerial responsibility (Chilton, 2014).

At the same time, workload management should be seen as a shared team responsibility, rather than something that each individual has to manage alone. The literature defines team workload as the total effort required for task execution, coordination, situational response, and team maintenance processes (Kim et al., 2023). Project managers should therefore assess not only the volume of assigned tasks but also the coordination burden, communication demands, and adaptive pressures placed on the team. A more balanced workload distribution can support sustainable team functioning and strengthen the team's capacity to respond to changing conditions (Kim et al., 2023; Braun et al ., 2024).

From a financial view, effective cost management requires a reliable budget, regularly tracking spending, and taking action quickly when costs begin to deviate from the plan (Khesal et al., 2019; Rosu et al., 2018). Budgeting establishes the initial financial baseline, whereas continuous tracking enables managers to compare actual expenditures with planned performance and identify potential overruns (Rosu et al., 2018; Mahamid & Bassioni, 2012). Earned Value Management (EVM) is particularly valuable because it integrates scope, schedule, and cost into a unified control system and supports the early detection of performance deviations (Khesal et al., 2019; Mahamid & Bassioni, 2012). Recent research also highlights the importance of linking variance detection with corrective action, since the primary aim of project control is timely intervention rather than mere deviation reporting (Vanhoucke et al., 2022; Wauters & Vanhoucke, 2020).

These resource and cost decisions are closely intertwined with stakeholder expectations, making communication and stakeholder management another critical pillar of project success.

1.7 Stakeholder Communication and Management: Stakeholders, Communication Planning, and Progress Reporting

Communication and stakeholder management are critical to project success. Stakeholders are individuals, organizations, or interest groups that can influence a project or be affected by it ; they should therefore be identified early and assessed in terms of their interests, influence,

information needs, and expected degree of involvement (Turkulainen et al., 2015; Ukoha, 2022). Research shows that stakeholder communication cannot be treated as a one-size-fits-all process because strategies must vary according to stakeholder importance, project uncertainty, and decision-making needs (Turkulainen et al., 2015; Zulch et al., 2023).

The stakeholder management process begins with stakeholder mapping and analysis. At this stage, key internal and external stakeholders are identified, their power, legitimacy, urgency, and expectations are assessed, and the most appropriate approach to engagement is determined (Turkulainen et al., 2015). The literature also shows that communication gaps often emerge when project teams fail to account for stakeholders' level of knowledge, preferred communication channels, or communication context (Zulch et al., 2023; Galli, 2019). Managers must therefore not only categorize stakeholders but also adapt communication to stakeholder capacities and information requirements.

Communication planning translates stakeholder analysis into procedures for information exchange. In formal projects, clients should be informed regularly at predetermined intervals and whenever changes occur in scope, cost, schedule, or risk, since such changes influence strategic decisions about project value (Naqvi et al., 2011; Ukoha, 2022). Project teams require regular operational communication to maintain alignment, clarify roles and responsibilities, and coordinate activities (Aaltonen et al., 2016). Senior management, by contrast, should receive concise decision-oriented reports focused on progress, deviations from baselines, risks, and required managerial action (Galli, 2019). Effective communication planning should therefore specify who needs information, what information should be shared, when communication should occur, which channels should be used, and who is responsible for delivering it (Ukoha, 2022).

Progress reports are indispensable within this communication system because they provide an overview of project performance and challenges. A comprehensive progress report typically includes the reporting period, completed work, schedule and objective status, major risks and challenges, action items, future plans, and decisions required from stakeholders or management (Naqvi et al., 2011; Galli, 2019). The literature further indicates that effective reports should be clear, transparent, and audience-centered rather than overloaded with technical detail (Zulch et al., 2023; Ukoha, 2022). When combined with active listening, transparency, and regular engagement, progress reporting strengthens stakeholder trust and supports project performance (Ukoha, 2022; Naqvi et al., 2011).

Taken together, methodology, leadership, tools, risk management, resources, and stakeholder communication create the conditions under which project success can be defined and assessed at completion.

1.8 Project Success and Project Completion

Project success is not determined only by the traditional "iron triangle" of time, cost, and quality. While these criteria are still important, a project should also be assessed according to whether it achieves its intended objectives and meets the expectations of its stakeholders (Baccarini, 1999; Takim & Adnan, 2024). In this context, success criteria are the standards used to assess the project's outcome, whereas success factors are the conditions that help

produce that outcome (Baccarini, 1999). A broader perspective is therefore needed—one that combines efficiency with effectiveness in addressing the needs of the client and the wider organization (Baccarini, 1999; Takim & Adnan, 2024).

One of the main criteria of project success is the formal handover and final acceptance of deliverables by the client. Acceptance indicates that deliverables have been completed within the agreed scope and are fit for their intended purpose. It is therefore more than an administrative step at project termination; it is a substantive indication that project outputs satisfy user requirements (Takim & Adnan, 2024). Contemporary approaches to project evaluation also consider end-user acceptance and usability (Takim & Adnan, 2024).

Project closure should also include a systematic review designed to capture lessons learned. This type of review helps the team understand what was successful, where problems occurred, and what could be done better in future projects. Lessons learned are most useful when they are captured during the project, properly recorded, and shared with teams working on future projects (Lindner & Wald, 2011; Wyrozębski & Pawlak, 2021). A project may therefore be considered successful when it is completed within agreed constraints, formally accepted by the client, and reviewed in a way that generates useful knowledge for future application (Baccarini, 1999; Takim & Adnan, 2024).

Chapter 2: Earned Value Management for Project Performance Monitoring and Control

2.1 Concept and Core Principles of Earned Value Management

Earned Value Management (EVM) is a project-control method which combines scope, schedule and cost information in one framework. Its main purpose is to assess whether a project is progressing according to the approved plan. Unlike traditional project-control methods, which may examine costs and schedule progress separately, EVM compares the work that was planned, the work that has actually been completed and the resources used to complete this work. Therefore, it provides a more structured and objective view of project performance, since progress is assessed in relation to the budgeted value of completed work rather than only through expenditure or time information (Anbari, 2003; Chen and Zhang, 2012).

The main purpose of EVM is to determine whether a project delivers the expected amount of work within its approved budget and schedule. A project may appear to be progressing satisfactorily when expences remains within the available budget. However, this doesn't necessarily mean that the planned work has been completed. In the same way, a project may appear to follow its schedule while consuming more resources than initially expected. EVM addresses these issues by combining scope, cost and schedule performance in a common measurement system (Anbari, 2003; Mayo-Alvarez et al., 2022).

The basic principles of EVM are based on three main variables: Planned Value (PV), Earned Value (EV) and Actual Cost (AC). Planned Value measures the authorised budget for work planned up to a particular date, while Earned Value captures the budgeted cost of the work that has been completed in practice. Actual Cost, in contrast, represents the amount of money that has been spent to carry out that completed work. When these indicators are examined together, they provide a structured basis for assessing deviations in time and cost, helping managers recognise schedule delays or advances as well as budget overruns or savings (Kim, Wells and Duffey, 2003; Project Management Institute, 2021).

Apart from the three main variables, EVM also includes a number of performance indicators and variance measures. The most common indicators are Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI) and Schedule Performance Index (SPI). The indicators help project managers examine whether project resources are being used efficiently and whether the completed work is consistent with the approved project baseline. EVM also uses forecasting measures, such as Estimate at Completion (EAC) and Estimate to Complete (ETC), to estimate the final cost of a project based on how it is currently performing (Kim, Wells and Duffey, 2003; U.S. Department of Energy, 2017).

Therefore, EVM should not be considered only as a reporting method. It is also a predictive project-control method which can provide early warning signs when project cost or schedule performance begins to deviate from the approved plan. By identifying deviations at an early

stage, project managers can investigate their causes, apply corrective actions and provide meaningful performance information to the relevant stakeholders (Mayo-Alvarez et al., 2022; Aramali et al., 2022).

2.1.1 EVM within PMBOK Monitoring and Controlling

The importance of EVM becomes clearer when it is examined within the Monitoring and Controlling process group of project management. As noted earlier, project management involves initiating, planning, executing, monitoring and controlling, and closing a project. The Monitoring and Controlling process group is concerned with checking project performance, comparing actual results with the approved plan, and taking corrective or preventive action when needed.

Within this process group, EVM is widely recognised as an important method for monitoring and controlling project cost and schedule performance. It provides a structured way of comparing actual project progress with the approved scope, schedule and cost baselines. Instead of depending only on descriptive progress reports or expenditure records, project managers can use PV, EV and AC to obtain measurable information about project performance. In this way, deviations can be identified in a more systematic manner, and corrective action can be taken when the project no longer follows the approved baseline (Project Management Institute, 2019; Mayo-Alvarez et al., 2022).

EVM also supports effective project management. Since EVM combines scope, time and cost information, it can help managers understand whether a cost overrun is related to low cost efficiency, delayed work, inaccurate planning assumptions or changes in project scope. Therefore, EVM should not be viewed only as an additional reporting tool, but as a structured approach to project performance measurement and control (Anbari, 2003; Kim, Wells and Duffey, 2003).

A further contribution of EVM concerns project communication and reporting. Projects usually involve different stakeholders, such as project sponsors, senior managers, clients and project-team members. These stakeholders require clear and comparable information about the current project status. EVM supports this need through standardised indicators, such as EV, CPI and SPI. These measures allow project performance to be presented in a concise and consistent way, reducing reliance on subjective descriptions of project progress (Anbari, 2003; Aramali et al., 2022).

For example, a CPI of 0.90 shows that the project produces only €0.90 of budgeted value for every €1.00 spent. Similarly, an SPI of 0.90 shows that the project has completed 90% of the work that was planned at a specific control point. These indicators can help decision makers understand the importance of a project deviation more clearly than a general statement that the project is “slightly delayed” or “experiencing higher costs”. However, these indicators should always be interpreted together with other project information, such as risks, change requests, quality issues, resource availability and the critical path of the project schedule.

2.1.2 Extensions, Limitations and Contemporary Developments in EVM

Although EVM is widely used for project monitoring and control, the traditional method has also received criticism and has been further developed over time. One important limitation concerns the measurement of schedule performance. Conventional Schedule Variance and the Schedule Performance Index are expressed in currency because they are calculated using Earned Value and Planned Value. As a result, they do not show directly how many calendar days or weeks a project is delayed. In addition, the traditional SPI tends to move towards 1.00 as the project approaches completion, even when important delays still remain. Therefore, conventional EVM may not provide a complete picture of schedule performance, particularly in the final stages of a project (Lipke, 2003; Mayo-Alvarez et al., 2022).

A further limitation is that traditional EVM does not directly consider the critical path of a project. A negative Schedule Variance may indicate that less work has been completed than planned. However, the delayed activities may not necessarily affect the final project completion date. On the other hand, a small delay in a critical activity may have a significant effect on the total project duration. For this reason, EVM indicators should not be interpreted separately from the project network, the critical path and the dependencies between activities (Kerkhove and Vanhoucke, 2017; Nizam and Elshannaway, 2019).

Traditional EVM also depends on the existence of a clear, stable and controlled project baseline. Its reliability is reduced when the project scope changes frequently without formal approval or when the schedule and budget baselines are not updated consistently. In dynamic project environments, where customer requirements, technical specifications or development priorities may change, the comparison between PV and EV may become less meaningful if the original baseline no longer reflects the work that must be completed (Liu and Jiang, 2020; Safari Zarch and Mokaberian, 2026).

Data quality is another important issue in the application of EVM. EVM calculations depend directly on accurate PV, EV and AC data. If actual costs are incomplete, progress measurements are subjective or work packages are not clearly defined, the calculated indicators may provide misleading results. Therefore, the effective implementation of EVM requires objective rules for measuring project progress, reliable cost-recording procedures, clearly defined work packages and regular reporting periods (Kim, Wells and Duffey, 2003; Netto et al., 2020).

Several extensions have been developed in order to address these limitations. Earned Schedule is one of the most widely recognised approaches. It transforms earned-value information into time-based measures, allowing schedule performance to be expressed in time units instead of monetary units. Earned Duration is another approach that focuses on the duration performance of project activities and can provide additional information about the time-related effects of delays. These approaches can be particularly useful when they are used together with critical-path analysis and risk-based forecasting methods (Lipke, 2003; Mayo-Alvarez et al., 2022; Elsaid et al., 2025).

Other contemporary developments include the use of advanced performance indices, risk-adjusted forecasting methods and digital project-control systems. These developments aim to improve the reliability of EVM indicators, include uncertainty in the analysis and support more accurate project forecasts. Therefore, recent literature presents EVM not as a fixed and

isolated method, but as a set of approaches that can be developed and adapted according to the requirements of different project environments (Kerkhove and Vanhoucke, 2017; Aramali et al., 2022).

2.1.3 EVM, SMEs and Digital Project Management Platforms

The use of Earned Value Management is particularly important for small and medium-sized enterprises (SMEs) and for digital project-management platforms. SMEs often operate with limited financial resources, small project teams and less capacity to absorb cost overruns or delays in project delivery. Under these conditions, even relatively small deviations from a project budget or schedule may have important operational consequences. Therefore, SMEs can benefit from accessible project-performance information that helps managers identify problems before they become costly or difficult to manage (Johansson, 2014).

At the same time, SMEs may not have the resources, specialised staff or project-management maturity required to implement complex EVM systems manually. Spreadsheet-based calculations can be time-consuming, difficult to maintain and vulnerable to data-entry, formula and version-control errors. When an organisation manages several projects at the same time, it may become more difficult to collect accurate cost and progress information, calculate indicators consistently and prepare timely reports for management (Netto et al., 2020; Nizam and Elshannaway, 2019).

Digital project-management platforms can make the application of EVM more practical by centralising project data and automating selected calculations. A digital platform can combine task schedules, project budgets, work-package information, progress updates, time records and actual-cost data in one environment. When the platform is appropriately configured, PV, EV and AC can be recorded or calculated systematically, while CV, SV, CPI, SPI and EAC can be displayed through dashboards, and structured reports. This reduces dependence on separate spreadsheets and allows project managers to access updated project-performance information more efficiently (Oracle, 2020; Hexagon, 2024).

For SMEs, the main advantage of digital project-management tools is not necessarily the use of highly advanced analysis. Rather, it is the ability to establish a project-control process which is manageable and understandable. A user-friendly platform can help project teams create project baselines, record task completion, enter actual costs and review EVM indicators without having to develop complex spreadsheet models. In this way, EVM can become more accessible to organisations that do not have specialised project-control departments or advanced technical knowledge (Johansson, 2014; Cora Systems, 2025).

Recent developments in digital project controls have also increased the possibility of linking EVM with business-intelligence tools, risk registers, change logs and forecasting methods. This allows EVM indicators to be examined within a broader project-management context. For example, a declining CPI can be assessed together with recorded project risks, approved scope changes or resource-related issues. This can help managers identify the reasons for cost inefficiency rather than only observing the result. Similarly, an unfavourable SPI can be examined together with task dependencies and critical-path information (Galorath, 2025; Hexagon, 2024).

In relation to the present thesis, EVM has two main roles. First, it provides the theoretical basis for the integrated control of project cost and schedule within the Monitoring and Controlling process group. Second, it provides measurable indicators that can be incorporated into an accessible digital platform for SMEs. The following section examines the three basic EVM variables—Planned Value, Earned Value and Actual Cost—in greater detail before presenting the performance indicators that are derived from them.

2.2 Basic Concepts and Definitions of EVM

Earned Value Management is based on three fundamental variables that support the integrated assessment of project performance: Planned Value (PV), Earned Value (EV) and Actual Cost (AC). These variables form the basis of EVM analysis because they connect the approved project plan, the work that has actually been completed and the resources used to complete this work. Therefore, a clear understanding of PV, EV and AC is necessary before examining the variance measures, performance indices and forecasting indicators presented in the following sections (Mayo-Alvarez *et al.*, 2022; Project Management Institute, 2021). The main importance of these variables lies in their combined interpretation. Planned Value shows what should have been achieved according to the approved project baseline. Earned Value shows what has actually been achieved, while Actual Cost shows how much has been spent to achieve this result. When these measures are examined together, they provide a structured basis for determining whether the project is progressing according to plan, whether project resources are being used efficiently and whether corrective action is required.

2.2.1 Planned Value

Planned Value demonstrates the authorised budget assigned to work that is scheduled to be completed by a particular control date. In other words, PV shows the budgeted value of the activities that should have been completed according to the approved project schedule and cost baseline. Therefore, PV is based on the project plan and not on actual work progress or actual expenditure (Project Management Institute, 2021).

PV is closely connected with the time-phased performance measurement baseline. At the beginning of a project, the total approved budget is allocated across work packages, activities and reporting periods. This allocation allows project managers to identify the budgeted value of work that is planned to be completed at each control point. The resulting PV information provides the reference point against which actual project progress can be assessed.

From a project-control perspective, PV answers the following question:

What budgeted value of work was planned to be completed by this date?

For example, assume that a project has a total approved budget of €10,000 and a planned duration of five months. If the approved baseline indicates that 40% of the project work should be completed by the end of month two, the Planned Value at this control point is €4,000. This does not mean that €4,000 has already been spent. Instead, it means that the project plan expects work with a budgeted value of €4,000 to have been completed by that date.

PV is important because it establishes the expected level of project progress. Without an approved time-phased baseline, project managers cannot determine whether completed work is ahead of, behind or in line with the planned schedule. However, PV remains meaningful only when the project baseline is properly maintained. When approved changes in scope, budget or schedule occur, the project baseline should be updated through formal change-control procedures. Otherwise, the comparison between planned and actual performance may become unreliable (Liu and Jiang, 2020; Nizam and Elshannaway, 2019).

2.2.2 Earned Value

Earned Value refers to the approved budget linked to work that has been completed by a specific date. Rather than showing the amount of money actually spent, as Actual Cost does, EV expresses confirmed project progress in budget terms. It therefore shows how much of the project budget has been earned through completed work (Anbari, 2003; Mayo-Alvarez et al., 2022).

The main principle of EV is that it is calculated according to the original or formally revised project budget, rather than according to the actual cost of the work completed. For example, if a work package has a budget of €1,000 and is verified as 50% complete, its Earned Value is €500. This remains the same even if the project has spent €600 or €400 to complete that part of the work. Therefore, EV provides a common basis for comparing actual progress with planned work and actual expenditure.

From a project-control perspective, EV answers the following question:

What budgeted value of work has actually been completed by this date?

The reliability of EV depends on the method used to measure project progress. In physical projects, progress may be measured through completed quantities, installed units, approved milestones or verified deliverables. In software-development or digital-platform projects, progress can be measured through the completion of predefined tasks, approved system features, tested modules, project milestones or accepted deliverables. It is important that the progress-measurement method is defined in advance and applied consistently during the project (Kim, Wells and Duffey, 2003).

The use of subjective completion percentages may reduce the reliability of EV. For example, recording a task as 90% complete without objective evidence may create the impression that a large amount of value has been earned, even when important work is still unfinished. These methods help ensure that Earned Value reflects actual project progress rather than overly optimistic assessments.

2.2.3 Actual Cost

Actual Cost represents the amount of money that has been spent on the work completed up to a specific reporting date. AC may include direct costs, such as labour, materials, equipment, subcontracting and software licences. It may also include indirect costs where these are included in the project's cost-accounting system. Unlike PV and EV, which are based on approved budget values, AC represents the financial resources that have actually been used by the project (Project Management Institute, 2021).

From a project-control perspective, AC answers the following question:

How much has the project actually spent to complete the work performed?

For example, if a project team has paid 3,500€ for salaries, external services and software tools by the end of month two, the Actual Cost at that control point is 3,500€. This figure should be compared with EV rather than PV when examining cost efficiency. A comparison between AC and PV only indicates whether expenditure is higher or lower than planned. It does not show whether the expenditure has produced the expected amount of completed work.

Accurate AC information is necessary for reliable cost-performance analysis. If costs are recorded late, allocated inconsistently or omitted from the project-reporting system, the resulting CPI, CV and EAC calculations may be misleading. Therefore, EVM implementation requires a clear connection between the project-control system and the accounting or cost-recording process. The reporting period used for actual costs should also be consistent with the period used to measure Planned Value and Earned Value (Kim, Wells and Duffey, 2003; U.S. Department of Energy, 2017).

2.2.4 Combined Interpretation of PV, EV and AC

The importance of PV, EV and AC becomes clearer when these three variables are examined together. Planned Value shows what the project was expected to achieve by a specific date, Earned Value shows what the project has actually achieved and Actual Cost shows how much the project has spent in order to achieve this work. The relationship between these variables provides an immediate indication of the current project status.

If EV is lower than PV, the project has completed less work than originally planned and is therefore behind schedule in EVM terms. In contrast, if EV is greater than PV, the project has completed more work than planned and is ahead of schedule. Similarly, if EV is lower than AC, the project has spent more than the budgeted value of the work completed and is experiencing cost inefficiency. If EV is greater than AC, the budgeted value of the completed work is higher than the actual expenditure incurred.

The following simplified example demonstrates this relationship. Consider a digital project-management platform with a total approved budget of 10,000€. At the end of the second month, the approved baseline states that 40% of the project should be completed. Therefore, the Planned Value is 4,000€. If the project team has completed only 30% of the total work, the Earned Value is 3,000€. If actual expenditure at the same control point is 3,500€, the Actual Cost is 3,500€.

Variable	Value	Interpretation
Budget at Completion (BAC)	10,000€	Total approved project budget
Planned Value (PV)	4,000€	Work planned for completion by the end of month two

Earned Value (EV)	3,000€	Verified work completed by the end of month two
Actual Cost (AC)	3,500€	Actual expenditure incurred by the end of month two

Table 2 Example of the Combined Interpretation of PV, EV and AC

In this example, EV is lower than PV, indicating that less work has been completed than originally planned. EV is also lower than AC, showing that the project has spent more than the budgeted amount for the work completed. As a result, at this stage, the project is behind schedule and experiencing cost overruns.

This example is particularly relevant to digital project-management initiatives because software and platform-development projects often include interconnected tasks, milestones, resource inputs and changing requirements. Project managers need a structured method for comparing planned work, completed deliverables and actual expenditure. Tracking time alone is not sufficient, because the number of hours spent on a task does not necessarily prove that the expected value has been delivered. PV, EV and AC provide the basis for a more meaningful assessment of project performance.

The variables also establish the connection between EVM theory and the proposed digital-platform solution. When project tasks, budgets, planned dates, progress updates and actual costs are recorded in a structured digital environment, PV, EV and AC can be monitored consistently. This can reduce dependence on separate spreadsheet files and provide SMEs with more timely and transparent information about the current status of their projects.

Although PV, EV and AC provide the basic information needed to assess project status, their managerial value becomes clearer when they are transformed into variances, performance indices and forecasts. The following section presents the main EVM indicators derived from these variables: Cost Variance, Schedule Variance, Cost Performance Index, Schedule Performance Index and Estimate at Completion.

2.3 EVM Indicators and Performance Metrics

Based on the basic variables of Planned Value, Earned Value and Actual Cost, Earned Value Management provides a number of indicators that can be used to assess project cost efficiency, schedule performance and the likely final cost of a project. These indicators transform the differences between the approved project baseline and actual project performance into measurable variances, indices and forecasts. Therefore, they support monitoring and controlling through measurable information rather than relying only on descriptive assessments of project status (U.S. Department of Energy, 2017; Project Management Institute, 2021).

The main EVM indicators are Cost Variance, Schedule Variance, Cost Performance Index, Schedule Performance Index and Estimate at Completion. Each indicator is calculated using PV, EV, AC and, where necessary, Budget at Completion. When project data are updated regularly, these measures can provide early warning signs of unfavourable cost or schedule

trends. This allows project managers to investigate the causes of deviations before they become more difficult to control.

2.3.1 Cost and Schedule Variances

The two main variance measures used in Earned Value Management are Cost Variance and Schedule Variance. Variances show the absolute difference between planned, earned and actual values. They are useful because they indicate the monetary size of a deviation from the approved project baseline.

Cost Variance

Cost Variance is calculated as follows:

$$CV = EV - AC$$

Cost Variance shows whether the budgeted value of the completed work is higher or lower than the actual cost incurred in completing this work. A positive CV indicates favourable cost performance because the project has produced more budgeted value than the amount spent. A negative CV indicates an unfavourable cost position because the project has spent more than the budgeted value of the work completed. When CV equals zero, the project is exactly on budget for the work performed (U.S. Department of Energy, 2017).

The interpretation of Cost Variance is as follows:

$CV > 0$: The project is under budget for the completed work
$CV < 0$: The project has a cost overrun for the completed work
$CV = 0$: The project is on budge

Schedule Variance

Schedule Variance is calculated as follows:

$$SV = EV - PV$$

Schedule Variance shows the difference between the budgeted cost of work actually completed and the budgeted value of work planned for completion by the same date. A positive SV means that the project is progressing ahead of schedule, while a negative SV suggests that less work has been completed than originally planned. When SV equals zero, project progress is in line with the approved schedule baseline at that control point (Project Management Institute, 2021).

The interpretation of Schedule Variance is as follows

$SV > 0$: The project is ahead of plan
$SV < 0$: The project is behind plan
$SV = 0$: The project is on schedule according to the approved baseline

SV is expressed in monetary units rather than days or weeks. Therefore, it indicates the value of work that is behind plan, but it does not directly show the duration of the delay. To assess calendar-time delay and the possible effect on the completion date, EVM should be used together with schedule-network analysis, critical-path analysis or Earned Schedule techniques where appropriate (Lipke, 2003; Mayo-Alvarez et al., 2022).

In digital project-management environments, CV and SV can be recalculated whenever actual-cost or task-completion data are updated. This supports continuous project monitoring and helps project managers identify whether variances are improving, remaining stable or becoming more serious over time. However, the reliability of the results always depends on the quality of the underlying cost and progress data.

2.3.2 Cost and Schedule Performance Indices

While Cost Variance and Schedule Variance show deviations in absolute monetary amounts, the Cost Performance Index and Schedule Performance Index show project performance in relative terms. These indices are particularly useful when comparing performance across different project stages, work packages or projects with different total budgets.

Cost Performance Index

The Cost Performance Index is calculated as follows:

$$CPI=EV/AC$$

CPI measures cost efficiency by comparing the budgeted value of completed work with the actual cost incurred. A CPI higher than 1.00 indicates favourable cost performance because the project earns more value than it spends. A CPI below 1.00 indicates cost inefficiency because the project spends more than the value of the work it earns. A CPI equal to 1.00 indicates that the project is performing in line with its approved cost baseline (U.S. Department of Energy, 2017).

The interpretation of CPI is as follows:

$CPI>1.00$: Cost performance is favourable
$CPI<1.00$: Cost performance is unfavourable
$CPI=1.00$: Cost performance is on target
Schedule Performance Index

The Schedule Performance Index is calculated as follows:

$$SPI=EV/PV$$

SPI measures progress efficiency by comparing the budgeted value of completed work with the budgeted value of work planned for completion. An SPI higher than 1.00 indicates that the project is progressing faster than planned. An SPI below 1.00 indicates that the project has completed less work than planned. An SPI equal to 1.00 indicates that project progress is in line with the approved schedule baseline (Project Management Institute, 2021).

The interpretation of SPI is as follows:

SPI>1.00: The project is ahead of plan
SPI<1.00: The project is behind plan
SPI=1.00: The project is progressing according to plan

CPI and SPI can be presented through digital dashboards, time-series charts and project-reporting interfaces. For example, a project manager may observe whether CPI remains below 1.00 for several reporting periods or whether SPI begins to decline after a change request or a resource problem. This type of visual reporting can make EVM information easier to understand, particularly for SMEs that require concise and accessible project-control information.

2.3.3 Forecasting Indicator: Estimate at Completion

In addition to analizying current project performance, EVM includes forecasting indicators that estimate the likely final cost of a project. Estimate at Completion (EAC) is one of the most commonly used forecasting measures. EAC represents the expected total cost of the project when it is completed, based on current performance data and the forecasting assumptions selected by the project manager (U.S. Department of Energy, 2017).

A commonly used EAC formula assumes that the current cost efficiency, expressed through CPI, will continue for the remaining work of the project:

EAC=BAC/CPI

where:

BAC = Budget at Completion, which is the total approved project budget.
CPI = Cost Performance Index

If CPI is lower than 1.00, EAC will be higher than BAC. This indicates that the project is likely to exceed its approved budget if the current level of cost inefficiency continues. If CPI is higher than 1.00, EAC will be lower than BAC, which may indicate possible cost savings.

It is important to interpret this forecast carefully. EAC is not a guaranteed final project cost, it's a conditional estimate. The formula assumes that current cost performance will continue during the remaining work. If the cause of the cost variance is temporary and corrective action is successful, the final cost may be lower than the EAC. On the other hand, if the underlying issue becomes more serious, the final cost may exceed the forecast. Therefore, project managers should use EAC together with risk analysis, change-control information and an assessment of the work that remains to be completed (Project Management Institute, 2021; Nizam and Elshannaway, 2019).

Other EAC formulas may be used depending on project conditions. For example, if the original estimate is no longer valid because of major scope changes or inaccurate planning assumptions, a bottom-up estimate of the remaining work may be more appropriate. In more complex situations, project managers may also use forecasting methods that consider both

cost and schedule performance. The choice of the formula should depend on the reason for the observed variance and the reliability of the available project data.

Although EAC is an important forecasting indicator within the wider EVM framework, it is not included in the current version of the proposed Airtable-based platform. The platform focuses on the calculation and visual presentation of PV, EV, AC, CPI and SPI, together with cost and schedule status indicators. This decision was made in order to maintain a simple and understandable project-control solution for SMEs. The inclusion of EAC and other forecasting measures may be considered as a future development of the platform.

2.3.4 Summary Table of Key EVM Indicators

Table 3 summarises the main EVM indicators presented in this section.

Indicator	Formula	Interpretation
Cost Variance (CV)	CV=EV−AC	CV>0: under budget CV<0: cost overrun CV=0: on budget
Schedule Variance (SV)	SV=EV−PV	SV>0: ahead of plan SV<0: behind plan SV=0: on plan
Cost Performance Index (CPI)	CPI=EV/AC	CPI>1: cost efficient CPI<1: cost inefficient CPI=1: on target
Schedule Performance Index (SPI)	SPI=EV/PV	SPI>1: ahead of plan SPI<1: behind plan SPI=1: on plan
Estimate at Completion (EAC)	EAC=BAC/CPI	EAC>BAC: forecast budget overrun EAC<BAC: forecast cost saving

Table 3: Summary of Key EVM Indicators

As shown in Table 3, the main EVM indicators are calculated from a limited number of variables: PV, EV, AC and BAC. This relatively simple mathematical structure makes EVM suitable for digital project-management systems, provided that the platform contains accurate and consistently updated cost, schedule and progress data.

A digital platform can calculate indicators automatically, present the results through dashboards and provide notifications when performance indicators exceed predefined thresholds. In the proposed Airtable-based platform, the main focus is placed on PV, EV, AC, CPI and SPI, together with cost and schedule status indicators. Although EAC is an important forecasting measure in the wider EVM framework, it is not included in the current version of the platform. Its implementation may be considered as a future development.

The practical value of these indicators does not depend only on the calculations. CV, SV, CPI and SPI help project managers identify deviations, understand the scale of emerging problems and make informed decisions about corrective action. The following section applies these indicators to a descriptive SME website-development project in order to demonstrate

how EVM transforms project data into a structured assessment of cost and schedule performance.

2.4 Example Application of EVM in a Project: Descriptive Case

To demonstrate the practical use of Earned Value Management, this section presents a hypothetical example concerning the development of a website for a small or medium-sized enterprise.This is particularly relevant for software and digital-development projects, where progress may be more difficult to measure than in traditional construction projects because the main project deliverables are often intangible (Jun and Kim, 2008; Syahputra, Zulkarnain and Ramos, 2023).

The example also supports the main purpose of this thesis, which is the development of a digital project-management platform based on EVM principles. It demonstrates the type of project information that can be recorded in a platform such as Airtable and explains how PV, EV, AC, CV, SV, CPI and SPI can be calculated from structured project data. Although EAC is not included in the current version of the proposed platform, it may be considered as a possible future forecasting function.

2.4.1 Project Description

Consider a small or medium-sized enterprise that plans to develop a website in order to improve its online presence and communication with customers. The project includes several main phases:

- Requirements gathering and planning
- Visual design
- Front-end development.
- Content preparation and implementation
- Testing and quality assurance
- Website deployment

The approved Budget at Completion (BAC) for the project is 10,000€, while the planned project duration is four months. The project manager decides to use EVM because it provides an integrated method for monitoring project progress, cost performance and schedule performance. Instead of examining expenditure and task completion separately, the project manager can assess whether the value of the completed work corresponds to the approved budget and schedule (Mayo-Alvarez *et al.*, 2022; Proaño-Narváez *et al.*, 2022).

The selected control point is the end of month two. According to the approved project baseline, 50% of the total project work should be completed by this date. Since the total approved project budget is 10,000€, the Planned Value at the end of month two is 5,000€.

However, after reviewing the completed work, the project manager determines that only 45% of the website-development project has been completed. Therefore, the Earned Value is

4,500€. Actual expenditure for staff salaries, external design support, software tools and other project-related costs has reached 5,000€. Table 4 presents the project information at this control point.

Control data	Value
Budget at Completion (BAC)	10,000€
Planned duration	4 months
Control point	End of month 2
Planned Value (PV)	5,000€
Earned Value (EV)	4,500€
Actual Cost (AC)	5,000€

Table 4: EVM Values at the Control Point

These values can now be used to calculate the min EVM indicators presented in the previous section.

2.4.2 Calculation of EVM Indicators

The values presented in Table 4 can be used to calculate the main EVM indicators for the website-development project.

Cost Variance

Cost Variance is calculated as follows:

$$CV = EV - AC$$

$$CV = 4{,}500 - 5{,}000 = -500€$$

The Cost Variance is negative, which indicates that the project has spent 500€ more than the budgeted value of the work completed. In other words, the project has incurred actual costs of €5,000 while generating only 4,500€ of Earned Value. This represents a cost overrun at the selected control point (U.S. Department of Energy, 2017).

Schedule Variance

Schedule Variance is calculated as follows:

$$SV = EV - PV$$

$$SV = 4{,}500 - 5{,}000 = -500€$$

The negative Schedule Variance indicates that the project has completed 500€ less budgeted work than planned by the end of month two. According to the approved baseline, the project should have achieved work with a value of 5,000€. However, the verified completed work

has a value of only 4,500€. Therefore, the project is behind plan in EVM terms (Project Management Institute, 2021).

Cost Performance Index

The Cost Performance Index is calculated as follows:

CPI=EV/AC

CPI=4,500/5,000 =0.90

A CPI of 0.90 indicates that the project produces only 0.90€ of budgeted value for every 1.00€ spent. This result shows cost inefficiency. The project uses more resources than expected to complete the work performed, and the project manager should investigate the causes of this deviation.

Schedule Performance Index

The Schedule Performance Index is calculated as follows:

SPI= EV/PV

SPI=5,000/4,500 =0.90

An SPI of 0.90 indicates that the project has achieved 90% of the progress planned by the end of month two. Therefore, the project is progressing more slowly than expected according to the approved baseline. Although the delay may not be critical at this stage, it should be monitored carefully because continued schedule inefficiency may affect later project activities, including testing and final deployment.

Estimate at Completion

Estimate at Completion is a forecasting indicator that can be calculated using the following formula:

EAC= BAC / CPI

EAC=0.90/10,000 =11,111.11€

The EAC result indicates that, if the current cost-efficiency level continues, the final project cost may reach approximately 11,111.11€. It's approximately 1,111.11€ above the original approved budget of 10,000. This result should be interpreted as a conditional forecast rather than a definite final cost because it assumes that current cost performance will remain unchanged for the remaining work (U.S. Department of Energy, 2017; Project Management Institute, 2021).

Although EAC is demonstrated in this theoretical example as part of the wider EVM framework, it is not calculated in the current version of the proposed Airtable-based platform. The platform focuses on PV, EV, AC, CV, SV, CPI and SPI, as well as cost and schedule status indicators. EAC may be incorporated as a future forecasting feature.

2.4.3 Interpretation of Results

The results of the descriptive case show that the website-development project is experiencing both cost and schedule difficulties at the end of month two. The negative Cost Variance shows that the project has spent more than the budgeted value of the work completed. The negative Schedule Variance shows that less work has been completed than originally planned. In addition, both CPI and SPI are equal to 0.90, confirming that the project is performing below the expected level in relation to cost efficiency and schedule progress.

These results should be treated as an early warning signal rather than evidence that the project has failed. At the halfway point of the planned project duration, there is still an opportunity to examine the causes of the variances and introduce corrective actions. Possible causes may include underestimated design effort, unexpected client revisions, delays in the delivery of website content, inefficient allocation of development resources, unclear requirements or technical issues during implementation.

The project manager should examine the relevant work packages in order to determine whether the cost and schedule variances result from a temporary issue or represent a continuing trend. Possible corrective actions may include clarifying project scope, prioritising essential website features, improving communication with the client, reallocating resources, revising the schedule of the remaining activities or preparing a new estimate for unfinished work. If significant changes in scope or requirements have occurred, the project baseline should be revised through an appropriate change-control procedure rather than continuing to compare project performance with an outdated plan (Liu and Jiang, 2020; Nizam and Elshannaway, 2019).

The example is particularly relevant for SMEs because even relatively small deviations may have important consequences when financial flexibility is limited. An increase in cost from 10,000€ to approximately 11,111€ may appear manageable for a large organisation. However, for a small business, this additional cost may affect profitability, cash flow or its ability to finance other activities. Similarly, a small schedule delay during the second month may lead to more significant delivery problems if testing, approval or deployment activities depend on the delayed work.

2.4.4 Relevance for an Airtable-Based Platform

This descriptive case also demonstrates the logic of the proposed Airtable-based project-management platform. Airtable can be configured as a central digital environment in which project tasks, work packages, budgets, planned completion dates, actual progress and actual-cost information are recorded. When the database structure is designed appropriately, the platform can support the systematic calculation and visual presentation of EVM indicators.

For example, each task can be connected to a project and a work package. Relevant fields can record the planned start date, planned completion date, budgeted amount, completion percentage and actual cost. Formula fields, rollups and linked records can then be used to

aggregate project information. This makes it possible to calculate PV, EV and AC for each reporting period, followed by the automatic calculation of CV, SV, CPI and SPI.

The main benefit of this approach is that it can reduce dependence on manually maintained spreadsheet calculations. Project managers can review project status through interfaces that display performance indicators, budget consumption, task completion and cost and schedule status. A big benefit for SMEs, where managers may require practical project-control information but may not have access to specialised enterprise project-control software.

However, the use of Airtable, or any other digital platform, does not automatically guarantee reliable EVM results. The quality of the output depends directly on the quality of the input data. Therefore, the organisation must establish clear rules for assigning budgets, measuring task completion, recording actual costs, approving changes and updating the project baseline. The digital platform should be viewed as a tool that supports disciplined project-control processes rather than as a substitute for managerial judgement.

2.4.5 Summary of the Descriptive Case

Table 5 summarises the results of the descriptive EVM example.

Metric	Value	Interpretation
BAC	10,000€	Total approved project budget
Planned duration	4 months	Baseline project duration
PV	5,000€	Work planned for completion by the end of month two
EV	4,500€	Verified work completed by the end of month two
AC	5,000€	Actual cost incurred by the end of month two
CV	-500€	Cost overrun for the work completed
SV	-500€	Progress below the approved baseline
CPI	0.90	Cost performance is inefficient
SPI	0.90	Schedule performance is below plan
EAC	11,111.11€	Forecast final cost exceeds BAC

Table 5: Summary of EVM Results for the Website-Development Project

Overall, the example demonstrates how EVM transforms routine project data into a structured assessment of project performance. Even in a relatively small website-development project, the method makes it possible to determine whether actual progress corresponds to the approved plan and whether expenditure is reasonable in relation to the value delivered. This demonstrates the relevance of EVM for SMEs and provides a practical basis for the design of the proposed digital project-management platform.

Although EAC is included in the example as a theoretical forecasting measure, the current Airtable-based platform focuses on PV, EV, AC, CV, SV, CPI and SPI. The EAC indicator is not calculated by the platform and may be considered for future development.

The following section examines the main advantages and limitations of EVM, with particular attention to its role in project monitoring, decision-making and digital implementation.

2.5 Advantages and Limitations of the EVM Method

Earned Value Management is widely recognised as an important project-control method because it combines cost, schedule and work performance within one analytical framework. Instead of examining expenditure and time separately, EVM assesses whether the work completed corresponds to the amount of work planned and the resources used. This integrated approach supports project monitoring and controlling and can help managers identify deviations before they become critical (Mayo-Alvarez *et al.*, 2022; Nizam and Elshannaway, 2019).

However, EVM should not be considered a solution to every project-control issue. Its effectiveness depends on the quality of the available data, the stability of the project baseline, the reliability of progress measurement and the ability of the organisation to apply the method consistently.

2.5.1 Advantages of EVM

One of the main advantages of EVM is that it provides an integrated view of project performance. By combining Planned Value, Earned Value and Actual Cost, project managers can identify at the same time whether a project is behind schedule, over budget or affected by both types of deviation. This is more informative than examining expenditure alone, because actual spending does not necessarily show whether the expected work has been completed.

For instance, a project may seem to be within budget if its actual spending is close to the planned budget at a particular reporting date. However, when Earned Value is much lower than Planned Value, this shows that less work has been completed than expected. In the same way, a project may appear to be on schedule, but if Actual Cost is higher than Earned Value, the completed work has cost more than planned. By linking expenditure with actual progress, EVM helps reveal these issues clearly (Anbari, 2003; Mayo-Alvarez et al., 2022).

A second advantage of EVM is its ability to provide early warning and support forecasting. Indicators such as CV, SV, CPI and SPI allow project managers to identify unfavourable trends during project execution. Estimate at Completion may also be used in the wider EVM framework to forecast the likely final cost when current performance continues. The early identification of negative trends allows managers to examine the causes of deviations and introduce corrective actions before the remaining budget or available time is exhausted (U.S. Department of Energy, 2017; Kim, Wells and Duffey, 2003).

EVM can also support more informed decision-making. When project performance is expressed through measurable indicators, managers can assess whether a problem requires resource reallocation, scope clarification, schedule revision, cost-control actions or a review of remaining work. This supports evidence-based decision-making because corrective actions can be linked to specific performance information instead of relying only on subjective impressions of project progress (Netto *et al.*, 2020).

Another advantage concerns project communication and reporting. EVM provides standardised indicators that can be understood and compared across different reporting

periods. Measures such as CPI and SPI allow project managers to communicate performance information clearly to sponsors, clients and senior management. Instead of providing only descriptive updates, the project team can show whether performance is improving or deteriorating and whether the project is likely to meet its cost and schedule objectives.

The use of EVM can also support stronger planning discipline. In order to apply EVM effectively, a project requires a work breakdown structure, a schedule baseline, a cost baseline, measurable work packages and a method for recording actual costs. Although these requirements may initially increase planning effort, they can improve the overall quality of project monitoring and control. For this reason, EVM contributes not only to performance measurement but also to the establishment of more structured project-management practices (Kim, Wells and Duffey, 2003; Netto *et al.*, 2020).

For SMEs, these advantages can be particularly important. Smaller organisations may have limited capacity to absorb unexpected costs or delays in project delivery. A timely indication that CPI or SPI is below 1.00 can help managers take action before a small deviation develops into a more significant financial or operational problem. When it is supported by an appropriate digital platform, EVM can also make project information more accessible and reduce reliance on fragmented manual reporting processes.

2.5.2 Limitations of EVM

Despite its advantages, EVM also has important limitations. One of the most significant limitations concerns data quality. EVM calculations depend directly on PV, EV and AC. If these values are inaccurate, incomplete or recorded inconsistently, the resulting variances, indices and forecasts may be unreliable. For example, an inaccurate estimate of percentage completion may increase Earned Value and create a misleading view of project progress. Similarly, late or incomplete recording of actual costs may produce an artificially favourable CPI (Kim, Wells and Duffey, 2003; Safari Zarch and Mokaberian, 2026).

The measurement of project progress is particularly important. In some projects, especially software-development, research or service projects, it may be difficult to determine objectively how much work has been completed. A task recorded as “90% complete” may still require substantial work before it can be tested, approved or delivered. Therefore, progress should preferably be measured through objective methods, such as completed deliverables, weighted milestones, approved requirements, tested modules or clearly defined completion criteria.

A further limitation concerns changes in project scope and the management of changes. Traditional EVM is more reliable when the project scope, schedule and cost baseline are clearly defined and properly controlled. If project requirements change frequently without formal baseline updates, Planned Value may no longer represent the work that should actually be completed. In this situation, a negative Schedule Variance may reflect an outdated plan rather than poor project performance. Therefore, effective change control is necessary in order to ensure that EVM comparisons remain meaningful (Liu and Jiang, 2020; Nizam and Elshannaway, 2019).

Traditional EVM also has limitations in relation to schedule analysis. Although SV and SPI indicate whether a project has completed more or less work than planned, they do not directly

show the delay in calendar days or weeks. They also do not show whether delayed activities are located on the critical path. A project may have an unfavourable SPI but still be able to meet its final deadline if the delayed activities have available float. On the other hand, a small delay in a critical activity may create a significant risk for the project completion date. By extension, EVM schedule indicators should be used together with network scheduling, critical-path analysis and, where appropriate, Earned Schedule or Earned Duration techniques (Lipke, 2003; Mayo-Alvarez et al., 2022).

Another limitation is the perceived complexity of EVM. Although the basic formulas are relatively simple, effective implementation requires organisational discipline. Project teams need appropriate training, clear procedures, management support, accurate cost data and a suitable reporting process. In organisations with low project-management maturity, EVM may be seen as bureaucratic or too complex, particularly when it is introduced without sufficient preparation. The main difficulty is often not the calculation of the formulas, but the establishment of the structured processes needed to produce reliable project information (Netto *et al.*, 2020).

This challenge is particularly relevant for SMEs. Small organisations may have limited staff, few project-management specialists and less formal project-control procedures. Under these conditions, manual EVM implementation through spreadsheets may become time-consuming and vulnerable to errors, especially when several projects are monitored at the same time. If data are not updated regularly, EVM may become a theoretical exercise rather than a practical tool for supporting management decisions.

2.5.3 Bridging EVM to Digital Platforms

The advantages and limitations of EVM provide a strong reason for using digital project-management platforms. EVM offers useful capabilities for monitoring project performance, identifying deviations and supporting management decisions. However, it also requires accurate, timely and consistently structured data. Digital systems can support this requirement by centralising tasks, budgets, planned dates, actual costs and progress information in one environment.

A properly configured platform can reduce manual calculation effort, minimise formula errors and improve the consistency of project reporting. It can also present EVM indicators through dashboards, charts and structured reports, making PV, EV, AC, CV, SV, CPI and SPI easier to interpret. Instead of transferring data manually between separate spreadsheets, project teams can record project information directly in a shared and structured database.

For SMEs, a digital platform can make EVM more accessible because it can provide structured data entry and formula-based calculations without requiring users to create complex spreadsheet models. However, the platform should be designed according to the actual needs of the organisation and its level of project-management maturity. A simple platform that is regularly updated is likely to provide more practical value than a complex system that users do not fully understand or maintain consistently.

Within the scope of this thesis, Airtable is used as a configurable environment that can support the implementation of selected EVM principles. It can combine project records, linked tables, formula fields, rollups and visual interfaces in order to support the structured recording and analysis of project data. Nevertheless, the effectiveness of the platform depends on the quality of the database design, the consistency of data entry and the existence of clear project-control procedures.

Overall, EVM offers important advantages in relation to integrated performance measurement, early warning, communication and decision-making. At the same time, its limitations show that it cannot operate effectively without reliable data, formal baseline control and an appropriate implementation process. These considerations provide the basis for the following section, which examines the relationship between EVM, digital project-management platforms and the particular needs of SMEs.

2.6 Linking EVM to Digital Platforms and SMEs

The practical use of Earned Value Management requires the continuous collection, organisation and interpretation of project data. In particular, project teams need to record planned budgets, planned progress, completed work, actual expenditure and relevant schedule information at regular control points. Although the basic EVM formulas are relatively simple, the manual collection and calculation of this information can be difficult, time-consuming and prone to error, especially when an organisation manages several projects at the same time (Kim, Wells and Duffey, 2003; Nizam and Elshannaway, 2019).

For this reason, the application of EVM is increasingly connected with digital project-management and project-control platforms. These systems can provide a structured environment in which project schedules, work packages, budgets, actual costs, progress updates and reports are recorded and managed. When properly configured, a digital platform can support the calculation of AC, EV and PV, as well as derived indicators such as CV, SV, CPI and SPI. This reduces the need for repeated manual calculations and allows project managers to access updated performance information more efficiently.

However, many commercial EVM and project-control systems have traditionally been designed for large organisations, major infrastructure projects or organisations with mature project-management processes. Such systems may require high licensing costs, complex implementation procedures, specialised technical support and extensive staff training. While these features may be appropriate for large enterprises, they may create barriers for small and medium-sized enterprises, which often have limited financial resources, fewer project-management specialists and less formal project-control processes (Netto *et al.*, 2020; Mayo-Alvarez *et al.*, 2022).

2.6.1 EVM Challenges in SMEs

Small and medium-sized enterprises often operate with limited budgets, small teams and a restricted ability to absorb cost overruns or schedule delays. In a large organisation, a relatively small project overrun may be manageable. However, in an SME, the same deviation may affect cash flow, profitability, customer relationships or the ability to

undertake other projects. Therefore, SMEs can benefit significantly from timely and understandable information about project performance (Johansson, 2014).

At the same time, SMEs may face practical difficulties when implementing EVM. They may not have dedicated project-control departments, specialised software, formal reporting procedures or staff trained in advanced project-management methods. Under these conditions, project managers may depend heavily on spreadsheets, informal task lists, email communication and manually prepared progress reports. Although these tools can be useful for simple projects, they may become inefficient when project information needs to be updated regularly and analysed across several work packages or projects.

Manual EVM implementation through spreadsheets also involves several risks. Formulas may be entered incorrectly or copied inconsistently between different files. Different team members may work with separate versions of the same spreadsheet, creating version-control issues. In addition, actual-cost data, planned values and progress information may not be updated at the same time, resulting in inaccurate calculations. Finally, EVM results may be difficult for non-specialist users to understand when the information is distributed across many worksheets or reports.

For SMEs, the main objective should not necessarily be the implementation of a highly complex enterprise Earned Value Management System. Instead, the aim should be the development or adoption of a practical, affordable and user-friendly solution that supports the basic principles of EVM. Such a system should help users define project baselines, record progress, monitor costs and interpret performance indicators without requiring advanced technical knowledge.

2.6.2 Digital Platforms as EVM Enablers

Digital project-management platforms can support EVM by centralising project information in a structured database. Instead of maintaining separate files for tasks, budgets, time records and expenses, a platform can connect these elements through common project and work-package records. This creates a more consistent information base for calculating EVM indicators.

A typical digital platform that supports EVM may include the following information:

- Project name, project manager and project status
- Work packages, tasks and deliverables
- Planned start dates and planned completion dates
- Budget at Completion and task-level budgets
- Planned completion percentages at defined control points
- Actual completion percentages or verified milestone status
- Actual labour, material, supplier and software costs
- Risk records, change requests and project issues
- EVM indicators and dashboard reports

When this information is recorded consistently, the platform can support the calculation of Planned Value, Earned Value and Actual Cost. For example, PV can be calculated from the

approved budget assigned to tasks that are planned to be completed by a specific reporting date. EV can be calculated from the budgeted value of tasks or milestones that have been verified as completed. AC can be calculated from the actual project expenditure recorded in the system. The platform can then automatically calculate CV, SV, CPI and SPI.

The main benefit of this approach is improved project visibility. Project managers can access performance information through dashboards instead of searching through different spreadsheets or manually calculating ratios. A dashboard may show whether CPI and SPI are above or below 1.00, whether actual expenditure is increasing faster than Earned Value and whether cost or schedule performance requires further attention. This can make it easier to identify emerging issues and support timely management action.

Digital systems can also improve project communication. Project stakeholders can receive consistent reports based on the same underlying data rather than relying on separate manually prepared updates. When EVM information is combined with visual indicators, charts and clear status summaries, it can become more accessible to senior managers and clients who do not require detailed technical calculations.

2.6.3 Airtable as a Configurable SME Solution

Airtable is considered a configurable digital environment that can support the practical implementation of EVM principles. It's not presented as a complete enterprise Earned Value Management System. Instead, it can be configured to create a structured and accessible project-control solution suitable for the needs of small and medium-sized enterprises.

An Airtable-based platform can include linked tables for projects, work packages, tasks, budgets, actual costs, reporting periods, risks and change requests. Each task can be connected to the relevant project and work package, while fields can record planned start dates, planned completion dates, assigned budgets, actual progress and actual costs. Formula fields and rollup fields can then combine task-level information and calculate project-level performance indicators.

For example, the proposed Airtable structure may include the following elements:

Table	Indicative information
Projects	Project name, client, project manager, BAC, planned duration and project status
Work Packages	Work-package description, planned budget, planned dates and responsible person
Tasks	Task name, linked work package, planned completion date, progress percentage and task status
Cost Records	Labour cost, supplier cost, software cost, invoice date and linked project
Reporting Periods	Control date, PV, EV, AC, CV, SV, CPI and SPI
Risks and Changes	Risk description, impact, probability, change request and approval status

Table 6: Indicative Airtable Structure for EVM Support

Through this structure, the platform can support the calculation and visual presentation of EVM data. For example, the total budget of tasks planned for completion before a control date can contribute to PV. The budgeted value of tasks marked as completed, or verified according to predefined rules, can contribute to EV. Recorded project costs can contribute to AC. Once these values are available, formula fields can calculate project variances and performance indices.

The practical value of Airtable is its ability to combine structured data entry with accessible visualisation. Interfaces can be configured to display information that is relevant to a project manager, such as the current project budget, actual expenditure, percentage completion, CPI, SPI, Cost Status and Schedule Status. Filters can be used to show delayed tasks, high-risk activities or projects with a CPI below 1.00. This can reduce the administrative burden of monitoring project performance and make EVM indicators easier for non-specialist users to understand.

However, successful implementation depends on more than the technical configuration of the platform. The organisation must establish clear procedures for creating project baselines, assigning task budgets, recording actual costs, verifying task completion and approving changes. If users enter incomplete or inconsistent data, EVM calculations will not be reliable. Therefore, Airtable can support the EVM process, but it cannot replace disciplined project-management practices.

2.6.4 Contribution of the Proposed Platform

The proposed digital project-management platform aims to reduce the gap between the theoretical benefits of EVM and the practical difficulties faced by SMEs. EVM provides an integrated method for monitoring cost and schedule performance, identifying deviations and supporting decision-making. However, many SMEs may not have the resources required to implement complex or expensive enterprise systems. A configurable and low-cost platform can provide a more realistic solution.

The platform proposed is intended to provide an accessible environment in which users can record project information and obtain EVM-based performance indicators without requiring extensive knowledge of advanced project-control methods. The purpose is not to replace managerial judgement or automate every project-management decision. Instead, the platform aims to provide timely, structured and understandable information that helps project managers recognise deviations and decide whether corrective action is required.

The platform includes project, milestone and task records, along with project-control fields for Reporting Date, PV, EV, AC, CPI, SPI, Cost Status, Schedule Status, Actual Cost, Progress Percentage and Due Date. It also provides interfaces for project planning, task management and performance monitoring. The dashboard presents portfolio-level EVM information and displays comments based on indicator values, for example whether a project is delayed or operating within budget.

The implementation of EVM calculations within the platform can improve consistency. Instead of calculating CPI and SPI manually, the prototype uses formula-based fields to calculate these indices from project-level PV, EV and AC values. This can reduce calculation

errors and support comparable reporting between projects. In addition, dashboards and visual status indicators can make performance information easier to communicate to relevant stakeholders.
Overall, EVM offers important benefits for project monitoring and control, but its practical value depends on the availability of reliable data and a suitable implementation environment. Digital platforms can make EVM more feasible for SMEs by reducing manual work, supporting consistent calculations and presenting indicators through accessible interfaces. The following chapter examines the requirements, data structure and technical design of the proposed Airtable-based project-management solution.

2.7 Chapter Summary

Earned Value Management was was considered as a combined method for monitoring project progress and keeping performance under control.EVM combines cost, schedule and scope-related information in order to assess whether a project is progressing according to its approved baseline. Its main variables—Planned Value, Earned Value and Actual Cost—provide the basis for assessing planned work, completed work and actual expenditure at specific project-control points.

The chapter also presented the main EVM indicators: Cost Variance, Schedule Variance, Cost Performance Index and Schedule Performance Index. These indicators help project managers identify whether a project is under or over budget and whether it is ahead of or behind plan. The descriptive website-development example demonstrated how a project with a BAC of €10,000, PV of €5,000, EV of €4,500 and AC of €5,000 produces negative cost and schedule variances, as well as SPI and CPI values of 0.90.

The analysis highlighted several advantages of EVM. These include the integrated assessment of cost, schedule and completed work, the early identification of unfavourable performance trends, improved project reporting, and support for evidence-based decision-making. EVM is particularly useful when project managers need to determine whether actual expenditure produces the expected amount of work rather than only examining whether spending follows the original budget.

At the same time, important limitations were identified. EVM depends on reliable data, objective progress measurement, clearly defined work packages, formal baseline control and consistent recording of actual costs. Traditional Schedule Variance and SPI also have limitations because they are expressed in monetary units and do not directly show calendar-time delays or critical-path effects. Therefore, EVM should be used together with sound scheduling, change-control and risk-management practices. Where detailed schedule forecasting is required, approaches such as Earned Schedule, Earned Duration and critical-path analysis may provide additional information.

Finally, EVM connected with the needs of SMEs and the use of digital project-management platforms. SMEs can benefit from early warning, cost control and accessible project reporting, but they may lack the resources required for complex enterprise EVM systems. A configurable platform such as Airtable can provide a practical alternative by centralising project data, supporting formula-based calculations and presenting EVM indicators through accessible interfaces and dashboards. The proposed platform focuses on PV, EV, AC, CPI

and SPI, together with Cost Status and Schedule Status indicators. Estimate at Completion was discussed as part of the wider theoretical EVM framework, but it is not included in the current platform implementation. The following chapter examines the design requirements, database structure and implementation of the proposed Airtable-based project-management solution.

Chapter 3: Design of an Airtable-Based EVM Project Management Prototype

3.1 Introduction

This chapter presents the design and implementation of a digital project management prototype that incorporates Earned Value Management (EVM) principles for small and medium-sized enterprises (SMEs). Building on the theoretical foundation and requirements analysis presented in the previous chapter, the prototype was developed in Airtable as a flexible, low-cost and no-code solution for project monitoring and analysis.

The purpose of the prototype is not to replace a complex enterprise project management system. Instead, it provides a structured digital environment through which SME users can organise projects, manage milestones and tasks, record cost and progress information, calculate EVM indicators and monitor project performance.

Initially, this chapter presents the functional and non-functional requirements of the platform. It subsequently explains the selection of Airtable as the implementation environment and presents the database design, EVM calculation logic, user-facing views, automatic field logic and overall platform architecture. Therefore, the chapter connects the theoretical principles of EVM with their practical implementation in a digital project management prototype.

3.2 Platform Requirements

The functional and non-functional requirements of the platform were determined according to the objective of developing an accessible, low-cost and EVM-enabled project management prototype for SMEs. These requirements guided the configuration of the Airtable base, the relational data model, the user-facing views and the formula-based field logic.

The prototype was designed to support project planning, task management, cost recording, EVM-based performance monitoring and automatically updated task-level and project-level status information. At the same time, it was necessary for the platform to remain understandable and adaptable for SME users who may have limited technical knowledge and limited access to specialised project management systems.

3.2.1 Functional Requirements

The platform supports the following functional requirements:

- Project creation and organisation: The platform enables users to create and manage a portfolio of projects. Each project includes information such as Project Name, Client, Start Date, Target End Date, Overall Budget, Status and Phase. Projects are organised through linked milestones and tasks in order to support project planning and monitoring.
- Milestone and task management: The platform enables users to create milestones and detailed tasks linked to the relevant project. Task records include information such as Assignee, Due Date, Task Status, Progress Percentage, Planned Cost and Actual Cost.
- Cost and budget monitoring: The platform enables users to record baseline planned costs and cumulative actual costs at task level. These data are then aggregated at project level in order to support budget monitoring and the analysis of cost performance.
- EVM indicator calculation: The platform calculates Earned Value (EV), Actual Cost (AC), Planned Value (PV), Planned Value (PV), Planned Value (PV), Schedule Performance Index (SPI) and Cost Performance Index (CPI). These indicators allow project managers to assess cost and schedule performance in relation to the project baseline.
- Project-performance visualisation: The platform provides operational views and a Project EVM Review interface. These components present task status, deadlines, task-risk classifications and EVM indicators without requiring users to manually aggregate information from the underlying records.
- Automatic status and EVM updates: The platform uses formula fields, lookup fields and rollup fields to update task-level schedule and cost status information. It also recalculates project-level EVM indicators when the relevant task data are modified.

3.2.2 Non-Functional Requirements

In addition to its functional capabilities, the prototype was designed to address the following non-functional requirements:

Usability and ease of use: The platform provides clearly structured data-entry forms, purpose-oriented interfaces and simplified views. These features are intended to support SME users who may not have specialised experience with project management software.

- No-code implementation: The prototype was configured without custom programming. Its logic is based on Airtable tables, linked records, lookup fields, rollup fields, formula fields, views and interfaces.
- Affordability and accessibility: The platform is a low-cost and web-based solution suitable for SMEs that may have limited financial and technical resources. Users can access the platform through a browser-based environment, subject to the selected Airtable plan and internet availability.
- Flexibility and extensibility: The Airtable-based design enables the platform to be adapted when organisational requirements change. Additional fields, views, interfaces, role-based access controls and notification workflows may be configured in future versions without redesigning the complete platform.

- Data consistency and integrity: The relational data model links Projects, Milestones and Tasks and supports the use of consistent task-level data for project-level EVM calculations. This structure reduces unnecessary duplication and improves the consistency of data used in monitoring activities.
- Collaboration and controlled access: The platform supports the sharing of project information among authorised users. In this way, it reduces dependence on isolated files or individual spreadsheets.
- Together, these requirements guided the design of the proposed Airtable-based prototype. They also provide the basis for the platform selection, database design, EVM calculation logic, interface design and formula-based field logic presented in the following sections.

3.3 Selection of the Technological Platform

Selecting the most appropriate platform was one of the most important considerations in the design of the proposed system. The platform needed to support the storage of structured project data, task management, milestone monitoring, cost recording, EVM calculations, reporting and automatically updated status information. At the same time, it was necessary to ensure that the selected platform would be affordable and applicable for SMEs that may have limited financial and technical resources and limited experience in using complex enterprise information systems.

Airtable was selected as the implementation environment because it combines spreadsheet-like usability, relational database capabilities and no-code application-development features. In other words, Airtable does not require the development of a separate software application. Instead, it provides the possibility to configure a database structure, establish connections between records, create views and interfaces, and configure formula-based field logic through a visual environment. Linked-record fields can create connections between records in different tables, whereas lookup fields can display information from related records dynamically and preserve changes made to the original source record (Airtable, n.d.-a).

3.3.1 Suitability for SMEs

SMEs require software that supports rapid implementation, adaptation to changing organisational needs and use without major investments in technological infrastructure or specialised employees. In comparison with larger organisations, SMEs may find it difficult to justify the cost of enterprise resource planning systems or specialised project portfolio management software.

Low-code and no-code platforms can reduce these constraints by enabling non-technical employees to participate in the development and adaptation of internal applications. Research on low-code and no-code development indicates that this type of software can reduce barriers to application development, support faster delivery and encourage innovation, especially within SMEs and internal application-development contexts (Jovanović, 2023). Likewise, Martinez et al. (2023) state that low-code development can support digitalisation and innovation through improvements in application-development productivity.

For the purposes of the present study, Airtable is relevant because the organisation can begin with a relatively simple configuration and expand the platform in the future. An SME may initially use the system for project and task registration and subsequently add milestones, EVM calculations, reporting views, role-based access controls and notification workflows if required. In this way, the risk of implementation failure can be reduced and the platform can develop according to organisational needs.

3.3.2 Advantages of the No-Code Approach

An important benefit of using Airtable is that users don't need to write software code in order to configure the platform. The implemented prototype is based on tables, fields, linked records, formulas, views and interfaces rather than custom-written software.
The main advantages of the no-code approach are the following:

- Reduced development effort: The platform can be configured more quickly than a customised web application because standard database and interface components are already available.
- Easier maintenance: Managers or administrators can modify selected fields, views and processes without depending on external software developers.
- Greater flexibility: Additional project categories, cost fields, project phases, views and notification workflows may be added if organisational requirements change.
- Rapid prototyping: The organisation can test the platform using a small number of projects and tasks before applying it more widely.

Greater accessibility: Users can access the platform through a web-based environment.

These advantages are particularly important for SMEs because they support digitalisation while reducing the initial costs associated with system development. Moreover, no-code platforms are useful when the purpose is to develop an internal operational tool rather than a commercial software product.

3.3.3 Airtable Database Capabilities

Airtable was also selected because it supports a relational database structure. The final prototype uses Projects, Milestones and Tasks as its core operational tables.

The use of linked records is especially important in this design. One project can include several milestones, while each milestone can include several tasks. Task-level cost, progress and due-date data are aggregated at project level and displayed through the Project EVM Review interface.

This relational model is more appropriate than a spreadsheet in which all project information is stored in one table. In a single-table spreadsheet model, the same project information may appear repeatedly in many task rows, creating a greater possibility of inconsistency. By contrast, the Airtable database allows related information to be recorded once and used across connected records.

3.3.4 Interfaces and Visualisation

Another reason for selecting Airtable is its ability to create interfaces that present operational data in a simpler and more user-oriented form than the underlying tables.
The prototype uses Airtable Interfaces to present operational data through role-oriented pages and dashboard elements, including records, filters and summary indicators.

In the developed platform, user-facing components support three main operations:

- Project planning: Supports the registration and structuring of projects and milestones.
- Task management: Presents projects, milestones and tasks in a structured manner, allowing users to monitor responsibilities, deadlines and progress.
- Performance monitoring: Presents EVM indicators, project-status information, progress data, workloads and performance comparisons at project level.

The final operational views and Project EVM Review enable users to examine project records, task deadlines, task-status information, delayed or over-budget tasks and project-level EVM indicators without manually calculating consolidated values.

3.3.5 Comparison with More Complex Solutions

Project management and enterprise software packages can provide many additional features, such as resource optimisation, advanced scheduling, integrated accounting, advanced risk management and sophisticated user-permission settings.

However, these systems may be too complex for the needs of many small businesses and for the scope of the prototype proposed in this study. Their use may involve high financial and time costs, as well as additional requirements for training and consultation. In addition, specialised systems may include functions that are unnecessary for a small project team and may therefore make project monitoring more complicated.

Airtable does not aim to replace a full enterprise resource planning system or a specialised project management system. It represents an intermediate solution: it is more advanced than an ordinary spreadsheet, but it does not have the complexity of enterprise software. This is significant for the present research because the objective is to propose a practical EVM-enabled project management platform for SMEs with limited technical capabilities.

3.3.6 Limitations of Airtable

Nevertheless, Airtable also has limitations that should be considered. Firstly, it is a cloud-based system, which means that its use depends on internet connection and Airtable availability. Secondly, its EVM capabilities depend on the correct configuration of fields, formulas and record-linking functions and do not include advanced native project-control functionality.

Therefore, the accuracy of the calculations depends on the consistency and timeliness of user-entered task progress, planned costs, due dates and actual costs.

Thirdly, Airtable has limitations related to its free version. The free plan is subject to restrictions regarding record capacity, attachment storage and feature availability under the selected Airtable plan (Airtable, n.d.-c). Consequently, a growing SME with a large project portfolio, many users or intensive automated workflows may need to purchase a paid version or move to a more specialised system.

Finally, Airtable cannot provide the advanced scheduling, forecasting, financial integration and governance capabilities required by large organisations. Therefore, it is more appropriate for SMEs and should not be considered a replacement for enterprise project management systems.

3.4 Database Design

The database design forms the foundation of the proposed platform. In this study, the database was designed to organise project-related information and support the monitoring of schedule, cost and EVM performance. Rather than storing all project information in one spreadsheet-like table, the proposed platform uses several interconnected tables in order to reduce unnecessary duplication and improve data consistency.

The database was configured in Airtable using linked records, lookup fields, rollup fields and formulas (Airtable, n.d.-a; Airtable, n.d.-b). Linked records define the relationship between tables, while lookups and rollups are used to retrieve or aggregate information from related records (Airtable, n.d.-a; Airtable, n.d.-b). This approach is appropriate for the platform because EVM monitoring requires project information, progress information and cost information to remain connected.

The database consists of three core operational tables: Projects, Milestones and Tasks. Project-level EVM values are calculated from task-level data and displayed through the Project EVM Review rather than through a separate EVM Metrics table.

3.4.1 Projects Table

The Projects table is the central table of the database. Each record represents one project undertaken by the SME. It contains the high-level information required for planning and monitoring a project throughout its life cycle.

The main fields included in the Projects table are presented in Table 7.

Field	**Purpose**
Project Name	Identifies the project
Start Date	Records the planned starting date of the project
Target End Date	Records the target completion date
Reporting Date	Defines the date at which current EVM performance is assessed

Overall Budget	Records the approved total budget of the project
Status	Indicates the current project situation, such as Planning, In Progress, On Hold or Completed
Phase	Identifies the current project phase, such as Initiation, Planning, Development, Execution, Testing or Closure
Progress Percentage	Indicates overall completion progress, calculated or derived from linked tasks
Linked Milestones	Connects the project with its milestones
Linked Tasks	Connects the project with its related tasks
Project-Level EVM Fields	Display PV, EV, AC, CPI and SPI values calculated from linked task-level data and used in the Project EVM Review

Table 7: Main Fields of the Projects Table

The Projects table serves as the central coordination point of the platform. It enables a project manager to review the project timeline, budget, current status and overall progress in one place. It also acts as the parent record for milestone, task and performance information.

3.4.2 Milestones Table

The Milestones table records the key events and deliverables within each project. Milestones are used to divide the project into stages and to support monitoring of the baseline schedule. Each milestone is linked to one project and may be associated with multiple tasks. In this way, several tasks can contribute to the completion of one milestone.

Field	**Purpose**
Milestone Name	Identifies the milestone or key deliverable
Due Date	Defines the target completion date of the milestone
Completion Status	Indicates whether the milestone is Not Started, In Progress, Completed or Delayed
Milestone Owner	Identifies the person responsible for monitoring or delivering the milestone

Table 8: Main Fields of the Milestones Table

Thus, the milestone represents an intermediate level between the whole project and its individual tasks. It makes the project structure more explicit, especially in projects that contain several stages. For example, in a website-development project, milestones may include “Requirements Approval”, “First Prototype”, “User Testing” and “Final Launch”.

The use of milestones also facilitates reporting because project managers can assess whether important deliverables are completed on time.

3.4.3 Tasks Table

The Tasks table contains the detailed activities required to complete the milestones and projects. It is the main operational table of the platform because it contains the information that users update frequently in relation to task status, progress and cost.
The task level is also important for the use of the EVM model because progress and cost data can be recorded at task level before being aggregated for analysis at project level. EVM is based on the comparison of budgeted work scheduled, budgeted value of work performed and actual cost (NASA, 2018).

Field	**Purpose**
Task Name	Identifies the individual activity to be performed
Related Project	Links the task to its parent project record
Related Milestone	Links the task to the milestone that it supports
Assignee	Identifies the team member responsible for completing or updating the task
Due Date	Defines the due date used for deadline monitoring and the simplified PV calculation
Task Status	Indicates whether the task is Not Started, In Progress, On Hold or Completed
Progress Percentage	Records the reported level of task completion, from 0% to 100%, and is used to calculate task-level Earned Value
Planned Cost	Records the approved budgeted cost allocated to the task
Actual Cost	Records the cumulative actual expenditure incurred for the task
Schedule Status	Automatically indicates whether the task is on schedule or delayed, based on the configured task-status and due-date logic
Cost Status	Automatically indicates whether the task is within budget or over budget, based on the relationship between Actual Cost and Planned Cost

Table 9: Main Fields of the Tasks Table

The Planned Cost field records the approved budget allocated to a task, whereas the Actual Cost field records the cumulative actual expenditure associated with that task. The Progress Percentage field is used to calculate task-level Earned Value.

The Due Date is treated as the planned baseline date used for the prototype's simplified Planned Value calculation. Therefore, it should be changed only when an approved change to the project baseline has been made.

The relationship between progress percentage and planned cost is particularly important. EVM is based on multiplying the budget of an activity by the percentage of work completed. In simple form, the formula is:

EV = Task Budget × Percentage Complete

This approach converts task-progress data into a measurable value of completed work. According to PMI, EV can be calculated by multiplying the budget of an activity or work package by the percentage of work completed (Project Management Institute, 2012).

3.4.4 Project-Level EVM Fields and Review

The final prototype calculates and displays EVM information at project level. Instead of using a separate EVM Metrics table, the relevant values are derived from task-level data through linked records, rollup fields and formula fields and are presented in the Project EVM Review interface.

The EVM Review is based on task-level Planned Cost, Actual Cost, Progress Percentage and Due Date. These inputs are aggregated for the selected project and used to calculate Planned Value, Earned Value, Actual Cost, Cost Performance Index and Schedule Performance Index. The interface also includes an Overall EVM Status field and a Recommended Action field, which provide a concise interpretation of the calculated indicators.

Table 10 presents the project-level EVM fields included in the final prototype.

Field	**Purpose in the prototype**
Reporting Date	Defines the control date used for the current EVM assessment
Planned Value (PV)	Represents the sum of planned task costs for tasks with a due date on or before the Reporting Date
Earned Value (EV)	Indicates the budget of completed work , calculated from task Planned Cost and recorded Progress Percentage
Actual Cost (AC)	Represents the cumulative actual cost recorded for tasks linked to the project
Cost Performance Index (CPI)	Measures cost efficiency using CPI = EV / AC
Schedule Performance Index (SPI)	Measures schedule performance using SPI = EV / PV
Overall EVM Status	Provides a project-level classification based on CPI and SPI values
Recommended Action	Provides a short management-oriented recommendation based on the EVM status

Table 10: Project-Level EVM Fields Included in the Final Prototype

3.4.5 Relationships Between Tables

The effectiveness of the database depends not only on the individual tables but also on the relationships between them. The main relationships are presented below.

Parent Table	**Related Table**	**Relationship**	**Purpose**

Projects	Milestones	One project can have multiple milestones	Supports project-stage planning and monitoring
Projects	Tasks	One project can have multiple tasks	Connects detailed activities to the overall project
Milestones	Tasks	One milestone can have multiple tasks	Connects tasks to a specific deliverable or control point

Table 11: Relationships Between the Core Tables of the Prototype

The central relationship can be represented as follows:

Project → Milestone → Task

Task-level Planned Cost, Progress Percentage, Actual Cost and Due Date information is aggregated through project-level rollups and formula fields. The resulting PV, EV, AC, CPI and SPI values are displayed in the Project EVM Review interface.

The model establishes a consistent flow of information. Users add or modify operational information at task level, while the system aggregates and presents the relevant information at milestone and project level. Airtable linked records, together with lookup, count and rollup fields, enable information to be retrieved and aggregated across related records (Airtable, n.d.-a; Airtable, n.d.-b).

3.5 Modelling of Earned Value Management Data

The platform uses task-level operational data as the basis for EVM calculations. Each task is linked to a project and contains the information required for performance measurement, including Planned Cost, Actual Cost, Due Date and Progress Percentage. Through linked records, formula fields and rollups, task-level data are aggregated to the relevant project and subsequently presented in the Project EVM Review interface.

The implementation follows the principle that EVM indicators should be derived from structured project data rather than entered manually by users. Users update operational information, especially task progress and actual cost, while the platform calculates the relevant project-level performance measures automatically.

3.5.1 EVM Data Inputs and Aggregation Logic

The EVM model is based on three main sources of data:

- Planned task cost, which represents the approved budget allocated to each task
- Task progress percentage, which represents the recorded level of completion of each task
- Actual task cost, which represents the expenditure incurred for the completion of the task

Planned Value (PV) is based on the approved project baseline. For the purposes of the prototype, PV is approximated by summing the baseline planned costs of tasks whose Due Date falls on or before the selected Reporting Date. This represents a simplified implementation of a time-phased cost baseline and is suitable for the scope of the proposed SME-oriented prototype.
Earned Value (EV) is calculated at task level by multiplying the Planned Cost of each task by its recorded Progress Percentage. Project-level EV is then calculated by aggregating the earned values of all linked tasks. Actual Cost (AC) is calculated by summing the actual costs recorded for the tasks associated with each project.

The logical flow of information is presented below:

Planned Cost + Due Date → Planned Value (PV)

Planned Cost + Progress Percentage → Earned Value (EV)

Recorded Actual Cost → Actual Cost (AC)

PV, EV and AC → CPI and SPI

This configuration allows operational updates to be converted into project-level performance information without requiring manual calculations by the project manager.

3.5.2 Implementation of EVM Indicators in Airtable

The Tasks table is the main source of EVM input data. The Planned Cost, Actual Cost and Progress Percentage fields are maintained at task level. A formula field calculates task-level Earned Value using the following expression:

EVTask = Planned Cost × Progress Percentage

The Progress Percentage is stored as a percentage value in Airtable. Therefore, the formula is configured so that a task with a Planned Cost of 2,000€ and recorded progress of 60% generates an Earned Value of 1,200€.

Linked records connect tasks to their respective projects, while rollup fields aggregate task-level values to calculate project-level Planned Value, Earned Value and Actual Cost (Airtable, n.d.-a; Airtable, n.d.-b). These values are displayed through one current EVM record for each project and are assessed at the selected Reporting Date.

The main project-level performance formulas implemented in the prototype are:

CPI = EV / AC

SPI = EV / PV

Conditional formula logic is applied to CPI and SPI in order to avoid division-by-zero errors when no Actual Cost or Planned Value has been recorded. In such cases, the relevant indicator is displayed as blank rather than as a misleading numerical value.

The project-level EVM values are subsequently displayed in the Project EVM Review interface. This enables managers to view PV, EV, AC, CPI and SPI without performing manual calculations or navigating through individual task records.

3.5.3 Interpretation and Data-Quality Considerations

The implementation supports project monitoring by transforming task-level cost and progress information into integrated project-level EVM indicators. CPI values below 1.00 indicate unfavourable cost efficiency, while SPI values below 1.00 indicate that less work has been completed than planned by the Reporting Date.

The reliability of the calculated indicators depends on the quality of the input data. In particular, Planned Cost values should be aligned with the approved project budget, task progress should be updated consistently and Actual Cost should be recorded accurately and promptly. Incomplete or outdated task data may lead to misleading EVM results.

The percentage-complete approach was selected because it is simple to understand and practical for SME users. However, it depends on users providing realistic estimates of task completion. In future versions of the platform, the progress-measurement method could be improved through milestone-based completion rules or fixed earning rules, such as the 0/100 or 50/50 rule, when a more objective method of measuring task completion is required.

3.5.4 Implementation Workflow in Airtable

The platform was configured in Airtable through a sequence of linked database, formula and interface-design steps. Initially, the Projects, Milestones and Tasks tables were created and linked through Airtable linked-record fields. Each milestone was linked to one project, while each task was linked to its related project and milestone.

Secondly, the task-level fields required for operational monitoring and EVM calculation were configured. These fields included Task Name, Assignee, Due Date, Task Status, Progress Percentage, Planned Cost and Actual Cost. Formula fields were then used to derive task-level values and status classifications where required.

Thirdly, lookup and rollup fields were configured at project level to aggregate task-level cost and progress information. These aggregated values were used in formula fields to calculate PV, EV, AC, CPI and SPI for each project. Conditional logic was applied to avoid division-by-zero errors in the CPI and SPI calculations.

Finally, operational views and the Project EVM Review interface were configured to present the underlying data in a usable form. The operational views support project setup, task-status monitoring, deadline monitoring and the identification of tasks requiring attention. The EVM Review presents the project-level indicators and management-oriented interpretation fields.

This configuration creates the following flow of information:

Project and milestone setup → Task creation and data entry → Task-level progress and cost updates → Project-level EVM calculations → EVM Review

3.6 User Interface Design

The user interfaces were designed to make project information accessible, understandable and operationally useful for SME users. Although the underlying Airtable base contains several connected tables and calculated fields, end users should not need to work directly with the full database structure during daily project-management activities. For this reason, Airtable Interfaces were used to provide a simplified layer through which users can plan projects, update tasks and monitor project performance.

Airtable Interfaces are designed above the existing data layer and can use different layouts, filters, visualisations and user actions. This feature was particularly useful in the development of the proposed platform because the same data can be presented in different ways according to the needs of the user. For example, project managers can use the EVM Review for project-level performance assessment, while task-level views support the review and updating of operational task information.

The interface design follows four principles:

- Simplicity: Information should be presented clearly, without requiring users to navigate complex database tables
- Relevance to the role: Each interface should support a specific project-management activity, such as planning, task execution or performance measurement
- Clarity: Indicators, progress values and status tags should allow users to understand the relevant information quickly
- Decision-making**:** The interface should support the early identification of delays, deviations and EVM performance issues

Three complementary interfaces were configured: Project Planning, Task Management and Performance Monitoring. Together, they create a workflow from project planning to performance measurement.

3.6.1 Project Planning Interface

The Project Planning interface supports the creation and review of projects and milestones. It provides users with a structured view of planned project activities and important delivery points. The interface is connected primarily to the Milestones table, while milestone records remain linked to the relevant projects.

The main purpose of this interface is to allow users to:

- View project milestones
- Identify key project deliverables

- Review planned milestone due dates
- Monitor milestone completion status
- Record new milestones or update existing ones
- Establish and maintain a basic project schedule

In the interface, milestones appear as a list. Each entry contains information such as the name of the milestone, the related project, the due date, the completion status and the milestone owner. This arrangement enables users to review the major control points of each project without examining all individual tasks.

The Project Planning interface is particularly appropriate for SMEs because project planning is often carried out by project owners, project managers and small teams that need a simple view of the planning process rather than a complex scheduling interface. Instead of using sophisticated scheduling systems with multiple configurations, the interface supports the simple establishment of baselines and monitoring of key deliverables.

Milestone-based planning also supports the application of EVM. Milestones connect project planning with the detailed tasks that form the project plan. They help managers understand whether a delay in a particular task may affect an important project deliverable.

3.6.2 Task Management Views

Task records can be updated through the Airtable base, allowing the project manager to maintain task status, Progress Percentage, Due Date and cost information. The Kanban Board, Deadline Calendar, At-Risk Tasks view and Tasks/Data view present these records from different operational perspectives.

The hierarchy between projects, milestones and tasks can be represented as follows:

Project → Milestone → Task

This hierarchical representation was adopted according to the work-breakdown principle followed by the platform. A user can begin at project level, examine the relevant milestone and then review the tasks that should be completed in order to achieve that milestone.

The Task Management interface is linked with the Projects table as its primary database. However, it also displays the milestones and tasks linked with each project. This design was selected because it allows users to understand the context of each task.

The Task Management interface includes information such as:

- Project Name
- Project Start Date and Target End Date
- Project Status
- Milestone Name and Due Date
- Milestone Completion Status
- Task Name
- Assigned team member

- Task Due Date
- Task Status
- Task Progress Percentage
- Planned Cost and Actual Cost, where applicable

In addition, authorised users can update relevant data through the interface. Thus, team members and project managers can change task status, Progress Percentage, Due Date and cost values. In the implemented interface, authorised users can search, filter and update records that are relevant to their responsibilities.

The Task Management interface is especially useful for SMEs for several reasons. Firstly, SMEs often have limited human resources, meaning that one employee may participate in more than one project at the same time. Therefore, monitoring task assignment is important for managers in order to clarify responsibilities and avoid misunderstandings. Secondly, SME teams usually require simple solutions that can be updated regularly without specialised technical skills. The interface presents operationally relevant fields rather than the entire database structure.

The Progress Percentage field is particularly important because it is used in EVM calculations. Changes in recorded Progress Percentage are used to calculate the Earned Value of each task.

3.6.3 Performance Monitoring Interface

The Project EVM Review interface provides a project-level view of the EVM monitoring function of the final prototype. It presents the EVM values calculated from the task records linked to the selected project.

The interface displays the following information:

- Planned Value (PV)
- Earned Value (EV)
- Actual Cost (AC)
- Cost Performance Index (CPI)
- Schedule Performance Index (SPI)
- Overall EVM Status
- Recommended Action

The purpose of the interface is to enable the project manager to review cost and schedule performance without manually aggregating task-level data. PV, EV and AC provide the basic performance values, while CPI and SPI provide relative indicators of cost and schedule efficiency.

The Overall EVM Status and Recommended Action fields translate the calculated EVM indicators into concise management-oriented information. For example, an SPI below 1.00 may indicate that less work has been completed than planned by the Reporting Date, while a CPI below 1.00 may indicate unfavourable cost efficiency. The user can then review the related tasks, due dates, progress entries and actual costs in order to investigate the reason for the deviation.

The detailed operation of the EVM Review interface and its response to task-level updates are demonstrated in a later section.

3.6.4 Role of Each Interface

The three interfaces were designed as complementary components rather than independent pages. Each one supports a different stage of the project-management process.

Platform component	Main purpose	Primary user
Create Project Form	Records core project information and creates a new project record	Project manager
Projects and Milestones records	Organise projects and their main control points	Project manager
Tasks/Data view	Records and reviews task-level progress, costs, deadlines and status information	Project manager and authorised team members

Table 12: Role of the Final Platform Views and Interface

The platform components support a sequence from project setup to task-level monitoring and project-level EVM review. Initially, project and milestone information is created. Then, tasks are added and updated. Finally, task-level progress and cost data are aggregated for performance monitoring through the Project EVM Review.

The intended information flow is as follows:

Planning → Task Management → Performance Monitoring

Firstly, project and milestone data are defined through the Project Planning interface. Secondly, tasks are created and maintained through the Task Management interface. Finally, progress and cost data are transformed into EVM information and presented through the Performance Monitoring interface.

This sequence creates a clear flow from the planning stage, through execution, to the control stage. It also reduces cognitive overload because users interact mainly with the page that is related to their responsibilities.

3.7 Automatic Field Logic and Decision Support

The final prototype does not use active notification automations, such as automated email reminders or budget-alert workflows. Instead, it uses Airtable formula fields, lookup fields and rollup fields to update calculated values and status information automatically when relevant task-level data are entered or modified.

At task level, the platform uses calculated fields to support the identification of schedule and cost issues. For example, the Schedule Status and Cost Status fields are derived from task Due Date, completion status, Planned Cost and Actual Cost information. These calculated fields are then used in the At-Risk Tasks view to highlight records that require attention.

At project level, linked records, rollups and formula fields aggregate task-level Planned Cost, Progress Percentage, Actual Cost and planned completion-date data. The resulting values are used to calculate PV, EV, AC, CPI and SPI. The Overall EVM Status and Recommended Action fields are then updated automatically according to the calculated EVM indicators.

This approach supports decision-making by reducing manual calculation and by presenting task-level and project-level status information in the relevant views and Project EVM Review interface. However, users remain responsible for reviewing the underlying data and deciding whether corrective action is required.

3.8 Overall Architecture of the Platform

The proposed platform was implemented as an integrated no-code project management prototype in Airtable. Its architecture combines a relational database, EVM calculation logic, user-facing interfaces and automatic field updates within a single digital environment.

At the operational level, users create projects, define milestones, assign tasks and update task progress and actual cost. Linked records, formula fields and rollup fields transform these task-level inputs into project-level EVM information. The resulting indicators are presented through the Performance Monitoring interface, while the Project Planning and Task Management interfaces support the planning and execution activities that provide the required data.

Formula fields, lookup fields and rollup fields operate throughout this workflow by updating task-level status information and project-level EVM values when relevant records are modified.

This design is appropriate for the scope of the prototype because it provides SMEs with a structured and accessible EVM-enabled environment without requiring custom software development or the complexity of an enterprise project management system.

3.9 Chapter Summary

This chapter presented the design and implementation of an Airtable-based digital project management prototype that incorporates Earned Value Management principles for small and medium-sized enterprises.

The prototype integrates project planning, milestone and task management, responsibility assignment, cost recording and EVM-based performance monitoring within a single no-code environment. Its relational database structure enables task-level Planned Cost, Actual Cost and Progress Percentage data to be transformed into project-level performance indicators, including PV, EV, AC, CPI and SPI. It also provides dedicated components for project planning, task management and performance monitoring.

Overall, the prototype demonstrates a practical approach to implementing EVM in an accessible digital environment for SMEs. It is intended to provide a structured alternative to fragmented spreadsheets and manual calculations, rather than to replace enterprise project-management or ERP systems.

Chapter 4: Implementation and Functional Evaluation of the Airtable-Based EVM Prototype

4.1 Introduction

This chapter presents the development, implementation and evaluation of the proposed digital project management platform for small and medium-sized enterprises (SMEs). The platform was developed in Airtable as a no-code solution which combines basic project management functions with Earned Value Management (EVM) tracking. Its purpose is to provide an accessible environment where project managers can organise projects, milestones and tasks, monitor deadlines and costs, and assess project performance through EVM indicators. Initially, the prototype was developed based on the relationship between Projects, Milestones and Tasks. At project level, the user can enter the main project information, such as Project Name, Start Date, Target End Date, Overall Budget, Status, Phase and Reporting Date. Each milestone is linked to a specific project, while each task is linked to the relevant milestone and project.

The platform also includes operational views, such as the Kanban Board, Deadline Calendar and At-Risk Tasks view, together with project-level EVM calculations. More specifically, the EVM component includes Planned Value (PV), Earned Value (EV), Actual Cost (AC), Cost Performance Index (CPI) and Schedule Performance Index (SPI). CPI is calculated as EV/AC and shows cost efficiency, whereas SPI is calculated as EV/PV and shows schedule efficiency.

The following sections explain how the platform operates and how the prototype supports project setup, task management, identification of risks and performance assessment. Finally, the chapter presents a dynamic update scenario in order to demonstrate how task-level changes are reflected in the project-level EVM results.

4.2 Prototype Development Environment

The final prototype was implemented in Airtable as a relational no-code project management application. Its main data structure consists of three operational entities: Projects, Milestones and Tasks. One project may include multiple milestones, while each milestone may include multiple tasks. In addition, each task is linked to its parent project in order to support project-level aggregation and reporting.

The Projects table stores the main project information, including Project Name, Start Date, Target End Date, Overall Budget, Status, Phase and Reporting Date. The Milestones table records the main project control points and deliverables. The Tasks table stores the

operational information needed for monitoring, including Task Name, Assignee, Due Date, Task Status, Progress Percentage, Planned Cost and Actual Cost.

The task-level data, such as Progress Percentage, Planned Cost, Actual Cost and Due Date, are aggregated through Airtable linked records, rollup fields and formula fields. In this way, the platform calculates project-level EVM values. Therefore, when users modify relevant task records, the project-level performance information can also be updated.

4.3 Project Creation and Initial Setup

The creation of a project is the first step in using the prototype. This is done through the Create Project Form, which provides a simple and structured way to enter the information required for a new project. The form supports more consistent data entry because the required project fields are presented in one interface. However, the quality of the project information still depends on the accuracy of the data entered by the user and the appropriate validation of the fields.

When information is submitted through the Airtable form, it is transferred directly to the Projects table and a new project record is created. The new record is then available for planning and monitoring activities.
Figure 1 shows a completed Create Project Form. The form includes the Project Name, Start Date, Target End Date, Overall Budget, Status, Phase and Reporting Date. The Project Name is used to identify the project within the prototype. The Start Date and Target End Date define the planned duration of the project. The Overall Budget provides the approved financial basis which is used later in the EVM calculations. In addition, Status and Phase show the current condition and lifecycle stage of the project. Finally, the Reporting Date is used as the reference date for analysing project progress and performance indicators.

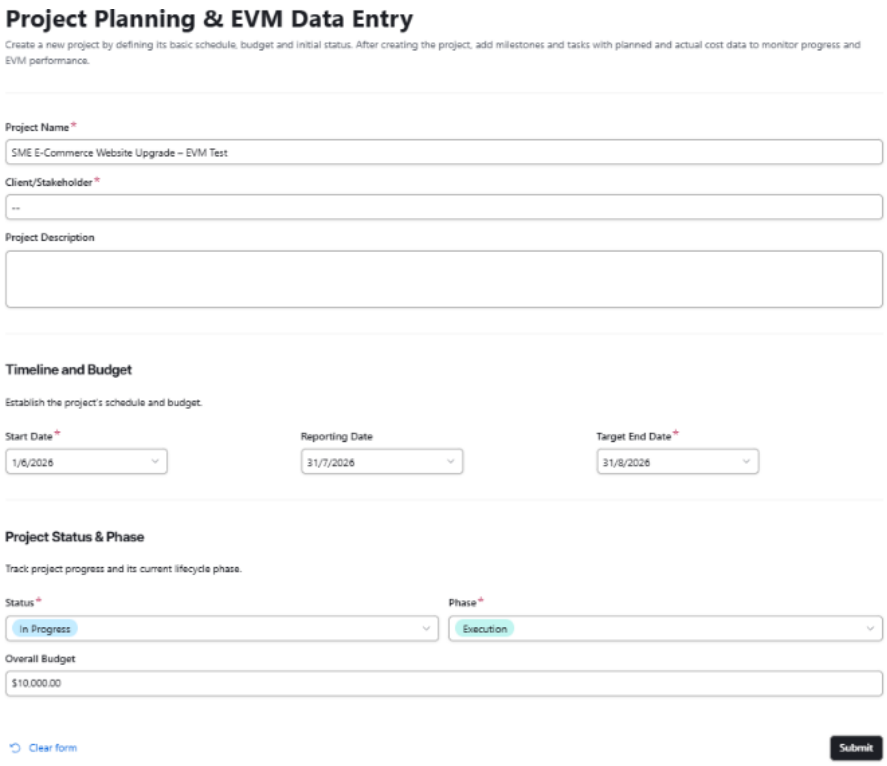


Figure 1: Completed Create Project Form prior to submission

After the form is submitted, the new project record is entered in the Projects table. This record becomes the parent record of the project structure and is connected with its respective milestones and tasks. Through linked-record fields, operational data recorded at milestone and task level can be connected with the correct project.

The next step is to create the milestones of the project. Milestones represent important control points, deliverables or phases within the project lifecycle. In the prototype, four milestones were created for the new project. Each milestone is linked to the project created above and includes information such as Due Date and Completion Status. Therefore, users can monitor the project stages according to their planned completion date and their current status.

Figure 2 shows the project record together with its four corresponding milestones. The use of milestones provides an intermediate control level between the whole project and the separate tasks. More specifically, milestones allow the project scope to be divided into smaller and more manageable stages. They also allow the user to check whether important output’s are being completed on schedule.



Figure 2: New project record and its four linked milestones, including due dates and completion status

In conclusion, the creation of the project and the setup of milestones form the basis for the further operation of the platform. After the project and milestones are created, detailed tasks can be assigned to each milestone. This makes it possible to collect task-level information about progress and costs and then calculate Earned Value Management indicators at project level.

4.4 Task Management and Operational Views

After the project and milestones have been created, the next step in the use of the prototype is the management of individual tasks. The Tasks table represents the main operational level of the platform because it stores the information required for task planning, assignment, progress monitoring and cost recording. Each task is linked to a specific project and milestone. Therefore, the platform creates a hierarchical structure:

Project → Milestone → Task

This hierarchy ensures that each task can be associated with a specific project deliverable and with the relevant performance information.

The main information recorded for each task includes Task Name, Assignee, Due Date, Progress Percentage, Planned Cost and Actual Cost, as shown in Figure 3. The Assignee field identifies the person responsible for completing the task. The Due Date field defines the planned deadline. The Progress Percentage field indicates the proportion of work completed and is used as an input for the Earned Value calculation. Planned Cost represents the budgeted cost of completing the task, whereas Actual Cost represents the expenditure recorded for the task.

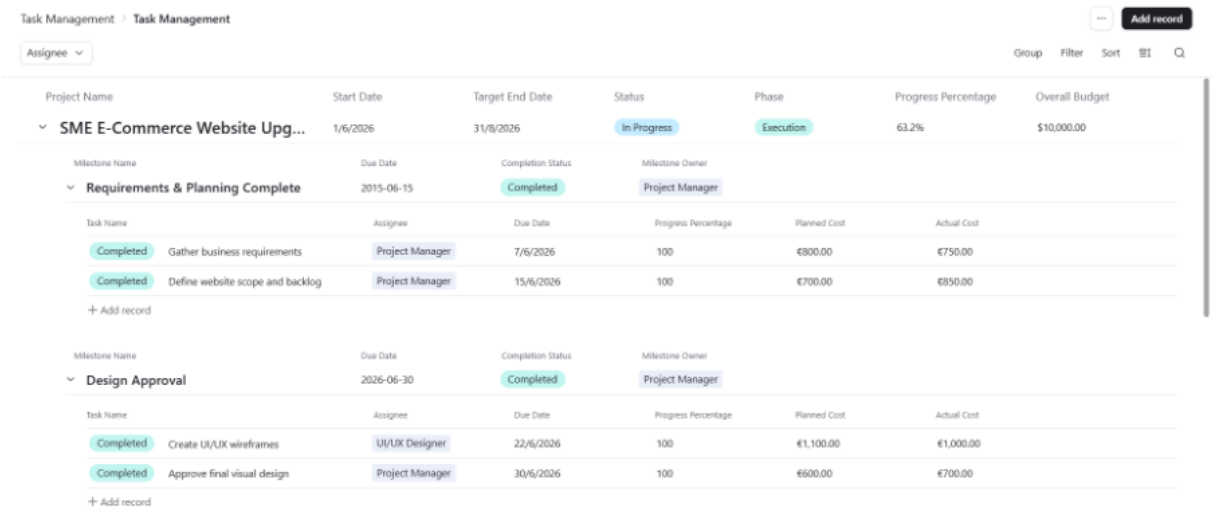


Figure 3: Task management structure showing the Project, Milestone and Task hierarchy and task-level fields

Task records allow the prototype to collect the information required for daily project coordination and EVM monitoring. More specifically, users enter progress and cost information at task level. Then, linked records, formula fields and rollup fields aggregate the information at milestone and project level. This reduces the need for separate spreadsheets and manual calculations. As a result, it also reduces the possibility of inconsistencies between task-level records and project-level reporting.

Another feature included in the prototype is the Kanban Board for task-status monitoring. As shown in Figure 4, tasks are grouped according to the statuses Not Started, In Progress and Completed. In this way, the project manager can obtain a direct view of the current workload and the distribution of tasks at different stages of completion.

The Kanban view in Airtable groups records into visual columns according to the value of a selected field, such as Task Status. Therefore, it can be used to monitor the workflow of the project.

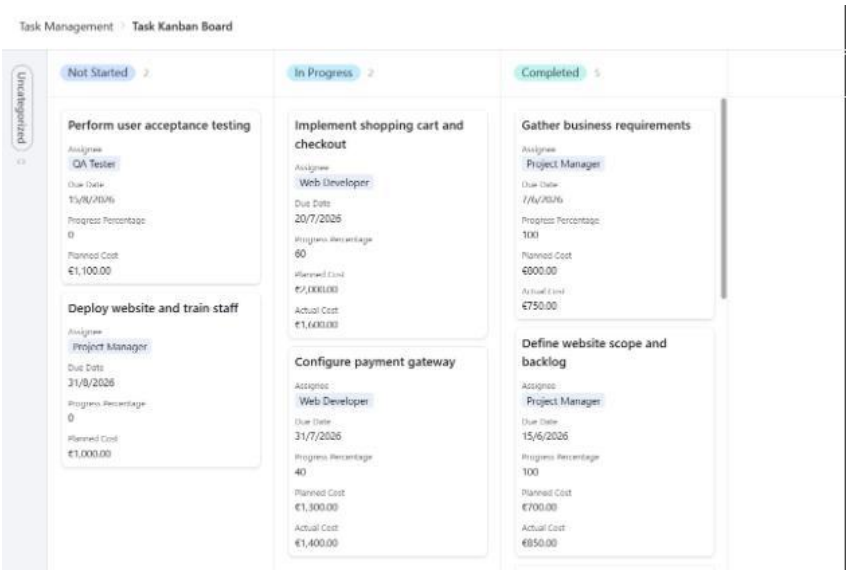


Figure 4: Task Kanban Board organised by task status

The platform also includes a Deadline Calendar. Figure 5 shows how the tasks of the new project are organised in a calendar view. This enables users to monitor task deadlines and identify periods in which several activities overlap. The Due Date field is used in the calendar view in order to arrange task records chronologically. Therefore, this view supports the monitoring of deadlines and the planning of upcoming activities.

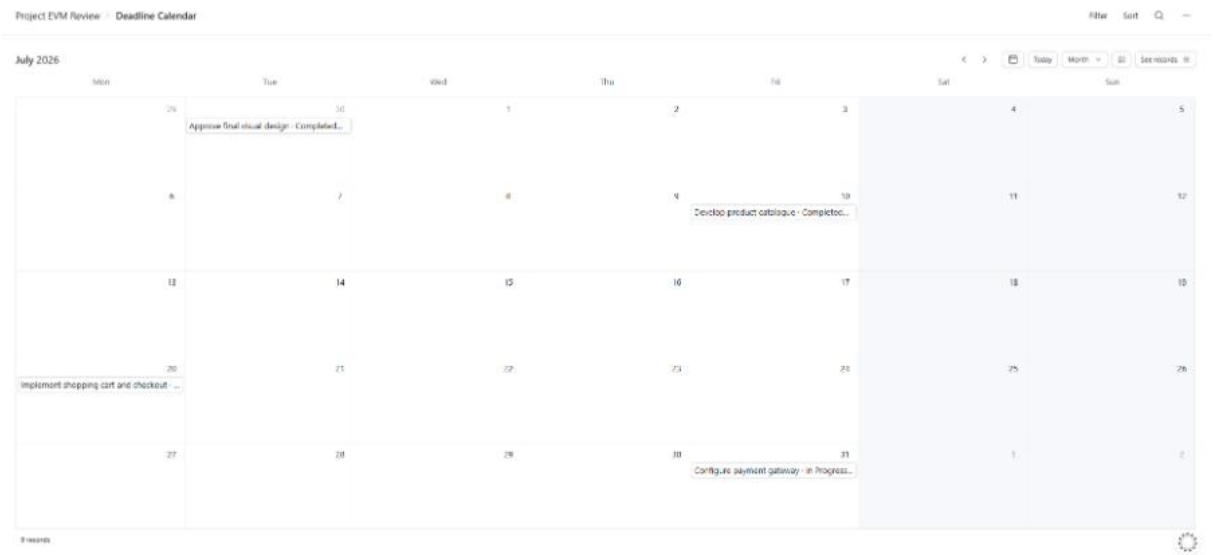


Figure 5: Deadline Calendar displaying task due dates for the new project

The At-Risk Tasks view is another feature of the platform. As shown in Figure 6, this view filters task records according to the conditions Schedule Status = Delayed or Cost Status = Over Budget. The purpose of this view is to direct the attention of the project manager towards tasks which may require corrective action.

Airtable filters allow records to be displayed according to selected conditions while the original task records remain available in the other views. Therefore, the project manager can identify problematic tasks without losing access to the complete task information.

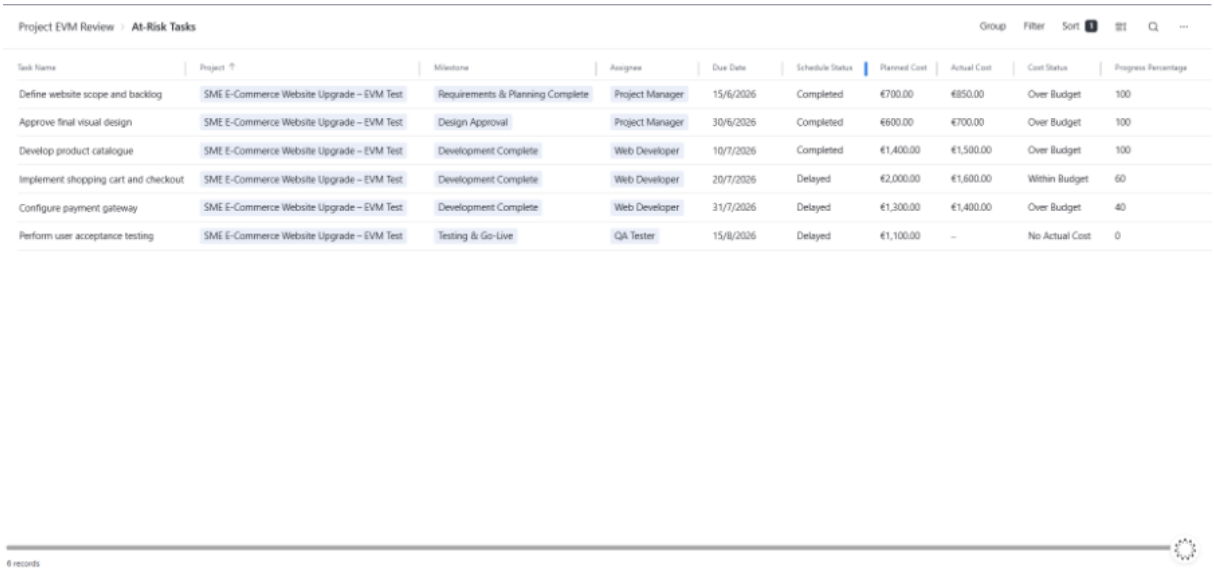


Figure 6: At-Risk Tasks view showing tasks classified as delayed or over budget

Finally, Figure 7 presents the Tasks/Data view. This view includes the main control information related to each task, such as Task Name, Due Date, Progress Percentage, Planned Cost, Actual Cost, Schedule Status and Cost Status. It provides a clear presentation of task-level data inputs and the automatic controls created by the prototype. Thus, users can observe the relationship between the information entered for each task and the schedule or cost-status results produced by the platform.

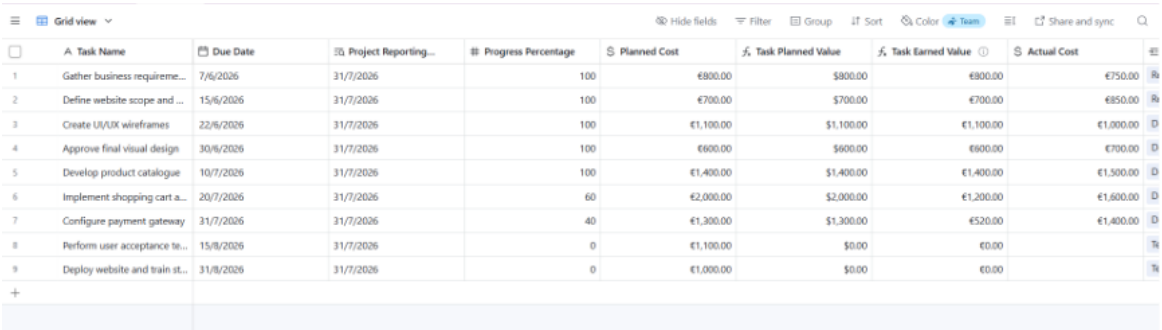


Figure 7: Tasks/Data view showing key task inputs and automatic schedule and cost-status controls

Overall, the views described above show that the prototype includes both task-management and project-monitoring functions. It allows users to manage tasks through task records, monitor task status, review deadlines and identify delayed or over-budget tasks. On that account, these views provide a centralised environment for task monitoring, deadline review and exception-based management.

4.5 Earned Value Management Review

The EVM Review is the main project-level monitoring component of the final prototype. It combines task-level information related to planned cost, due date, progress and actual cost into one project-level review. In this way, the project manager can assess the current cost and schedule performance of the project without manually collecting information from individual task records.

Initially, Planned Value (PV) is calculated as the sum of the Planned Cost of tasks with a Due Date on or before the selected Reporting Date. This creates a simplified time-phased baseline for the prototype. Earned Value (EV) is calculated at task level by multiplying the Planned Cost of each task by its recorded Progress Percentage. Actual Cost (AC) is calculated as the sum of the Actual Cost values recorded for the tasks linked to the selected project.

This PV calculation represents a simplified approach to time-phased planning. In conventional EVM, Planned Value is usually derived from a detailed cost baseline in which the budget of each activity is distributed across its planned duration. Therefore, a task that extends over several reporting periods may contribute only part of its planned budget to PV at a particular control date.

In the current prototype, the full Planned Cost of a task is included in PV when its Due Date is on or before the selected Reporting Date. The task Due Date is therefore used as the planned completion point for recognising the budgeted value of the activity. This approach was selected in order to maintain a simple and transparent calculation logic that can be applied using the task-level information recorded in Airtable.

The simplified calculation is appropriate for the intended SME context, where tasks may be relatively short and monitored through clearly defined deadlines or deliverables. It reduces the need to allocate each task budget across multiple reporting periods and avoids additional data-entry requirements. However, the approach depends on the use of meaningful Due Dates and a controlled project baseline. For longer-duration or high-cost activities, a more detailed time-phased allocation of Planned Cost could be incorporated in a future version of the platform.

The project-level values are calculated as follows:

PV = Sum of Planned Cost for tasks due on or before the Reporting Date

EV = Sum of (Planned Cost × Progress Percentage)

AC = Sum of Actual Cost

The prototype then calculates the Cost Performance Index and the Schedule Performance Index:

CPI = EV / AC

SPI = EV / PV

Conditional formula logic is used in order to avoid division-by-zero errors. When Actual Cost or Planned Value has not yet been recorded, the relevant index is displayed as blank rather than as a potentially misleading value.

Forecasting indicators, such as Estimate at Completion (EAC) and Estimate to Complete (ETC), are not included in the current EVM Review interface. Although these indicators are part of the wider EVM framework, their calculation requires assumptions regarding the expected performance of the remaining project work. For example, it is necessary to determine whether the current cost performance is expected to continue until project completion or whether the observed cost variance is temporary. Since different assumptions may produce different forecast values, EAC and ETC were considered outside the scope of the current prototype. The EVM Review therefore focuses on PV, EV, AC, CPI and SPI in order to provide SME users with a clear and directly interpretable view of current project cost and schedule performance. Forecasting indicators may be incorporated in a future version of the platform when more consistent project data and updated estimates of remaining work are available.
Figure 8 presents the EVM Review interface for the selected project. The interface displays PV, EV, AC, CPI and SPI, together with the Overall EVM Status and Recommended Action fields. These two fields are used to translate the numerical EVM results into a short management interpretation.

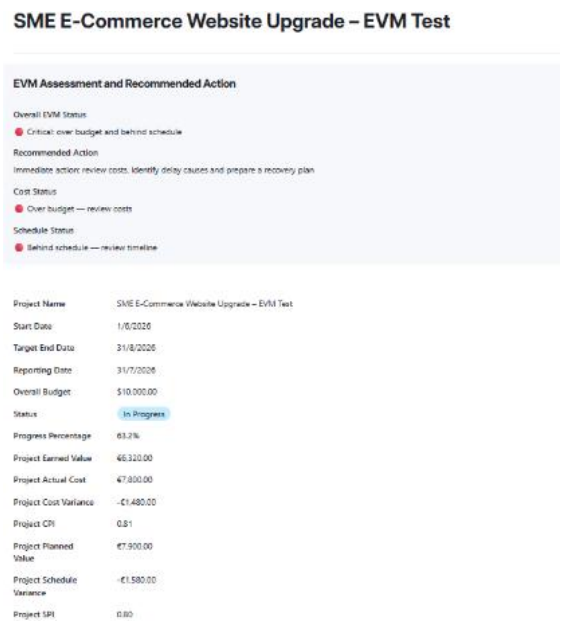


Figure 8: Project EVM Review displaying PV, EV, AC, CPI, SPI, Overall EVM Status and Recommended Action

Within the prototype, a CPI below 1.00 is interpreted as an indication of unfavourable cost efficiency. Similarly, an SPI below 1.00 indicates that less work has been completed than planned by the Reporting Date. When both indices are below 1.00, the Overall EVM Status identifies the project as requiring attention in relation to both cost and schedule performance.

These classifications are intended to support the initial review of the project manager. However, they should be interpreted together with the detailed information about tasks, milestones and costs that is available in the platform.

Therefore, the EVM Review creates a direct connection between operational task updates and project-level performance monitoring. Its use is demonstrated further through the dynamic update scenario presented in the following section.

4.6 Dynamic Update Scenario and Results

A dynamic update scenario was conducted in order to examine whether changes in task-level information were automatically reflected in project-level EVM indicators. The objective of the scenario was to demonstrate the automatic transfer of changes from task-level data to project-level EVM results.

This ability is important for an effective project management system because performance information should remain updated. In this way, project managers can identify deviations from the baseline and take the necessary corrective actions. EVM combines scope, schedule and cost information in order to create a performance baseline.

The scenario was based on a task recorded as In Progress, with a Progress Percentage of 63% and an Actual Cost of 7,800€. At this stage, the task represented partially completed work. Its Progress Percentage contributed proportionally to the Earned Value of the milestone and the project. At the same time, its Actual Cost was included in the cost-performance information of the project.
The task was then updated to Completed. Its Progress Percentage was changed from 63% to 100%. A revised Actual Cost was also entered to reflect the final recorded expenditure of the task. This action represents a realistic project-control situation in which work completion and cost information become available gradually, rather than being fully known at the beginning of the project.

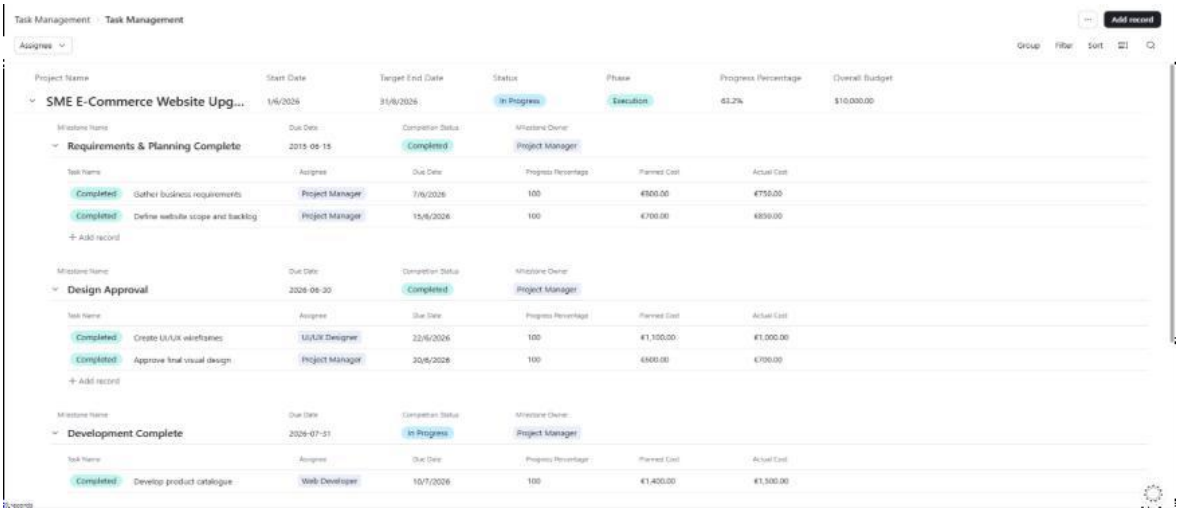


Figure 9: Task record before the update, showing an In Progress status, 63% progress and an Actual Cost of 7,800€

After the update, the platform recalculated the relevant task-level and project-level values. The completion of the task increased its contribution to EV because the full planned value of the completed task could now be recognised. At the same time, the revised Actual Cost affected the aggregated AC value. Since CPI is calculated from EV and AC, and SPI is calculated from EV and PV, any change in task progress or expenditure can affect the project's cost and schedule performance indicators.

This demonstrates the importance of maintaining accurate and timely task-level information. EVM uses EV, PV and AC to measure project progress and efficiency. Values below 1.00 for either CPI or SPI indicate performance that requires management attention.

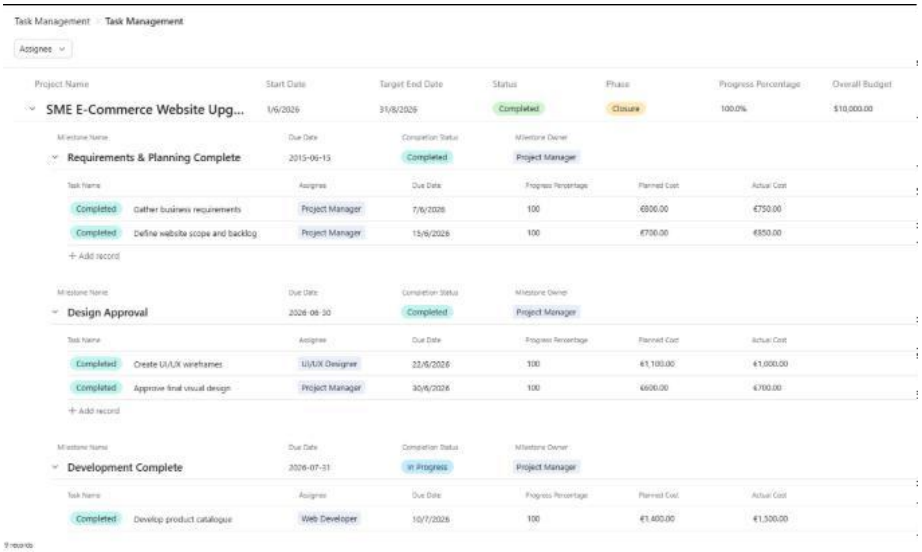


Figure 10: Updated task record showing Completed status, 100% progress and the revised Actual Cost

Figure 11 presents the updated EVM Review after the selected task was changed from In Progress to Completed, its Progress Percentage was updated from 63% to 100% and its Actual Cost was revised. Table 13 summarises the corresponding changes in the project-level EVM values.

After the update, PV, EV and AC became current, while the system recalculated CPI and SPI. The Overall EVM Status and the Recommended Action were also updated according to the new information. Therefore, the project manager can immediately observe whether the completed task improved the project's schedule performance, affected its cost efficiency or created a situation that requires further investigation.

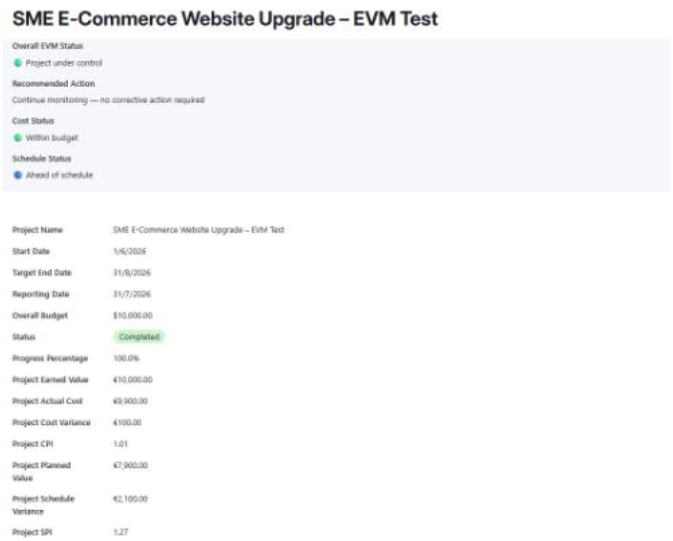


Figure 11: Updated Project EVM Review after the task status, Progress Percentage and Actual Cost were changed

Indicator	**Before update**	**After update**	**Change and interpretation**
Planned Value (PV)	7,900€	7,900€	PV remained unchanged because the Reporting Date, Planned Cost values and Due Dates were not modified during the scenario.
Earned Value (EV)	6,320€	10,000€	EV increased by €3,680 because the selected task was updated from partial completion to 100% completion. The increase shows that a greater amount of budgeted work was recognised as completed.
Actual Cost (AC)	7,800€	9,900€	AC increased by €2,100 following the update of the selected task's Actual Cost to reflect its final recorded expenditure.
Cost Performance Index (CPI)	0.81	1.01	CPI increased. Before the update, the project was cost inefficient because Earned Value was lower than Actual Cost. After the update, the project generated slightly more Earned Value than the Actual Cost incurred, indicating favourable cost performance.
Schedule Performance Index (SPI)	0.80	1.27	SPI increased. Before the update, the project had completed less work than planned by the Reporting Date. After the update, EV exceeded PV, indicating that the project had achieved more budgeted work than planned at the selected control point.
Overall EVM Status	Critical	Project under control	The project status changed. Both CPI and SPI improved to values above 1.00 after the task-level update. This indicates favourable cost and schedule performance according to the

			classification rules implemented in the prototype.

Table 13: Updated EVM Review

As shown in Table 13, the task-level update caused important changes in the project-level EVM results. Planned Value remained unchanged because no modification was made to the project baseline or to the Reporting Date. However, Earned Value increased from €6,320 to €10,000 because the selected task was updated to 100% completion.

Although Actual Cost also increased from 7,800€ to 9,900€, the increase in Earned Value was proportionally greater. Therefore, CPI improved from 0.81 to 1.01, while SPI improved from 0.80 to 1.27. The Overall EVM Status was also updated automatically from Critical to Project under control.

This result demonstrates that the prototype can transform task-level progress and cost updates into revised project-level performance information without requiring manual recalculation. The scenario also demonstrates that, within the prototype, a task-level update is transferred through the linked data structure and reflected in the EVM Review automatically. In other words, a change entered once at task level is transferred through the linked project structure and then appears in the project-level EVM Review. This reduces the possibility of inconsistent information and allows project managers to assess the current position of the project more quickly.

From the perspective of the project manager, the value of the platform is not limited to the calculation of EVM indicators. More specifically, it converts the indicators into information that can support management action. When the updated data show CPI or SPI values below 1.00, the project manager should investigate the reasons for the variance, assess the effect on the remaining tasks and take the necessary corrective measures.

Overall, the dynamic update scenario showed how the prototype can support a continuous monitoring process. New task-level data are entered, the project performance information is recalculated, deviations are identified and management action can be taken when required. This capability may be useful for SMEs because it reduces the effort required to consolidate task-level information for project-level performance review.

4.7 Evaluation of the Prototype

The prototype was evaluated according to the functional requirements defined in Section 3.2. The evaluation examined whether the final Airtable configuration could support the main functions required for structured project setup, task-level monitoring, basic EVM calculations and project-level performance review.

Table 14 presents the results of the evaluation.

Functional requirement	**Evidence in the final prototype**	**Evaluation result**
Project creation and organisation	Create Project Form, Projects table and linked milestones	Achieved

Milestone and task management	Linked Projects, Milestones and Tasks records; task-level data fields	Achieved
Deadline monitoring	Deadline Calendar and Task Due Date fields	Achieved
Task-status monitoring	Kanban Board organised by Task Status	Achieved
Identification of tasks requiring attention	At-Risk Tasks view filtered by Schedule Status and Cost Status	Achieved
Cost and progress recording	Planned Cost, Actual Cost and Progress Percentage fields	Achieved
Project-level EVM monitoring	EVM Review displaying PV, EV, AC, CPI and SPI	Achieved
Automatic recalculation after task updates	Dynamic update scenario in Section 4.6	Achieved
Forecasting indicators, such as EAC and ETC	Not included in the current prototype	Not achieved / future enhancement
Long-term evaluation by SME users	No longitudinal pilot deployment conducted	Not evaluated

Table 14: Evaluation of the Prototype Against the Functional Requirements

The evaluation indicates that the prototype achieved the main functional requirements defined for the study. More specifically, it demonstrated the integration of project organisation, task-level operational monitoring and basic EVM performance review within one Airtable environment. The dynamic update scenario also showed that modifications to task progress and Actual Cost data were reflected automatically in project-level EVM results.

However, the evaluation was limited to functional testing and demonstration. It did not examine long-term usability, user acceptance, organisational adoption, data-entry discipline or the effect of the platform on actual project outcomes in SMEs. These limitations should be considered when evaluating the practical usefulness of the prototype.

4.8 Chapter Summary

The final prototype uses linked Projects, Milestones and Tasks records in order to support project setup, task assignment, deadline monitoring, progress recording and cost recording within one relational environment.

The platform includes operational views, such as the Create Project Form, Kanban Board, Deadline Calendar, At-Risk Tasks view and Tasks/Data view. At project level, the EVM Review aggregates task-level information in order to display PV, EV, AC, CPI and SPI, together with Overall EVM Status and Recommended Action.

The dynamic update scenario demonstrated that a change in task progress and Actual Cost was reflected automatically in the project-level EVM results. The functional evaluation showed that the prototype achieved its main design requirements. However, its usability and practical value in real SME environments require further evaluation.

Chapter 5: Conclusions and Recommendations

5.1 Introduction

The purpose of the study was to examine whether a practical, low-cost and accessible digital platform could combine basic project-management functions with EVM-based cost and schedule monitoring for SMEs.

5.2 Summary of Findings

The study demonstrated that it's technically possible to develop an Airtable-based no-code prototype which combines structured project organisation with basic Earned Value Management monitoring. The final prototype linked Projects, Milestones and Tasks through a relational structure. This allowed task-level progress and cost information to be combined and reviewed at project level.

The prototype achieved the main functional requirements of the study. More specifically, it supported project creation, milestone and task organisation, task-status monitoring, deadline monitoring and the identification of delayed or over-budget tasks. It also allowed users to record Planned Cost, Actual Cost and Progress Percentage. These functions were presented through operational views which support the day-to-day monitoring of projects.

The main result of the study was the implementation of project-level EVM monitoring. The prototype calculated and displayed Planned Value, Earned Value, Actual Cost, Cost Performance Index and Schedule Performance Index. These indicators allowed the project manager to examine cost and schedule performance together, rather than relying only on task-status updates or total expenditure.

The dynamic update scenario also demonstrated that a change in the Progress Percentage and Actual Cost of a task was reflected automatically in the project-level EVM Review. Within the scope of the prototype, this showed that linked records, formula fields and rollup fields can reduce the need for manual aggregation of task-level information.

Overall, the findings suggest that an accessible no-code environment can support the implementation of basic EVM monitoring when project cost, schedule and progress information is structured and updated consistently. The prototype is not intended to replace specialised enterprise project-control systems. Instead, it presents a lower-complexity approach which can be further evaluated in SME environments.

5.3 Contribution of the Study

The main contribution of this study is the design and implementation of a functional Airtable-based prototype which combines core project-management functions with basic EVM monitoring. The prototype demonstrates how project, milestone and task information can be linked in order to aggregate task-level progress and cost data into project-level performance indicators.

A second contribution is related to the implementation environment selected for the prototype. Airtable was used to create a relational database without conventional programming. More specifically, linked records, formulas, rollups, forms and operational views were used to combine information about projects, milestones and tasks. The use of Airtable reduced the need for traditional software development during the creation of the prototype. Therefore, it may reduce implementation barriers for organisations that need a configurable solution without developing a separate software application.
The platform also contributes by combining operational monitoring with management-level review. Project managers can use the task views to coordinate day-to-day work, while the EVM Review provides a broader view of whether the project is progressing according to its planned budget and schedule. This connection follows the EVM principle that scope, schedule and cost information should be linked to a defined performance baseline (Fleming and Koppelman, 2016).

Finally, the platform translates numerical indicators into easier-to-understand outputs through the Overall EVM Status and Recommended Action fields. This is important for users who may not be familiar with the interpretation of CPI and SPI. Instead of presenting only numerical values, the platform helps users identify whether the project is on track, delayed, over budget or affected by both cost and schedule problems.

ΒΙΒΛΙΟΓΡΑΦΙΑ

- Aaltonen, K., Ahola, T. and Ruuska, I. (2016) ‘Project change stakeholder communication’, *International Journal of Project Management*, 34(8), pp. 1579–1595.
- Abdullah, A., Abdul-Samad, Z., Abdul-Rahman, H. and Salleh, H. (n.d.) ‘Project management methods, guides and standards: A critical overview’, *Journal of Project Management Practice*, 1(1), pp. 35–51. Available at: https://doi.org/10.22452/jpmp.vol1no1.3.
- Affandi, M.L. and Nainggolan, R. (2026) ‘The effect of path-goal leadership on project success through communication with conflict management as a moderating variable’, *Journal of Economics and Management Sciences*, 8(2), pp. 738–746. Available at: https://doi.org/10.37034/jems.v8i2.378jems.
- Airtable (n.d.-a) ‘Linking records in Airtable’. Available at: https://support.airtable.com/v1/docs/linking-records-in-airtable.
- Airtable (n.d.-b) ‘Rollup field overview’. Available at: https://support.airtable.com/v1/docs/rollup-field-overview.
- Airtable (n.d.-c) ‘Airtable Pricing: Compare plans, features and costs’. Available at: https://airtable.com/pricing.
- Al-Baik, O. and Miller, J. (2015) ‘The Kanban approach, between agility and leanness: A systematic review’, *Empirical Software Engineering*, 20(6), pp. 1861–1897. Available at: https://doi.org/10.1007/s10664-014-9340-x.
- Alvarenga, J.C., Branco, R.R., Guedes, A.L.A., Soares, C.A.P. and Silva, W.S.E. (2020) ‘The project manager core competencies to project success’, *International Journal of Managing Projects in Business*, 13(2), pp. 277–292. Available at: https://doi.org/10.1108/IJMPB-12-2018-0274.
- Anbari, F.T. (2003) ‘Earned value project management method and extensions’, *Project Management Journal*, 34(4), pp. 12–23. Available at: https://doi.org/10.1177/875697280303400403.
- Aramali, V., Sanboskani, H., Gibson, G.E., El Asmar, M. and Cho, N. (2022) ‘Forward-looking state-of-the-art review on earned value management systems: The disconnect between academia and industry’, *Journal of Management in Engineering*, 38(3), 03122001. Available at: https://doi.org/10.1061/(ASCE)ME.1943-5479.0001019.
- Archibald, R.D., Di Filippo, I. and Di Filippo, D. (2012) ‘The six-phase comprehensive project life cycle model including the project incubation/feasibility phase and the post-project evaluation phase’, *PM World Journal*, 1(5).
- Baccarini, D. (1999) ‘Criteria of project success: An exploratory re-examination’, *International Journal of Project Management*, 17(1), pp. 25–32.
- Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R.C., Mellor, S., Schwaber, K., Sutherland, J. and Thomas, D. (2001) *Manifesto for Agile Software Development*. Available at: https://agilemanifesto.org.
- Benington, H.D. (1983) ‘Production of large computer programs’, *Annals of the History of Computing*, 5(4), pp. 350–361. Available at: https://doi.org/10.1109/MAHC.1983.10102. (Original work presented 1956).

- Braun, C.C., Johnston, J.H. and Wildman, J.L. (2024) ‘Team workload in action teams: A review of empirical evidence’, *Human Factors*, advance online publication.
- Čabarkapa, J. (2019) ‘Analysis and comparison of ISO 21500 Guidance on project management and PMBOK 6th Guide’, in *5th IPMA SENET Project Management Conference (SENET 2019)*. Atlantis Press, pp. 266–271.
- Cardona-Meza, L. and Olivar-Tost, G. (2017) ‘Modeling and simulation of project management through the PMBOK® standard using complex networks’, *Complexity*, 2017, pp. 1–12. Available at: https://doi.org/10.1155/2017/4791635.
- Chen, S. and Zhang, X. (2012) ‘An analytic review of earned value management studies in the construction industry’, in *Construction Research Congress 2012: Construction Challenges in a Flat World*. Reston, VA: American Society of Civil Engineers, pp. 236–246.
- Chilton, M.A. (2014) ‘Resource allocation in IT projects: Using schedule optimization’, *International Journal of Information Systems and Project Management*, 2(3), pp. 47–59. Available at: https://doi.org/10.12821/ijispm020303.
- Cora Systems (2025) ‘Earned Value Management Systems: Key tools and benefits’. Available at: https://corasystems.com/blog/what-is-earned-value-management-and-how-does-it-work.
- Dicks, E.P. and Molenaar, K.R. (2025) ‘Causes of incomplete risk identification in major transportation engineering and construction projects’, *Transportation Research Record*, 2679(2). Available at: https://doi.org/10.1177/03611981241263565.
- Dong, H., Dacre, N., Baxter, D. and Ceylan, S. (2024) ‘What is agile project management? Developing a new definition following a systematic literature review’, *Project Management Journal*, 55(6), pp. 607–626. Available at: https://doi.org/10.1177/87569728241254095.
- Dybå, T. and Dingsøyr, T. (2008) ‘Empirical studies of agile software development: A systematic review’, *Information and Software Technology*, 50(9–10), pp. 833–859. Available at: https://doi.org/10.1016/j.infsof.2008.01.006.
- Elsaid, M. *et al.* (2025) ‘Comparative analysis of earned value management techniques in forecasting project cost and time’, *Scientific Reports*, 15, 21611. Available at: https://doi.org/10.1038/s41598-025-05834-z.
- Fleming, Q.W. and Koppelman, J.M. (2016) *Earned Value Project Management*. 4th edn. Newtown Square, PA: Project Management Institute.
- Galli, B.J. (2019) ‘Barriers to effective communication and stakeholder management in project environments and how to overcome these barriers’, *International Journal of Applied Logistics*, 9(2), pp. 39–57.
- Galorath (2025) ‘AI-driven forecasting for earned value management’. Available at: https://galorath.com/seer/use-case/earned-value-management-evm/.
- Gomes, J. and Romão, M. (2016) ‘Improving project success: A case study using benefits and project management’, *Procedia Computer Science*, 100, pp. 489–497.
- Hexagon (2024) ‘Earned value and performance management’. Available at: https://hexagon.com/solutions/earned-value-performance-management.
- Johansson, M. (2014) *Performance Measurement in Small to Medium-Sized Development Projects: A Study of Earned Value Management*. Master’s thesis. Available at: https://www.diva-portal.org/smash/get/diva2:752382/FULLTEXT01.pdf.

- Jovanović, M. (2023) ‘Low-Code/No-Code Platforms and Their Impact on Traditional Software Development: A Literature Review’, *SSRN*. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4499564.
- Jun, S.-C. and Kim, J.-H. (2008) ‘Case studies of software development applying EVM (Earned Value Management)’, *Journal of IT Services*. Available at: https://koreascience.kr/.
- Kelley, J.E., Jr. (1961) ‘Critical-path planning and scheduling: Mathematical basis’, *Operations Research*, 9(3), pp. 296–320. Available at: https://doi.org/10.1287/opre.9.3.296.
- Kerkhove, L.-P. and Vanhoucke, M. (2017) ‘Extensions of earned value management: Using the earned incentive metric to improve signal quality’, *International Journal of Project Management*, 35(2), pp. 148–168. Available at: https://doi.org/10.1016/j.ijproman.2016.10.014.
- Khesal, T., Saghaei, A., Khalilzadeh, M., Rahiminezhad Galankashi, M. and Soltani, R. (2019) ‘Integrated cost, quality, risk and schedule control through earned value management (EVM)’, *Journal of Engineering, Design and Technology*, 17(1), pp. 183–203. Available at: https://doi.org/10.1108/JEDT-02-2018-0034.
- Kim, B.C., Wells, W.G. and Duffey, M.R. (2003) ‘A model for effective implementation of earned value management methodology’, *International Journal of Project Management*, 21(5), pp. 375–382.
- Kim, T., Cho, H., Jung, M., Kim, T. and Park, J. (2023) ‘Team workload: Review and conceptualization’, *Applied Ergonomics*, advance online publication.
- Krupa, M. and Hájek, J. (2024) ‘Hybrid project management models: A systematic literature review’, *International Journal of Project Organisation and Management*, 16(2), pp. 233–261. Available at: https://doi.org/10.1504/IJPOM.2024.139253.
- Leal, G.F.L., Malheiros, V., Penaforte, A.A., Soares, M.S., Cunha, J. and Oliveira, T.C. (2018) ‘On the benefits and challenges of using Kanban in software engineering: A structured synthesis study’, *Journal of Software Engineering Research and Development*, 6(1), Article 15. Available at: https://doi.org/10.1186/s40411-018-0057-1.
- Lindner, F. and Wald, A. (2011) ‘Success factors of knowledge management in temporary organizations’, *International Journal of Project Management*, 29(7), pp. 877–888.
- Lipke, W. (2003) ‘Schedule is different’, *The Measurable News*, Summer, pp. 31–34.
- Liu, G. and Jiang, H. (2020) ‘Performance monitoring of project earned value considering scope and quality’, *KSCE Journal of Civil Engineering*, 24, pp. 10–18. Available at: https://doi.org/10.1007/s12205-020-1054-6.
- Mahamid, I. and Bassioni, H. (2012) ‘Using the earned value management system to improve electrical project control’, *Journal of Construction Engineering and Management*, 138(3), pp. 369–379.
- Martinez, E. *et al.* (2023) ‘Benefits and limitations of using low-code development to support digital transformation’, *The Journal of Strategic Information Systems*.
- Mayo-Alvarez, L., Alvarez-Risco, A., Del-Aguila-Arcentales, S., Sekar, M.C. and Yáñez, J.A. (2022) ‘A systematic review of earned value management methods for monitoring and control of project schedule performance: An AHP approach’, *Sustainability*, 14(22), 15259. Available at: https://doi.org/10.3390/su142215259.

- Michelberger, P. and Pató, B.S.G. (2021) ‘Project risks and risky projects’, *International Journal of Engineering and Management Sciences*, 6(2), pp. 164–189. Available at: https://doi.org/10.21791/IJEMS.2021.2.14.
- Mitchell, D. and Mitchell, S. (2024) ‘Don’t go chasing waterfalls? How complexity demands more agile project management approaches to municipal strategy implementation’, *State and Local Government Review*, 56(2), pp. 137–156. Available at: https://doi.org/10.1177/0160323X231215056.
- Naqvi, I.H., Aziz, S. and Kashif-ur-Rehman (2011) ‘The impact of stakeholder communication on project outcome’, *African Journal of Business Management*, 5(14), pp. 5824–5832.
- National Aeronautics and Space Administration (NASA) (2018) ‘EVM Tutorial’. Available at: https://www.nasa.gov/.
- Netto, J.T., de Oliveira, N.L.F., Freitas, A.P.A. and dos Santos, J.A.N. (2020) ‘Critical factors and benefits in the use of earned value management in construction’, *Brazilian Journal of Operations & Production Management*, 17(1), pp. 1–10. Available at: https://doi.org/10.14488/BJOPM.2020.007.
- Nieto-Rodriguez, A. (2024) *Hybrid Project Management: First Global Survey*. Available at: https://antonionietorodriguez.com/wp-content/uploads/2024/06/Hybrid-Project-Management-Global-Survey-Results-2024-1.pdf.
- Nizam, A. and Elshannaway, A. (2019) ‘Review of earned value management (EVM) methodology, its limitations, and applicable extensions’, *Journal of Management and Engineering Integration*, 12(1), pp. 59–70. Available at: https://doi.org/10.62704/10057/24251.
- Oracle (2020) ‘Earned Value Management re-imagined solution brief’. Available at: https://www.oracle.com/construction-engineering/unifier-project-controls-asset-management/earned-value-management-solution-brief/.
- Pacagnella Junior, A.C. and da Silva, V.R. (2023) ‘20 years of the Agile Manifesto: A literature review on agile project management’, *Management and Production Engineering Review*, 14(2), pp. 37–48. Available at: https://doi.org/10.24425/mper.2023.146021.
- Petrović, D., Mihić, M. and Obradović, V. (2014) ‘Strategic project management—Project strategy and measurement of success’, in Vrontis, D., Weber, Y. and Tsoukatos, E. (eds.) *Innovative Management and Firm Performance: An Interdisciplinary Approach*. Basingstoke: Palgrave Macmillan, pp. 276–289.
- Proaño-Narváez, M. *et al.* (2022) ‘Earned Value Method (EVM) for construction projects’, *Buildings*, 12(3), 301. Available at: https://doi.org/10.3390/buildings12030301.
- Project Management Institute (PMI) (2012) ‘Make earned value work on your project’. Available at: https://www.pmi.org/learning/library/make-earned-value-work-project-6001.
- Project Management Institute (PMI) (2019a) *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*. 6th edn. Newtown Square, PA: Project Management Institute.
- Project Management Institute (PMI) (2019b) *Practice Standard for Work Breakdown Structures*. 3rd edn. Newtown Square, PA: Project Management Institute.

- Project Management Institute (PMI) (2021) ‘Earned value management systems (EVMS)’. Available at: https://www.pmi.org/learning/library/earned-value-management-systems-analysis-8026.
- Rehan, A., Heravi, A., Kabirifar, K., Shibani, A. and Boskabadi, A. (2024) ‘Project manager’s leadership behavioural practices: A systematic literature review’, *Asia Pacific Management Review*, advance online publication.
- Reiff, J. and Schlegel, D. (2022) ‘Hybrid project management—A systematic literature review’, *International Journal of Information Systems and Project Management*, 10(2), pp. 45–63. Available at: https://doi.org/10.12821/ijispm100203.
- Rosu, M.M., Tarba, I.C. and Tiriplica, P.G. (2018) ‘Methodology for budget projects monitoring’, *IOP Conference Series: Materials Science and Engineering*, 400, Article 062026. Available at: https://doi.org/10.1088/1757-899X/400/6/062026.
- Royce, W.W. (1970) ‘Managing the development of large software systems’, *Proceedings of IEEE WESCON*, 26, pp. 328–338.
- Safari Zarch, A.M. and Mokaberian, M. (2026) ‘Analysis of the limitations of the earned value management method and evaluation of modern improvement approaches in project management’, *Management Strategies and Engineering Sciences*, 8(1), pp. 1–14. Available at: https://doi.org/10.61838/msesj.312.
- Sampaio, S., Wu, Q., Cormican, K. and Varajão, J. (2022) ‘Reach for the sky: Analysis of behavioral competencies linked to project success’, *International Journal of Managing Projects in Business*, 15(1), pp. 192–215. Available at: https://doi.org/10.1108/IJMPB-09-2020-0276.
- Sanchez-Cazorla, A., Alfalla-Luque, R. and Irimia-Diéguez, A.I. (2016) ‘Risk identification in megaprojects as a crucial phase of risk management: A literature review’, *Project Management Journal*, 47(6), pp. 75–93. Available at: https://doi.org/10.1177/875697281604700606.
- San Cristóbal, J.R., Carral, L., Diaz, E., Fraguela, J.A. and Iglesias, G. (2018) ‘Complexity and project management: A general overview’, *Complexity*, 2018, Article 4891286. Available at: https://doi.org/10.1155/2018/4891286.
- Saravanos, A. (2025a) ‘A brief history of the Waterfall model: Past, present, and future’, *arXiv*. Available at: https://arxiv.org/abs/2510.03894.
- Saravanos, A. (2025b) ‘Simulating the Waterfall model: A systematic mapping study’, *arXiv*. Available at: https://arxiv.org/abs/2506.19653.
- Stray, V., Moe, N.B., Dingsøyr, T. and Sjøberg, D.I.K. (2023) ‘A theory of Scrum team effectiveness’, *ACM Transactions on Software Engineering and Methodology*, 32(3), Article 74. Available at: https://doi.org/10.1145/3571849.
- Syahputra, D., Zulkarnain, I. and Ramos, S. (2023) ‘Design of a web-based project cost management information system using the Earned Value Management method’, *Ekstensi*, 1(3), pp. 135–142.
- Takim, R. and Adnan, H. (2024) ‘Developing success evaluation criteria of building projects for stakeholders’, *Buildings*, 14(6), Article 1259. Available at: https://doi.org/10.3390/buildings14061259.
- Tausworthe, R.C. (1980) ‘The work breakdown structure in software project management’, *Journal of Systems and Software*, 1(3), pp. 181–186. Available at: https://doi.org/10.1016/0164-1212(79)90018-9.

- Turkulainen, V., Aaltonen, K. and Lohikoski, P. (2015) 'Managing project stakeholder communication: The Qstock festival case', *Project Management Journal*, 46(6), pp. 74–91. Available at: https://doi.org/10.1002/pmj.21548.
- U.S. Department of Energy (DOE) (2017) *Earned Value Management System Basics (DOE EVMS Gold Card)*. Washington, DC: U.S. Department of Energy. Available at: https://www.energy.gov/sites/prod/files/2017/09/f37/DOE%20EVMS%20Gold%20Card.pdf.
- Ukoha, J. (2022) *Project management communication strategies to engage stakeholders and improve project performance*. Doctoral dissertation. Walden University.
- Vanhoucke, M., Colin, J. and Wauters, M. (2022) 'Using earned value management and schedule risk analysis with exponential smoothing to improve project control', *European Journal of Operational Research*, 297(2), pp. 451–466.
- Ward, S.C. (1999) 'Assessing and managing important risks', *International Journal of Project Management*, 17(6), pp. 331–336. Available at: https://doi.org/10.1016/S0263-7863(98)00051-9.
- Wauters, M. and Vanhoucke, M. (2020) 'Integrating corrective actions in project time forecasting using exponential smoothing', *Journal of Management in Engineering*, 36(5), Article 04020058. Available at: https://doi.org/10.1061/(ASCE)ME.1943-5479.0000806.
- Wyrozębski, P. and Pawlak, R. (2021) 'The role and meaning of lessons learned in project knowledge management in organizations in Poland', *Procedia Computer Science*, 192, pp. 4787–4796.
- Zulch, B., Klar, B. and Marnewick, C. (2023) 'Enhancing project stakeholder communication under insufficient knowledge of project management concepts', *Engineering, Construction and Architectural Management*, 30(10), pp. 5007–5029.