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Applying Earned Value Management for Enhanced Cost and Schedule Monitoring in Public Procurement

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“What gets measured gets managed.”
Peter Drucker

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Abstract

Public procurement is a critical function through which governments allocate substantial public resources to develop infrastructure, deliver essential services, and foster economic growth. Given its scale and importance, effective monitoring of procurement projects is vital to ensure the transparent and efficient use of taxpayer funds. Despite comprehensive regulatory frameworks designed to uphold integrity and accountability, public procurement projects frequently face persistent challenges, including significant cost overruns, delays in schedules, and unexpected scope changes. These issues often result in decreased public trust, increased fiscal burdens, and hindered socio-economic development.

This thesis investigates the application of Earned Value Management (EVM)—a structured, quantitative approach traditionally employed in private sector project management—to the public procurement process within Italy, specifically focusing on a real-world case study managed by SCR Piemonte. EVM integrates key project elements such as scope, schedule, and cost into a unified monitoring framework, allowing for real-time assessment and proactive management of project performance.

Employing a deductive research methodology, this study combines quantitative analysis of fundamental EVM metrics—Planned Value (PV), Earned Value (EV), Actual Cost (AC), Cost Performance Index (CPI), and Schedule Performance Index (SPI)—with qualitative insights gathered from structured interviews with key stakeholders, including project managers and procurement officials. The quantitative findings reveal specific areas where project performance deviated from initial baselines, highlighting particular phases characterized by substantial delays and cost inefficiencies. The qualitative analysis complements these findings by identifying underlying causes such as administrative delays, fluctuating market conditions, inadequate monitoring tools, and insufficient training and capacity among personnel.

The primary contribution of this thesis lies in demonstrating how EVM can provide a robust framework for the early detection of performance deviations, enabling timely corrective actions in public procurement projects. It also offers a practical set of recommendations tailored to enhance project monitoring effectiveness, including the adoption of digital dashboards for integrated real-time reporting, structured capacity-building programs for public officials, streamlined administrative processes, and continuous monitoring practices.

Overall, the research addresses a significant gap in the academic and practical understanding of EVM's potential within public sector contexts, particularly within the complex regulatory and administrative environment of Italian public procurement. By aligning theoretical insights with empirical evidence, this thesis not only enriches existing literature but also provides actionable guidance for policymakers and project managers seeking to improve the transparency, accountability, and efficiency of public investments.

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Introduction

Public procurement represents a critical process through which governments allocate public resources to various infrastructural, economic, and social development projects. Efficient management of public procurement is essential to maximize value from public investments, ensure timely project delivery, and uphold standards of transparency and accountability. Despite these critical requirements, public procurement processes, particularly in the context of public works, frequently encounter challenges such as delays, cost overruns, and scope changes, which significantly affect the intended outcomes and the effective use of public funds.

In Italy, public procurement practices are primarily governed by Legislative Decree No. 50/2016, also known as the "Codice degli Appalti," which outlines detailed rules, procedures, and principles aimed at enhancing efficiency and transparency in managing public contracts. This legislative framework establishes clear roles and responsibilities, such as the pivotal role of the Responsabile Unico del Procedimento (RUP), and provides procedural guidelines to facilitate effective project management and execution.

Among various project management methodologies, Earned Value Management (EVM) has emerged as a highly effective tool for monitoring cost and schedule adherence, particularly beneficial in managing complex public procurement projects. EVM provides an integrated approach, combining scope, schedule, and budgetary control, thus enabling early detection of performance variances and facilitating proactive corrective actions.

This thesis examines the application of Earned Value Management within the framework of Italian public procurement, focusing specifically on public works projects. Through an in-depth case study of the SCR Piemonte sporting site project, this research explores both the quantitative and qualitative dimensions of EVM implementation, assessing its practical effectiveness in enhancing transparency, accountability, and operational efficiency.

By investigating the intersection of structured project monitoring tools and Italian regulatory environments, the study addresses key challenges such as administrative complexity, fragmented data management systems, and varying levels of project management maturity. Furthermore, it seeks to provide actionable recommendations aimed at overcoming these barriers, advocating the adoption of digital dashboards for real-time monitoring, comprehensive stakeholder training programs, and streamlined administrative processes.

Ultimately, this research contributes to academic literature by expanding the discourse on EVM application in public procurement and offers practical insights into enhancing project outcomes, supporting more efficient management of public resources, and promoting greater accountability in public infrastructure projects.

Theoretical Background

Project management is a systematic discipline that involves applying specialized knowledge, skills, tools, and techniques to plan, execute, control, and close projects efficiently. It involves processes designed to meet defined project objectives within specific constraints, typically including scope, time, cost, quality, resources, and risk. Effective project management balances these constraints, managing stakeholder expectations and aligning project outcomes with organizational goals (PMI, 2013).

1. What is a Project?

According to the PMI (2013), a project is a temporary endeavor undertaken to create a unique product, service, or result. The "temporary" aspect indicates that a project has a specific start and end date. The outcome of a project can be tangible, such as infrastructure or software, or intangible, like improved organizational processes or new knowledge from research. Despite the temporary nature, the impact of projects is often lasting, influencing social, economic, or organizational environments long after the project's completion. Typical examples of projects include constructing a building, developing new technologies, launching a new product or service, or conducting research aimed at developing new methods or systems.

Project Construction and Phases

Projects typically follow a structured lifecycle, which may consist of sequential, overlapping, or iterative phases designed for systematic control and effective management. PMI (2013) outlines a generic project lifecycle comprising distinct phases:

- Initiation: This phase involves defining the project's purpose, scope, objectives, and securing initial authorization.
- Planning: Involves defining the detailed scope of the project, establishing clear objectives, developing timelines, budgets, resources allocations, and risk management plans.
- Executing: Implementation of project activities according to the planned procedures and methodologies to achieve deliverables.
- Monitoring and Controlling: Tracking, reviewing, and regulating project progress and performance to ensure adherence to the project management plan, identify deviations, and implement corrective actions.
- Closing: Completing all project tasks, formally handing over deliverables, and capturing lessons learned and insights for future projects.

Tools such as the Work Breakdown Structure (WBS) are commonly employed to clearly delineate detailed project tasks and deliverables, providing a structured framework for planning and control.

Work Breakdown Structure (WBS)

The Work Breakdown Structure (WBS) is a fundamental project management tool used to systematically decompose project deliverables into smaller, more manageable components or work packages. It organizes and defines the total scope of the project by dividing larger tasks into detailed sub-tasks. This decomposition enhances clarity, supports precise resource allocation, simplifies estimation, and facilitates performance tracking and control. The WBS is hierarchical, starting with the final deliverable or outcome at the top, progressively decomposing into detailed, manageable components at lower levels. Each level represents a more detailed definition of the project’s work scope, enabling accurate assignment of responsibilities, scheduling, cost estimation, and performance tracking.

Project Monitoring

Monitoring and controlling are critical elements of project management, involving continuous assessment and measurement of the project's progress to ensure compliance with predefined plans. Effective monitoring enables timely identification of variances in schedule, budget, or scope, facilitating prompt and effective corrective actions. Within the public procurement context, project monitoring becomes particularly critical due to substantial financial investment and increased risks of delays and budget overruns. Consequently, robust monitoring systems contribute significantly to the transparent and efficient use of public funds and resources (PMI, 2013).

2. Principles and Methodologies of Earned Value Management (EVM)

Earned Value Management (EVM) is a project management methodology that integrates scope, schedule, and cost parameters to assess project performance and predict future trends. It is widely used in industries such as construction, defense, and public sector procurement due to its ability to provide objective performance measurement. EVM allows project managers to answer critical questions related to schedule adherence, cost efficiency, and resource allocation (PMI, 2005).

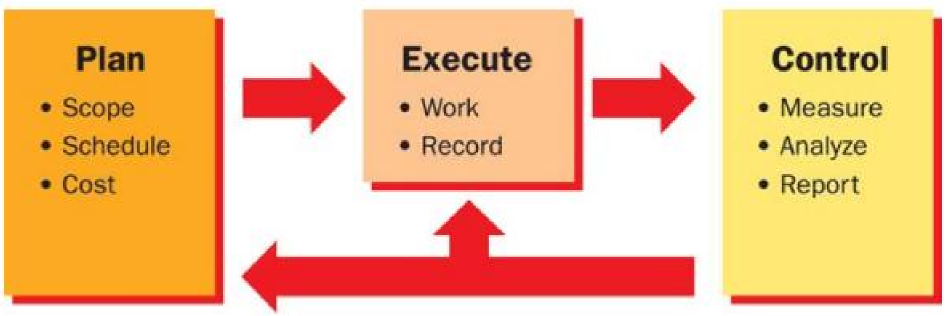


Figure 10 Project phases

According to the Standard Practise for EVM (PMI, 2005) EVM is based on four key elements which are part of the Performance Measurement Baseline:

- Planned Value (PV)
- Earned Value (EV)
- Actual Cost (AC)
- Budget at Completion (BAC)

- Planned Value (PV) also known as Budgeted Cost of Work Scheduled (BCWS)

Planned value shows how much work is supposed to be done at any given point in the project schedule. It answers the question: "How much work should have been done at this point in time according to the plan?" It explains how much work should have been completed, regardless of what happened. It is the baseline, a snapshot in time, with which the actual progress of the project is measured.

- Earned Value (EV) also known as Budgeted Cost of Work Performed (BCWP)

Earned Value shows the the value of the work completed at a specific point in time, measured in terms of the budget. It uses the budget values and the completion percentage to calculate the actual value of the work performed.

- Actual Cost (AC), also known as the Actual Cost of Work Performed (ACWP)

Actual Cost is the accurate amount of money spent for the work done within the control time. It is also called actual expenditures.

- Budget at Completion (BAC)

Budget at Completion represents the total Planned Value for the project

3. The S-Curve in EVM

The S-Curve is a graphical representation of project progress over time, displaying PV, EV, and AC with the x-axis representing time and the y-axis showing costs. It follows an "S" shape due to the natural progression of projects, which often start slow, accelerate in the middle, and slow down as they reach completion.

Planned (Scheduled), Actual and Earned Value S-curves can have six possible arrangements, as in the chart presented in the Figure. (De Marco,2018). Just by analysing the graphs we can already come to certain conclusions.

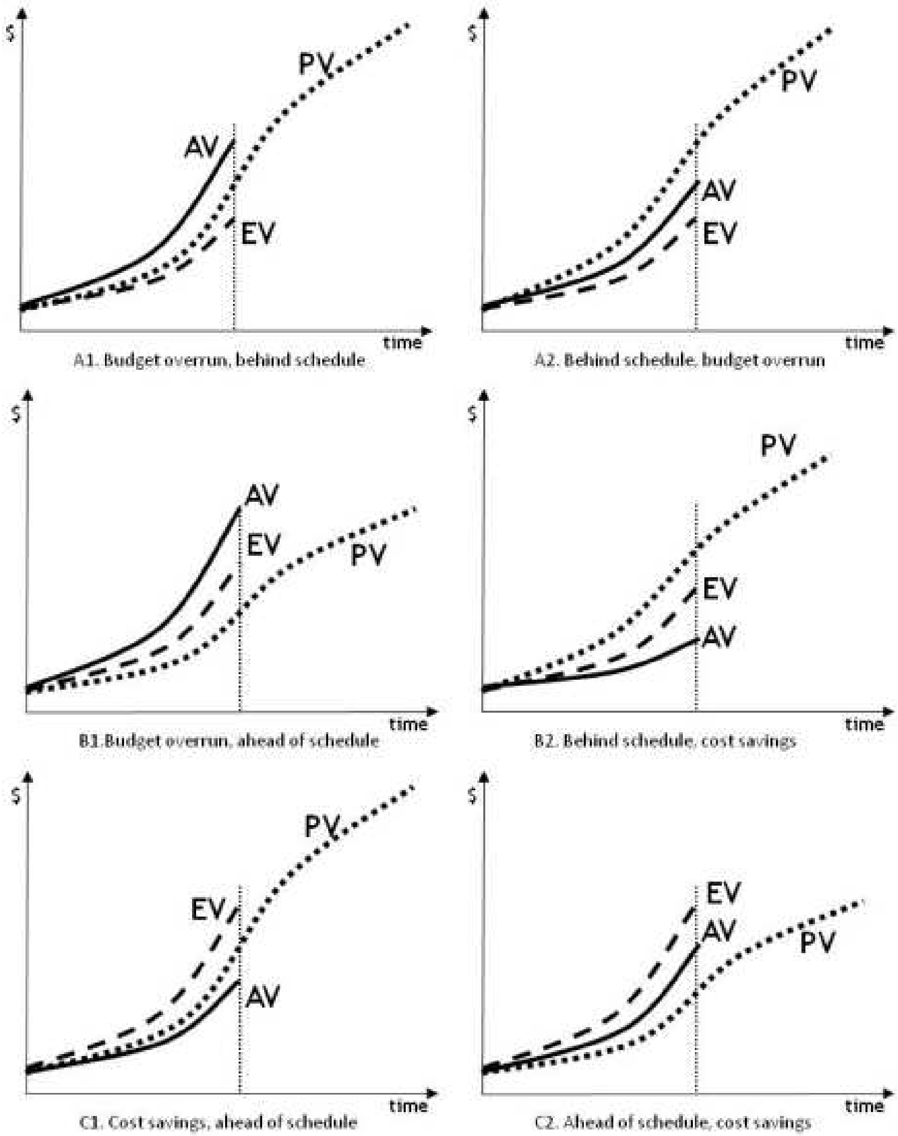


Figure 11 S-curve

By analyzing these curves, general insights can be drawn. If the AC curve is above the EV curve, it indicates that the project is over budget, meaning actual costs have exceeded planned expenditures. Conversely, if the AC curve is below the EV curve, the project is experiencing cost savings. Comparing the PV and EV curves provides insights into schedule performance: when PV is above EV, the project is behind schedule, while if PV is below EV, the project is ahead of schedule.

The most unfavourable scenario occurs when a project is both over budget and behind schedule. This situation is depicted in the A1 graph, where cost overruns are the primary concern, and in the A2 graph, where schedule delays dominate. Conversely, the optimal scenario is when a project achieves both cost savings and schedule efficiency. This is represented in the C1 graph, where cost performance is better than planned, and in the C2 graph, where the project is ahead of schedule while maintaining cost efficiency.

To be more accurate in the analysis , as mentioned in the (PMI,2005) other metrics are introduced: The elements of the EVM can be used to analyse the current status of a project and forecast its future. To do that other metrics are needed:

- Variances: Schedule Variance (SV); Cost Variance (CV); and Variance at Completion (VAC)
- Indices: Schedule Performance Index (SPI); Cost Performance Index (CPI); and ToComplete Performance Index (TCPI)
- Forecasts: Time Estimate at Completion (EACt); Estimate at Completion (EAC); and Estimate to Complete (ETC)

Variances

1. **Schedule Variance (SV)**
   Measures the difference between the Earned Value (EV) and the Planned Value (PV). It shows whether the project is ahead or behind schedule.

SV= EV - PV

- SV > 0: Project is ahead of schedule.
- SV < 0: Project is behind schedule.

2. **Cost Variance (CV)**

Measures the difference between the Earned Value (EV) and the Actual Cost (AC). It indicates whether the project is within or over budget.

CV=EV - AC

- CV > 0: Project is under budget.
- CV < 0: Project is over budget.

3. **Variance at Completion (VAC)**

Forecasts the difference between the Budget at Completion (BAC) and the Estimate at Completion (EAC).

VAC= BAC - EAC

- VAC > 0: Project is expected to be under budget.
- VAC < 0: Project is expected to be over budget.

These are expressed in the following graph taken by (De Marco,2018):

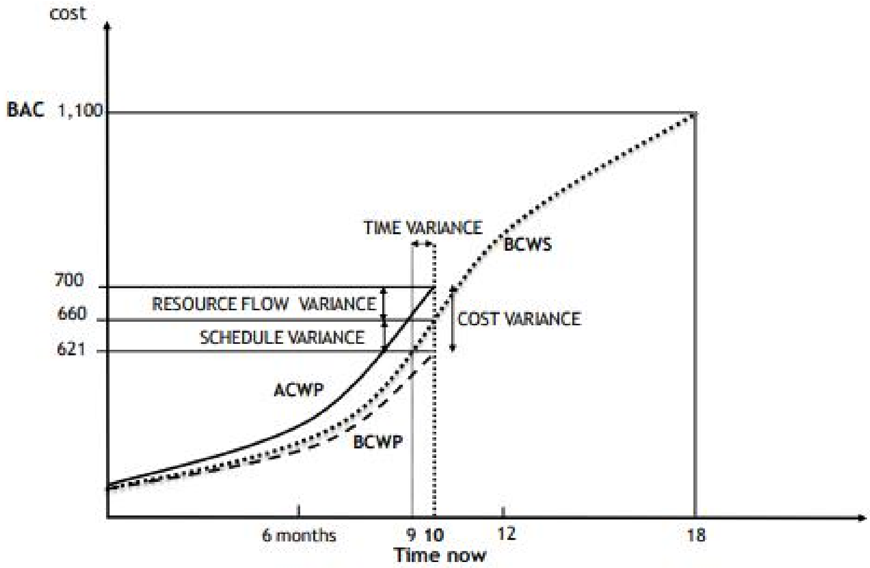


Figure 12 Representation of variances on a S-curve chart

Indices

1. **Schedule Performance Index (SPI)**
   Measures schedule efficiency by comparing the Earned Value (EV) to the Planned Value (PV).

SPI=EV/PV

- SPI > 1: Ahead of schedule.
- SPI < 1: Behind schedule.

2. **Cost Performance Index (CPI)**

Measures cost efficiency by comparing the Earned Value (EV) to the Actual Cost (AC).

CPI=EVA/CPI

- CPI > 1: Cost-efficient.
- CPI < 1: Cost-inefficient.

3. **To-Complete Performance Index (TCPI)**

Predicts future cost efficiency required to meet the Budget at Completion (BAC) or Estimate at Completion (EAC).

- **Formula for BAC:** TCPI(BAC)=BAC−EV/BAC−AC
- **Formula for EAC:** TCPI(EAC)=BAC−EV/EAC−AC

- TCPI > 1: Higher efficiency required.
- TCPI < 1: Lower efficiency required.

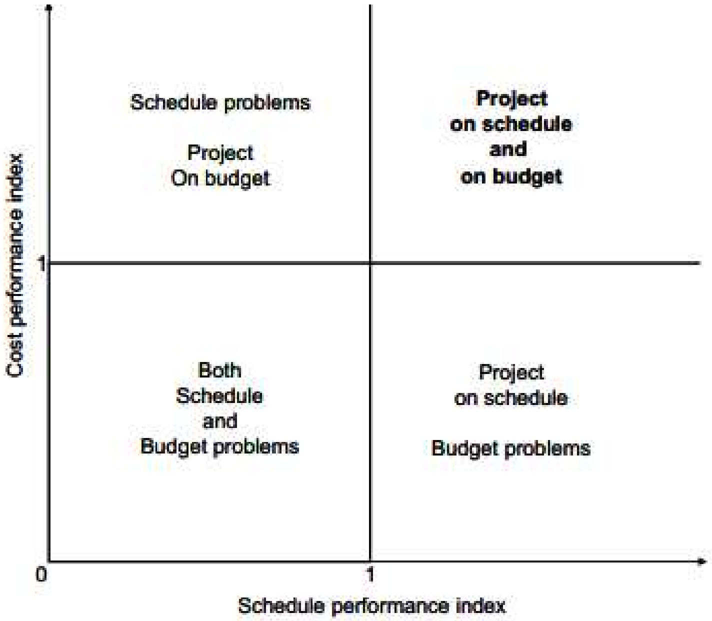


Figure 13 Areas of cost and time performance using Cost and Schedule performance indexes

4. Forecasts

1. **Estimate at Completion (EAC)**
   Forecasts the total cost of the project when completed.

- **Common Formula:** EAC=AC+(BAC−EV)
- If performance continues as is: EAC=BAC/CPI

2. **Estimate to Complete (ETC)**
   Forecasts the cost needed to complete the remaining work.

- **Formula:** ETC=EAC−AC

3. **Time Estimate at Completion (EACt)**
   Forecasts the total duration to complete the project.

- EACt=Planned Duration/SPI

A complete performance measurement representation:

Performance Measures		Schedule		
		SV > 0 & SPI > 1.0	SV = 0 & SPI = 1.0	SV < 0 & SPI < 1.0
Cost	CV > 0 & CPI > 1.0	Ahead of Schedule Under Budget	On Schedule Under Budget	Behind Schedule Under Budget
	CV = 0 & CPI = 1.0	Ahead of Schedule On Budget	On Schedule On Budget	Behind Schedule On Budget
	CV < 0 & CPI < 1.0	Ahead of Schedule Over Budget	On Schedule Over Budget	Behind Schedule Over Budget

Figure 14 Interpretations of Basic EVM Performance Measures

Literature Review

1. Introduction to Public Procurement

Public procurement represents a vital instrument through which governments allocate public resources to support infrastructure, social services, and economic development. As a core function of the public sector, it carries the dual responsibility of ensuring both efficiency in spending and adherence to principles of transparency, competition, and accountability. Given its role in executing publicly funded projects, procurement must balance multiple stakeholder interests, legal obligations, and often-complex administrative procedures.

In many countries, including Italy, public procurement is governed by a comprehensive legal and regulatory framework designed to uphold fairness, integrity, and proper use of taxpayer funds. The "Codice degli Appalti" (Legislative Decree 50/2016) plays a central role in defining procurement procedures, contractor selection criteria, and execution rules. This legal framework is complemented by guidance from the National Anti-Corruption Authority (ANAC), which provides standardized monitoring and oversight practices to reduce corruption and inefficiency.

Despite these regulations, persistent challenges remain. Public procurement projects are frequently subject to cost overruns, schedule delays, and scope changes, which undermine public confidence and the effective delivery of services. Moreover, public projects often involve multiple stakeholders, evolving requirements, and unpredictable external risks, which increase their complexity and make monitoring particularly difficult.

Addressing these challenges requires not only legal compliance but also the adoption of structured project management and performance monitoring frameworks. Within this context, Earned Value Management (EVM) emerges as a promising methodology for enhancing the transparency, predictability, and efficiency of public procurement processes—especially in large-scale infrastructure and construction projects where deviations from baseline plans can be costly.

2. Foundations of Project Management

Project management provides the essential tools and methodologies needed to guide complex initiatives from planning to successful delivery. Rooted in early industrial management theories, modern project management has evolved into a structured discipline that integrates planning, execution, monitoring, and control functions across a project's lifecycle.

2.1 Historical Development

The foundations of project management can be traced back to the early 20th century with the introduction of scientific management by Frederick Taylor, who emphasized labor efficiency and task standardization. Henry Gantt contributed further with the development of the Gantt chart, a visual scheduling tool still widely used in project planning today.

During the 1940s and 1950s, the complexity of large-scale defense and engineering projects led to the development of more advanced techniques such as the Program Evaluation and Review Technique

(PERT) and the Critical Path Method (CPM). These tools enabled project managers to plan, sequence, and monitor interdependent activities under conditions of uncertainty and time pressure—challenges that remain relevant in public procurement.

2.2 Standardization and the PMBOK® Framework

Over the last few decades, project management has undergone significant formalization through globally recognized standards. Chief among these is the Project Management Body of Knowledge (PMBOK® Guide), developed by the Project Management Institute (PMI). The PMBOK® Guide organizes project management into five process groups—Initiating, Planning, Executing, Monitoring and Controlling, and Closing—and identifies ten knowledge areas ranging from scope and cost to risk and stakeholder management.

This structured approach ensures that projects are systematically managed, with clear roles, responsibilities, and performance criteria. In the context of public procurement, where accountability and transparency are paramount, adherence to standardized project management practices is increasingly recognized as essential.

2.3 The Italian Context: Role of the RUP

In Italy, the principles of structured project management have been institutionalized through regulatory mandates, most notably via the Codice degli Appalti (D.Lgs. 50/2016). A key feature of this legislation is the formalization of the Responsabile Unico del Procedimento (RUP)—the designated official responsible for the planning, coordination, and oversight of public projects.

The RUP functions as the project manager within public agencies and is entrusted with tasks ranging from feasibility assessments and procurement strategy design to contract execution and performance monitoring. Recent ANAC guidelines have emphasized the need for RUPs to possess professional project management qualifications and to adopt internationally recognized standards such as those found in the PMBOK® framework.

This alignment of Italian public sector roles with global best practices reflects a growing recognition that modern project management is not merely administrative—it is a strategic function necessary for improving the delivery and governance of public investments.

3. Project Monitoring in Public Procurement

Project monitoring is a core component of effective project management, particularly within the public procurement sector where transparency, accountability, and compliance are critical. Monitoring serves as the mechanism by which project progress is systematically tracked, deviations from the plan are identified, and corrective actions are initiated to ensure successful project outcomes.

3.1 The Importance of Monitoring

In public procurement, monitoring extends beyond basic schedule tracking; it is a safeguard for the responsible use of public funds. Projects funded through public budgets are subject to heightened scrutiny, and as such, continuous oversight is essential to detect inefficiencies, cost overruns, and delays before they escalate into systemic failures. According to PMI (2008), effective monitoring ensures that projects adhere to established scopes, timelines, budgets, and quality standards—especially crucial in environments with multiple stakeholders and layers of regulation.

3.2 Common Challenges

Despite its importance, monitoring in public procurement often suffers from structural and procedural shortcomings. Studies by Ismail et al. (2018) reveal that inadequate monitoring mechanisms are a primary contributor to procurement inefficiencies, fraud, and non-compliance. Problems such as insufficient job rotation, weak internal controls, and lack of standardized procedures hinder effective oversight. Similarly, World Bank (1995) findings highlight that public procurement systems lacking rigorous monitoring are particularly susceptible to corruption and mismanagement.

3.3 Legislative Framework and Italian Practice

In Italy, monitoring responsibilities are clearly outlined within the Codice degli Appalti (D.Lgs. 50/2016). The RUP plays a pivotal role in overseeing each phase of a public project, from planning to completion. In practice, this includes ensuring the project stays within its legal, budgetary, and timeline constraints. The ANAC (National Anti-Corruption Authority) has further reinforced the importance of rigorous monitoring, urging public institutions to adopt standardized, internationally recognized project management methodologies to address persistent inefficiencies.

3.4 Towards Enhanced Monitoring Tools

As public projects grow in size and complexity, traditional monitoring tools such as Gantt charts or periodic status reports are often insufficient. There is a growing need for data-driven, predictive, and integrated approaches to performance tracking. In this context, Earned Value Management (EVM) presents a valuable alternative by combining cost, schedule, and scope data into a single monitoring framework. EVM enables project managers not only to assess current performance but also to anticipate future deviations and respond proactively.

Adopting advanced monitoring techniques is particularly critical for the public sector, where project delays and budget overruns can have cascading effects on public services and trust. Therefore, integrating methodologies like EVM into public procurement monitoring frameworks offers a path forward for improved performance, transparency, and efficiency.

4. Application of EVM in Public Procurement

The application of Earned Value Management (EVM) within public procurement settings provides a powerful framework for aligning cost, schedule, and performance control. Although originally developed for military and industrial use, EVM has demonstrated increasing value in the public sector, particularly for large-scale infrastructure and construction projects that are prone to delays and cost overruns.

4.1 Why EVM Suits Public Procurement

Public procurement projects typically operate within fixed budgets, involve multiple stakeholders, and are governed by strict compliance requirements. These characteristics make them ideal candidates for structured performance monitoring tools like EVM. Unlike traditional tracking methods that focus solely on timelines or expenditures, EVM integrates scope, cost, and schedule into a single evaluative model, offering real-time insights and forward-looking indicators.

By calculating metrics such as **Cost Performance Index (CPI)** and **Schedule Performance Index (SPI)**, public project managers can identify inefficiencies early and make data-driven decisions. This helps to preserve public trust, optimize resource allocation, and demonstrate compliance with fiscal accountability standards.

4.2 Integration into Contractual Frameworks

Effective use of EVM begins at the contractual stage. The **National Defense Industrial Association (NDIA)** guide, *Contracting with EVM Requirements* (2022), emphasizes the need to define performance measurement baselines (PMBs), clearly outline EVM metrics, and specify thresholds for corrective actions. When embedded within procurement contracts, EVM requirements ensure continuous monitoring is not an afterthought but a foundational element of project delivery.

While these practices are common in sectors like defense and aerospace, their adoption in public procurement—particularly in the Italian context—remains limited. However, integrating such standards into public contracts could significantly improve transparency and oversight.

4.3 Case-Based Evidence of EVM Use

Numerous case studies support the effectiveness of EVM in public procurement. For example:

- **NASA** has successfully used EVM to manage complex aerospace programs, enabling real-time variance tracking and forecasting (NASA, 2018).
- In **Malaysia**, EVM has been applied in Public-Private Partnership (PFI) construction projects, resulting in more reliable performance control (Khan, Khamidi & Idrus, 2010).
- The **Ostana Wellness Center** project in Italy applied EVM during construction. Although the project encountered delays and cost changes, EVM helped quantify performance gaps, allowing corrective measures to be taken (Cencioni, 2018).

These examples highlight how EVM enhances project visibility and fosters a culture of accountability, even in projects facing complex external challenges.

4.4 Benefits for Stakeholders

When properly implemented, EVM improves communication among stakeholders by using a common set of metrics to assess progress. This unified language reduces ambiguity and supports more collaborative, transparent decision-making. Furthermore, by facilitating early detection of deviations, EVM empowers public authorities to act proactively, reducing the likelihood of budgetary shortfalls or extended delays.

5. Advancements in EVM Methodologies

While traditional Earned Value Management (EVM) offers a solid foundation for project monitoring, its limitations—especially in dealing with uncertainty, schedule accuracy, and evolving project contexts—have prompted researchers and practitioners to propose advanced methodologies. These enhancements aim to increase the accuracy, flexibility, and real-world applicability of EVM, particularly in complex and data-scarce environments like public procurement.

5.1 Earned Schedule (ES)

One key advancement is the **Earned Schedule (ES)** technique, which addresses EVM's difficulty in accurately tracking schedule performance, especially near project completion. Traditional schedule metrics like the **Schedule Performance Index (SPI)** tend to converge toward 1.0 as the project nears its end, regardless of actual delays. ES redefines SPI in time units rather than cost-based equivalents, introducing the **Earned Schedule Index (ESI)** to provide a more realistic view of timeline adherence (Bosché, 2023; Avlijaš, 2022). This enhancement allows public project managers to better detect and respond to schedule slippage.

5.2 Fuzzy-EVM and Uncertainty Handling

Public procurement projects often involve ambiguous or incomplete data, stakeholder subjectivity, and qualitative performance assessments. In response, researchers have developed Fuzzy EVM models, which use fuzzy logic to incorporate uncertainty into project evaluations. For example, Golpîra (2015) proposed an Extended EVM (EEVM) model combining Fuzzy Analytic Hierarchy Process (AHP) and Fuzzy TOPSIS. This approach enables project managers to assess progress across multiple criteria—like cost, quality, and risk—even when numerical precision is lacking.

5.3 Integrated Earned Value Method (IEVM)

To improve forecasting accuracy, the Integrated Earned Value Method (IEVM) combines EVM with machine learning techniques. By training algorithms on historical performance data, IEVM dynamically adjusts projections for cost and schedule completion. This approach, as demonstrated by Pang (2023), provides adaptive forecasts that respond to real-time data, making it especially useful for large-scale public projects affected by fluctuating economic or political conditions.

5.4 Multivariate Approaches: Principal Component Analysis (PCA)

Traditional EVM evaluates indicators in isolation, which may obscure relationships between project variables. Colin et al. (2015) introduced a multivariate approach that uses Principal Component Analysis (PCA) to track patterns across multiple performance metrics simultaneously. By projecting data into a space of principal components and applying control statistics (e.g., Hotelling's T^2, Squared Prediction Error), project managers can detect early anomalies in project behavior. This method enhances control accuracy and responsiveness in complex, multi-phase public procurement projects.

5.5 Grey Earned Duration Management (EDM-G)

When project environments are highly uncertain and data is sparse or incomplete—common issues in public procurement—Grey System Theory provides an alternative to fuzzy logic. The Grey Earned Duration Management (EDM-G) model, introduced by Mahmoudi et al. (2021), allows performance evaluation without the need for complex mathematical membership functions. Its simplicity and robustness make it particularly attractive for public authorities lacking advanced data infrastructure.

These methodological innovations enhance EVM's utility in dynamic, high-stakes settings like public procurement. They also pave the way for hybrid models that combine traditional control structures with predictive analytics, qualitative evaluation, and uncertainty management—tools increasingly essential in modern project governance.

6. Challenges in EVM Implementation

Despite its clear benefits, the practical implementation of Earned Value Management (EVM) in public procurement environments is often hindered by a range of technical, organizational, and contextual challenges. Understanding these obstacles is essential for designing strategies that promote broader and more effective EVM adoption.

6.1 Technical and Methodological Complexity

A core technical challenge lies in establishing a consistent and reliable **Performance Measurement Baseline (PMB)**, which is critical for accurate EVM tracking. Developing the PMB requires detailed planning, budgeting, and scheduling, often involving a **Work Breakdown Structure (WBS)** and cost-loaded timelines. However, public sector projects frequently suffer from incomplete or inconsistent baseline data due to fragmented planning processes, evolving scopes, or unclear performance indicators (Fleming & Koppelman, 2016; NDIA IPMD, 2022).

Moreover, integrating performance data across multiple administrative units or contractors complicates the calculation of core EVM metrics such as **EV**, **AC**, and **PV**. These challenges are exacerbated in large-scale or multi-phase public projects where real-time performance data is difficult to consolidate.

6.2 Data Integration and System Limitations

Another major barrier is the lack of interoperable and modern information systems. Many public agencies continue to rely on legacy platforms or disconnected spreadsheets, making it difficult to automate data collection and perform real-time performance analysis. Without timely and accurate data, EVM metrics lose their predictive and diagnostic power (Kerzner, 2017; Bosché, 2023).

In Italy, as in many countries, public administrations often face bureaucratic hurdles and limited IT capabilities, resulting in data silos and inefficient reporting mechanisms. This undermines the reliability and responsiveness of EVM frameworks in government settings.

6.3 Organizational and Cultural Resistance

Public organizations frequently exhibit a strong adherence to traditional management and monitoring practices, leading to institutional inertia. The introduction of EVM—perceived as a technically demanding and foreign methodology—can encounter resistance from procurement officials and project managers accustomed to conventional workflows (Lorrai et al., 2003; Svejvig & Andersen, 2015).

In addition, limited training and a general lack of familiarity with EVM tools among public officials hinder effective implementation. Without strong leadership support and capacity-building programs, EVM may be implemented superficially, failing to deliver meaningful improvements.

6.4 Resource and Budget Constraints

EVM implementation often requires investment in software tools, staff training, and process redesign, all of which may be considered non-essential within constrained public budgets. When funding is limited, public entities may deprioritize EVM in favor of more immediate operational needs. This short-term focus restricts the long-term benefits of structured project monitoring and performance improvement (Khan, Khamidi & Idrus, 2010; Wayne, 2008).

6.5 Compliance, Fraud, and Control Limitations

Even when EVM is adopted, its effectiveness can be undermined by weak internal controls, procurement fraud, or lack of compliance monitoring. If project data is manipulated or inaccurate due to inadequate auditing mechanisms, EVM metrics become unreliable and may mislead rather than guide corrective actions (Ismail et al., 2018). This is particularly relevant in public procurement environments where accountability structures may be underdeveloped or inconsistently enforced.

6.6 Tensions with Agile and Adaptive Frameworks

As some public institutions experiment with Agile project management—especially in digital service delivery—there is growing interest in combining Agile with EVM. However, these two paradigms often clash: while EVM is based on fixed baselines and linear progress tracking, Agile emphasizes iteration, change, and flexibility. Integrating EVM with Agile requires hybrid models that balance structure and adaptability, a methodological challenge that remains unresolved in both theory and practice (Sapino, 2023).

7. Limitations of Earned Value Management (EVM)

While Earned Value Management (EVM) offers a powerful framework for integrating cost, schedule, and scope monitoring, numerous scholars have highlighted its limitations, particularly in complex, uncertain, and dynamic project environments. These limitations, if unaddressed, can compromise the accuracy of forecasts and the effectiveness of project control mechanisms, especially in public procurement contexts.

7.1 Oversimplification of Project Dynamics

EVM is grounded in a deterministic model that assumes fixed activity durations and costs, failing to reflect the variability and uncertainty inherent in real-world projects. As Ballesteros-Pérez and Elamrousy (2018) observe, this can lead to a phenomenon known as **merge event bias**, where optimistic forecasts result in unrealistic expectations of schedule performance. This simplification limits EVM's ability to model complex interactions between tasks and external influences, such as stakeholder interventions or weather-related delays, which are common in public construction projects.

7.2 Limited Adaptability to Dynamic Changes and Resource Constraints

EVM is traditionally suited for ideal scheduling environments and is often incapable of accurately capturing performance in **resource-constrained or dynamically changing scenarios**. Siu and Lu (2011) argue that EVM does not adequately adjust for project changes such as re-sequencing of tasks or resource reallocations, making it difficult to produce reliable indicators in volatile contexts. In the public sector, where projects often face unanticipated policy shifts or financial reprogramming, this rigidity undermines the methodology's usefulness.

7.3 Inattention to Activity Criticality

A major limitation of the Schedule Performance Index (SPI) in EVM is its **equal weighting of all activities**, regardless of their position on the critical path. Lennon and Francis (2010) highlight that this can distort assessments of true project urgency, as delays in non-critical tasks may offset more serious risks along critical paths. As a result, EVM may suggest acceptable progress even when key milestones are jeopardized, potentially leading to misinformed decisions.

7.4 Inadequate Treatment of Future Uncertainty

EVM relies heavily on **historical performance data** to predict future outcomes, with limited consideration for emerging risks or changing project conditions. Tabriz et al. (2013) argue that this backward-looking approach restricts a project manager's ability to adapt forecasts in light of future uncertainties—such as regulatory changes, inflation, or geopolitical disruptions. This limitation is especially problematic in long-term public procurement projects, where external variables frequently evolve over time.

7.5 Instability of Performance Indicators

Core EVM metrics such as the **Cost Performance Index (CPI)** and **Schedule Performance Index (SPI)** are often treated as reliable indicators of project health. However, studies by Souza and Rocha (2013) reveal that these indices can fluctuate significantly during project execution, particularly as projects approach completion. This volatility can result in misleading estimates of cost-to-complete or total project duration, weakening the credibility of performance reports and making timely interventions more difficult.

8. Best Practices and Future Directions

To overcome the challenges associated with implementing Earned Value Management (EVM) in public procurement, public agencies must adopt a combination of strategic, technical, and organizational measures. These best practices not only facilitate successful adoption but also enhance the long-term effectiveness and sustainability of EVM-based monitoring systems. At the same time, emerging trends and technologies point toward promising directions for future research and practice.

8.1 Best Practices for Implementing EVM

a) Targeted Training and Capacity Building

One of the most critical enablers of successful EVM implementation is a well-trained project team. Providing structured training programs for project managers, RUPs, and procurement officials ensures that key personnel understand how to apply EVM principles, interpret performance indicators, and respond to emerging issues (Kupec, 2015). This capacity building also supports a broader cultural shift toward data-driven decision-making.

b) Establishing Clear Processes and Documentation

Clarity in roles, responsibilities, and procedures is essential. Agencies should develop standard operating procedures (SOPs) that define how baselines are established, how data is collected and validated, and how performance is reported and acted upon. Embedding EVM requirements into procurement contracts—as recommended by NDIA (2022)—further ensures that performance monitoring is treated as a contractual obligation rather than an afterthought.

c) Leveraging Digital Tools for Monitoring

Technology plays a vital role in modernizing EVM practices. Real-time dashboards using tools like Power BI, MS Project, or specialized EVM software can automate data collection, visualize performance trends, and generate alerts when deviations occur (Bosché, 2023). Such platforms reduce the manual burden of reporting and enhance responsiveness.

d) Active Stakeholder Engagement

Inclusive communication and stakeholder participation throughout the project lifecycle help align expectations and build support for EVM practices. By sharing performance data transparently and using a common set of metrics, EVM can facilitate collaborative decision-making and reduce misunderstandings among project teams, contractors, and oversight bodies (Wayne, 2008).

e) Continuous Monitoring and Evaluation

EVM should not be treated as a one-time reporting tool but as a continuous monitoring system. Regular performance reviews and iterative recalibrations of baselines are crucial to ensuring that EVM remains responsive to real-world project dynamics (Khan, Khamidi & Idrus, 2010). Establishing a feedback loop between monitoring results and management action is key to turning insights into impact.

8.2 Future Directions for Research and Innovation

a) Hybrid EVM-Agile Frameworks

As public projects become more adaptive, especially in areas like digital transformation or post-pandemic recovery, there is growing interest in developing hybrid models that combine the predictive strengths of EVM with the flexibility of Agile. Research is needed to identify the optimal balance between structured control and iterative adaptation (Sapino, 2023).

b) AI and Predictive Analytics

Integrating artificial intelligence (AI) and machine learning into EVM offers enormous potential for enhancing predictive accuracy. By analyzing historical data and real-time inputs, AI-enhanced EVM models can forecast deviations earlier and suggest corrective actions dynamically (Pang, 2023). This opens new possibilities for proactive project governance.

c) Enhancing EVM Usability in Low-Maturity Contexts

Future research should explore how simplified or scaled versions of EVM—such as Grey EDM or Fuzzy-EVM—can be tailored to environments with low data quality, limited technical infrastructure, or low project management maturity. These approaches offer accessibility without sacrificing oversight (Mahmoudi et al., 2021; Golpîra, 2015).

d) Policy and Governance Innovations

Beyond tools and techniques, institutional support plays a decisive role in shaping project outcomes. Future studies should investigate how regulatory reforms, performance-based funding models, and cross-agency collaboration can incentivize the broader adoption of EVM in public procurement. This includes revisiting compliance frameworks, audit mechanisms, and procurement guidelines to make them more compatible with performance monitoring tools.

9. Research Gaps and Contributions

Despite the growing recognition of Earned Value Management (EVM) as a valuable tool for public sector project monitoring, several important gaps remain in both the academic literature and practical implementation. Identifying and addressing these gaps is essential for advancing the field and guiding future innovations in public procurement management.

9.1 Lack of Context-Specific Applications in Public Procurement

While EVM has been widely studied and applied in industrial, defense, and infrastructure projects, its use in public procurement—especially within the European and Italian context—remains limited. Most research focuses on general benefits or theoretical models, with few in-depth case studies demonstrating how EVM performs in real-world public sector settings with complex regulatory environments.

This thesis contributes to narrowing that gap by examining the application of EVM within an Italian public procurement project managed by SCR Piemonte, offering practical insights into how EVM functions under national procurement rules and administrative structures.

9.2 Limited Integration with Modern Public Sector Challenges

Much of the literature on EVM assumes relatively stable project environments with reliable data. However, public procurement projects often face uncertainty, fragmented data systems, and political or administrative delays. While advanced methodologies like Fuzzy-EVM or Grey EVM have been proposed, their adoption and practical validation in public projects are still rare. There is a need for empirical research that tests the applicability of these methods in low-data or high-uncertainty contexts.

9.3 Inadequate Exploration of Hybrid Models

As governments increasingly adopt Agile principles in areas like digital service delivery, the need to reconcile Agile flexibility with EVM's structured control becomes more urgent. However, hybrid frameworks that successfully blend these approaches remain underdeveloped in the literature. Future research should explore how EVM metrics can be adapted or reinterpreted in iterative, fast-changing environments without losing their analytical rigor.

9.4 Insufficient Focus on Digital and AI-Driven Tools

There is growing interest in using AI and real-time analytics to enhance project monitoring, but studies applying these technologies specifically within the EVM framework for public procurement are scarce. Exploring predictive models, anomaly detection, and dynamic performance tracking in EVM could significantly improve decision-making accuracy and responsiveness in public projects.

9.5 Weak Institutional Support and Policy Research

Finally, existing literature rarely addresses the institutional enablers and policy conditions necessary for successful EVM implementation. Topics such as regulatory alignment, compliance auditing, and capacity-building mandates are often overlooked. Future research should examine how governance structures and national procurement strategies can create a supportive environment for EVM adoption.

Research Methodology

1. Research Design

This thesis adopts a comprehensive mixed-method research design integrating both quantitative and qualitative methodologies. The primary objective is to investigate how Earned Value Management (EVM) enhances cost and schedule monitoring in public procurement projects. The case study research approach, as advocated by Yin (2009) and Martinsuo & Huemann (2021), was selected for its effectiveness in deeply exploring complex phenomena within their real-world contexts, particularly when the boundaries between the phenomenon and its environment are not clearly defined.

The selected case focuses on a complex and ongoing public sector project managed by SCR Piemonte, a leading organization specializing in public procurement in the Piedmont region of Italy. This project was chosen due to its known complexity, history of delays, and notable cost overruns, making it well-suited for examining the practical applications and limitations of EVM. As a single, critical case, it aligns with Yin's (2009) framework for generating in-depth, context-rich insights.

Following this framework, the case is defined as the procurement project itself, with multi-level analysis encompassing organizational processes, managerial practices, and stakeholder interactions. The mixed-methods approach—including documentary analysis, semi-structured interviews, and a review of internal databases—enables methodological triangulation, thus enhancing the validity and reliability of the findings (Martinsuo & Huemann, 2021).

2. Data Collection

Data collection was conducted during an internship at SCR Piemonte, where the researcher was directly involved in project management tasks, specifically creating and managing Gantt charts for several public sector projects. This role granted direct access to both internal documentation and key stakeholders, ensuring a rich and authentic data set.

Three primary methods of data collection were used:

- **Documentary Analysis:** Project contracts, financial records, schedules, and reports were reviewed to establish baseline values for scope, budget, and timelines. These documents, classified as secondary data, formed the basis for calculating Planned Value (PV).

- **Database Review:** SCR Piemonte's internal project management databases were examined to retrieve historical and real-time performance data. These databases provided secondary data, particularly for calculating Actual Costs (AC) and tracking Earned Value (EV).

- **Semi-Structured Interviews:** Interviews were conducted with three key stakeholders: the Responsabile Unico del Procedimento (RUP), who is an architect and directly oversees the project; a management engineer who also served as the research supervisor and was responsible for managing the project database; and a civil engineer who contributed technical insights into project execution. These interviews represent the primary data of the study and were essential for validating documentary data, understanding implementation challenges, and contextualizing performance variances.

The following data types were extracted and utilized in the analysis:

- **Initial Project Schedule Plan** – Baseline durations and sequencing of tasks.
- **Initial Budget Plan** – Approved budget figures used to calculate PV.
- **Actual Duration Data** – Time taken for task completion, used to assess schedule performance.
- **Actual Cost Data** – Expenditure data from financial records, necessary for AC calculations.
- **Schedule and Budget Revisions** – Documentation of administrative changes affecting scope, cost, or timing.
- **Revised Estimates** – Updated forecasts for time and cost, enabling EAC and ETC computations.

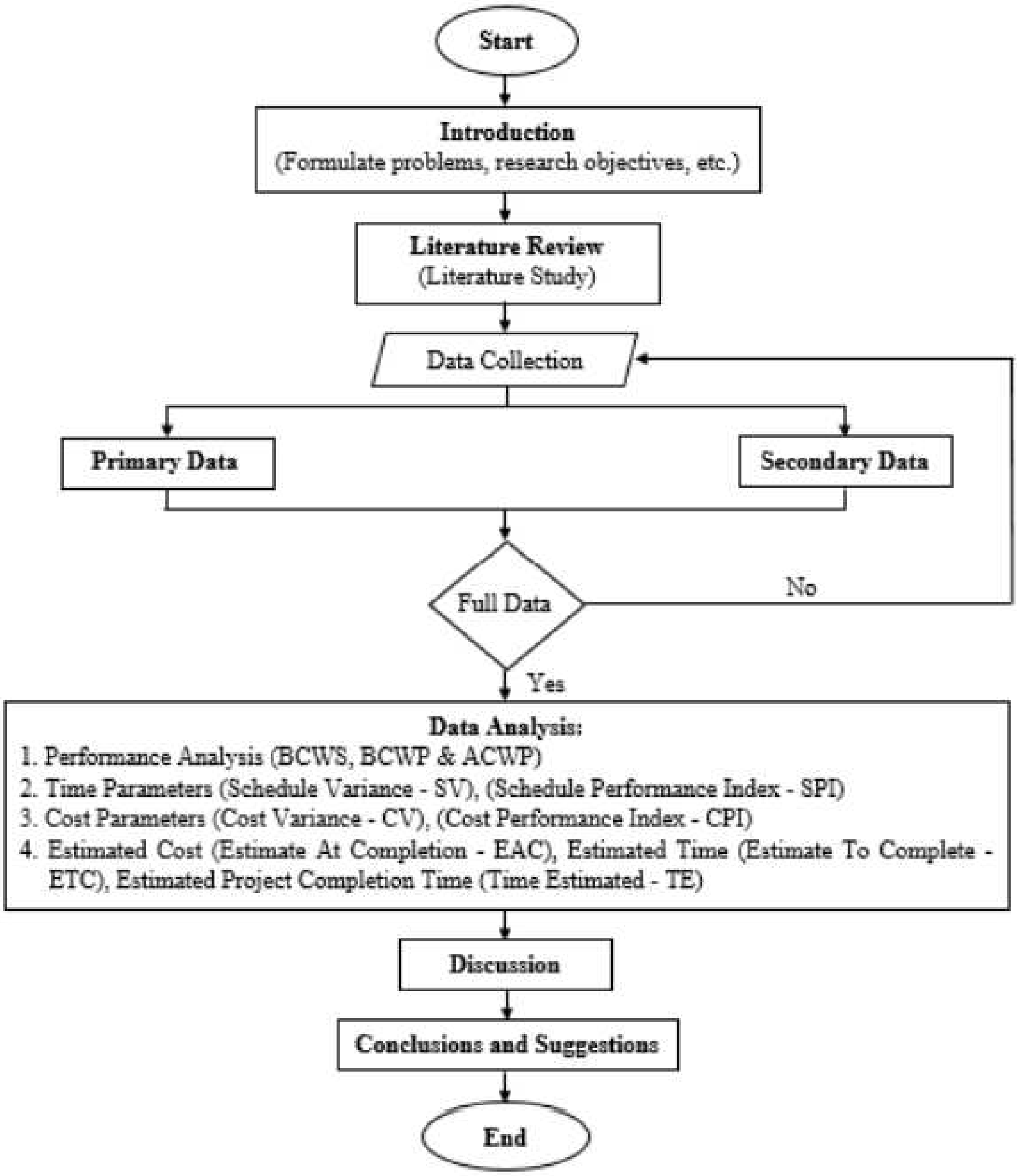


Figure 15 Research method. Adapted from Setiawati et al. (2023).

3. Search Strategy and Source Selection

To ensure a comprehensive and academically rigorous foundation for this thesis, a structured search strategy was adopted to identify literature relevant to project management, public procurement, and Earned Value Management (EVM). This strategy was essential in building a theoretical framework that supports both the quantitative and qualitative components of the research, with a particular focus on EVM's applicability in the public sector and its implementation within the Italian regulatory context.

The literature review drew upon a diverse range of academic and institutional databases, including Google Scholar, Scopus, Web of Science, SpringerLink, JSTOR, ScienceDirect, and ResearchGate.

These sources were selected for their broad coverage of disciplines such as engineering, public administration, economics, and project management. In addition, authoritative documents from organizations such as the Project Management Institute (PMI), NASA, the National Defense Industrial Association (NDIA), and the Italian National Anti-Corruption Authority (ANAC) were reviewed to ensure the inclusion of applied and policy-relevant perspectives.

Search terms were selected to capture both foundational theories and emerging applications of EVM in public sector contexts. Key phrases included: “Earned Value Management in public procurement,” “Project monitoring tools in public infrastructure,” “RUP role in Italian procurement projects,” “Cost and schedule control in government projects,” “EVM challenges in public sector,” “Performance measurement in public construction,” and “Agile-EVM hybrid models.” Additional terms such as “Fuzzy EVM,” “Grey EVM,” and “Digital dashboards for project control” were included to explore advanced and contemporary methodologies.

Inclusion criteria prioritized peer-reviewed journal articles, white papers, and conference proceedings published within the last 20 years (2003–2023), with exceptions made for seminal works foundational to EVM and project management. The selection emphasized studies focused on the application of EVM in government, infrastructure, or public-private partnership (PPP) projects. Regulatory documents such as the Italian Codice degli Appalti (D.Lgs. 50/2016) and official ANAC guidelines were also considered essential for grounding the analysis in the relevant institutional context.

Studies were excluded if they concentrated solely on EVM in defense or aerospace sectors without offering transferable insights for public procurement. Articles that lacked empirical validation, focused only on theoretical EVM modeling, or were outdated in terms of legal or methodological relevance were also omitted. Non-peer-reviewed sources such as blogs, discussion forums, and unverified opinion pieces were not included to maintain academic integrity.

Following the literature search, the sources were organized into thematic areas aligned with the research objectives: Introduction to Public Procurement, Foundations of Project Management and EVM Methodologies, Monitoring and Control in Public Procurement, Application of EVM in Public Procurement, Advancements in EVM Methodologies, Challenges in EVM Implementation, Limitations of EVM, Best Practices and Future Directions, and Research Gaps and Contributions. This thematic framework provided the basis for a structured and critical literature review that informed both the theoretical and practical dimensions of the thesis.

4. Framework for Earned Value Management (EVM) Application

The application of EVM within this thesis followed a systematic process consistent with international project management standards as outlined in the Project Management Body of Knowledge (PMBOK® Guide) (PMI, 2017). This framework involved four key stages:

Step 1: Establishing the Baseline

- **Planned Value (PV):** Derived from original project documents.
- **Scope and WBS:** Tasks and deliverables were mapped using the Work Breakdown Structure (WBS), structured according to legal and procedural guidelines.

Step 2: Data Collection and EVM Metrics Calculation

- **Core Metrics:** PV, EV, and AC were calculated.
- **Performance Indices:** CPI and SPI were derived to assess project health.
- **Forecasting:** Metrics such as EAC, ETC, and EACt were computed to estimate final project outcomes.

Step 3: Analysis

- EVM metrics were compared to baseline values.

Step 4: Qualitative Insights

- Interviews and documentation reviews provided insight into causes of deviations, such as administrative inefficiencies or funding changes.

5. Justification of Methodological Choices

The mixed-methods design was selected to capture the dual dimensions of EVM implementation: its measurable outcomes and its real-world complexity. The combination of documentary analysis, numerical EVM metrics, and stakeholder interviews provided both breadth and depth, offering a nuanced understanding of the methodology's potential and limitations.

The case study design was particularly suited for investigating a contemporary project embedded in a real-world setting. Given the contextual and operational complexity of the SCR Piemonte case, this approach allowed for detailed exploration of EVM in action, making it possible to derive insights applicable to other public procurement scenarios.

6. Ethical Considerations

Ethical integrity was maintained throughout the research process. All participants involved in interviews provided informed consent, and data confidentiality was preserved through anonymization. Sensitive financial and operational data were handled according to SCR Piemonte's internal policies and relevant data protection regulations.

This rigorous methodological structure ensures that the findings are both academically robust and practically valuable, offering a credible assessment of how EVM can be adapted and applied within public procurement in Italy.

Case Study

Project Introduction

The pilot project selected for this study is the development of a sporting site in a town located in the Piemont Region. This project started in 2018 and it was designed to create a sporting environment that would help the community to engage more in local sport activities. SCR Piemonte was responsible for managing this project and ensuring its completion according to the standards set in the beginning. The project was divided into macro phases including the feasibility study, the preliminary, definitive and executive design, the tender and contractor phase followed by the construction phase and the final conclusions. Each phase was planned carefully to guarantee the fulfillment of the objectives set while also being an efficient public procurement company.

Figure 16 Construction site. UDC Sports. (2022, November 17).

Despite attentive planning, the project was met with several challenges that have impacted its progress. These challenges start from administrative delays for different approvals, financial constraints that lead to request of new funding several times, the global pandemic which cause the construction works to stop etc. As of 2025, even though notable progress has been made, the project is still not finished. While being transparent and maintaining the safety of sensitive information the project data has been used according to disclosure guidelines. The objectives and the phases of the project are revealed while sensitive financial details and proprietary information have been anonymized. This still has allowed for a comprehensive analysis of the performance of the project with the Earned Value Management enhancing the project's monitoring.

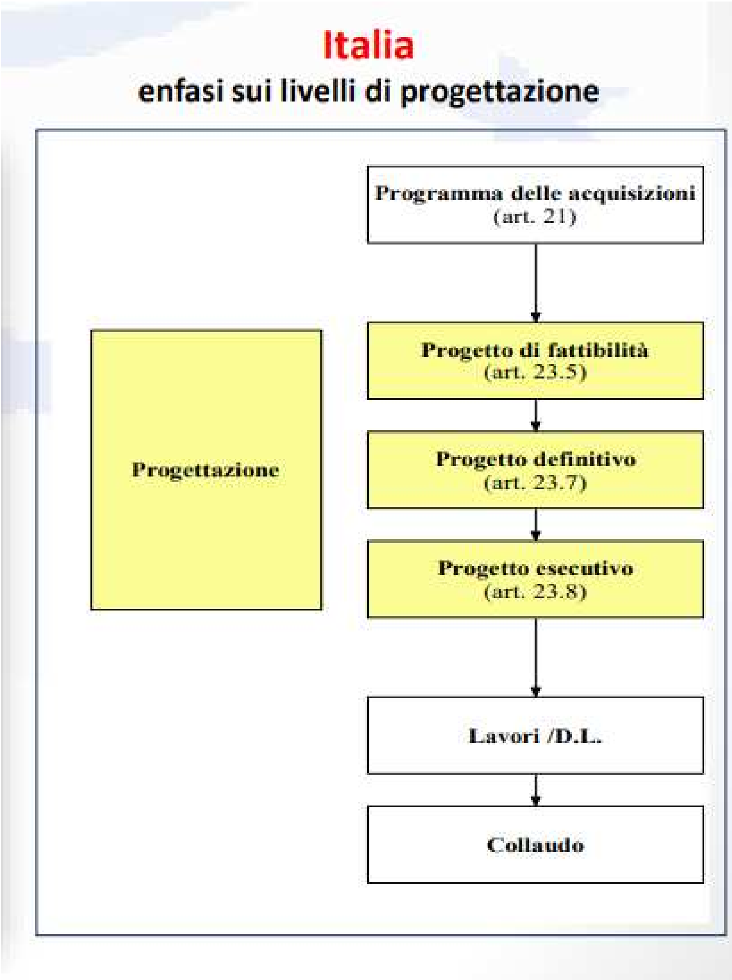


Figure 17 Project phases in Italy

Analysis

This section presents a comprehensive comparative analysis of the project's planned performance versus its actual performance. The analysis is structured in the following steps: establishing the project baseline, calculating Earned Value Management (EVM) metrics, analysis, and deriving qualitative insights from the findings.

Step 1: Establishing the Project Baseline

Work Breakdown Structure (WBS)

In order to effectively manage the project's complexity and ensure a structured approach to its planning and execution, a Work Breakdown Structure (WBS) was developed. The WBS serves as a hierarchical decomposition of the overall scope of work, dividing the project into manageable phases and work packages. This structure enables clearer allocation of responsibilities, better control of activities, and facilitates the tracking of cost and schedule performance using Earned Value Management.

The WBS for this project was created by analyzing the full project lifecycle from preliminary activities through to project closure, aligning with the procedural steps defined in Italian public procurement frameworks. It reflects both the chronological order of execution and the functional grouping of tasks.

The first phase, Preliminary Activities, includes the initial feasibility study, the drafting of planning and administrative documents, and the preliminary steps for project design procurement. These early actions set the foundation for project justification and scope definition.

The second phase, Preliminary Design, focuses on preparing the technical and conceptual basis of the project. It includes drafting the preliminary design documents, securing approvals, and conducting necessary consultations with relevant authorities.

The third phase, Definitive Design, involves the detailed development of the project from a technical and financial standpoint. It is during this stage that final decisions on project specifications are made, followed by validation and approval from oversight bodies.

The fourth phase, Executive Design, translates the approved definitive design into executable documents. This includes technical drawings, bills of quantities, and all project materials required for construction, along with administrative approvals and the management of project variants.

The final phase, Closing Activities, encompasses contract execution, construction work management, inspections, certifications, and the formal closure of the project. This phase also includes financial settlement, documentation of any savings, and the final handover to the contracting entity.

This hierarchical structure allowed for precise scheduling and monitoring through Microsoft Project. Each WBS element corresponds to specific activities with clear start and end points, facilitating Earned Value analysis and providing the framework for cost and schedule control throughout the project lifecycle.

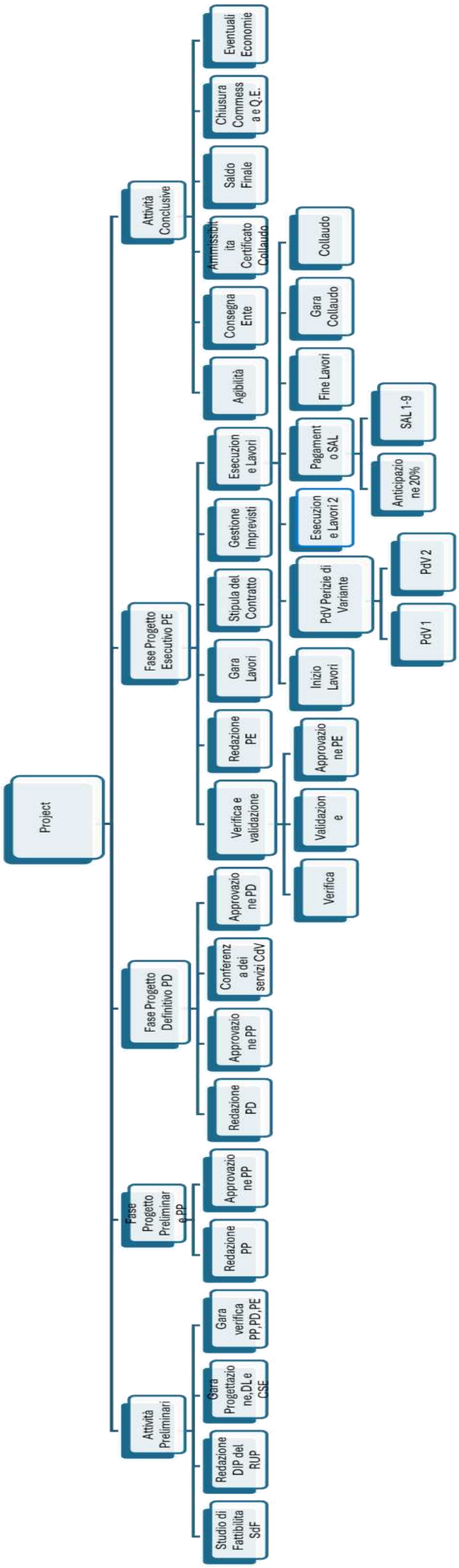


Figure 18 WBS

The Project Timeline

To complement the WBS and further support project monitoring and control, a Gantt chart was developed using Microsoft Project. This visual scheduling tool provided a clear chronological view of all activities, their durations, dependencies, and respective milestones. Each task, aligned with its WBS element, was assigned a specific start and end date based on the planned timeline.

As this analysis began when the project was already underway, all completed phases prior to the start of this study were reconstructed based on documented project records, including official approval dates and actual task completion timelines. These historical entries were used to accurately populate the Gantt chart and establish the project's baseline.

The Gantt chart enabled a comprehensive visualization of overlapping phases, critical paths, and task sequences. It highlighted the logical order of execution, from the early feasibility studies through the design phases and into the execution and closure activities. Milestones such as the approval of each design phase, the start of works, and key construction checkpoints were clearly marked.

The tool also facilitated the identification of dependencies between tasks—for example, how delays in design approvals would directly impact subsequent construction phases. The use of the Gantt chart proved essential in updating project progress dynamically and played a central role in the application of Earned Value Management by connecting planned values (PV) to actual progress over time.

Overall, the Gantt chart served not only as a planning reference but also as a real-time control mechanism that supported informed decision-making and proactive management throughout the project lifecycle.

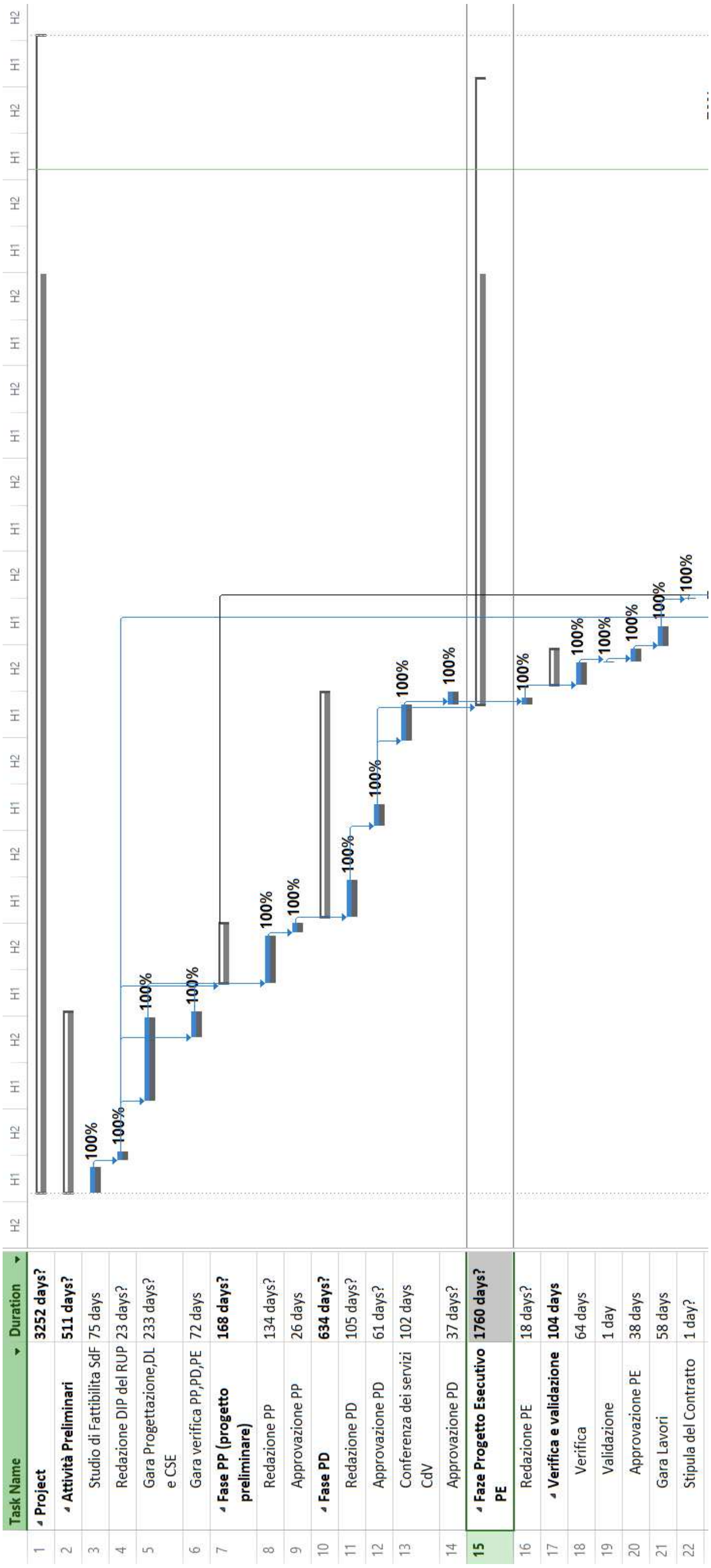
Network Technique: The Critical Path

Given that the project analysis started after execution was already in progress, the identification of the critical path was based on both scheduled plans and the actual progress recorded at the time of this study. The network diagram was used to map task dependencies and determine which ongoing or upcoming activities have the greatest impact on the final project timeline.

The critical path currently runs through the construction-related activities, especially those with tight dependencies such as the remaining works in the main structure and the utility infrastructure. These tasks have little to no scheduling flexibility, meaning delays in their execution could directly postpone the overall completion. As such, they require continuous monitoring and frequent updates within the planning tool.

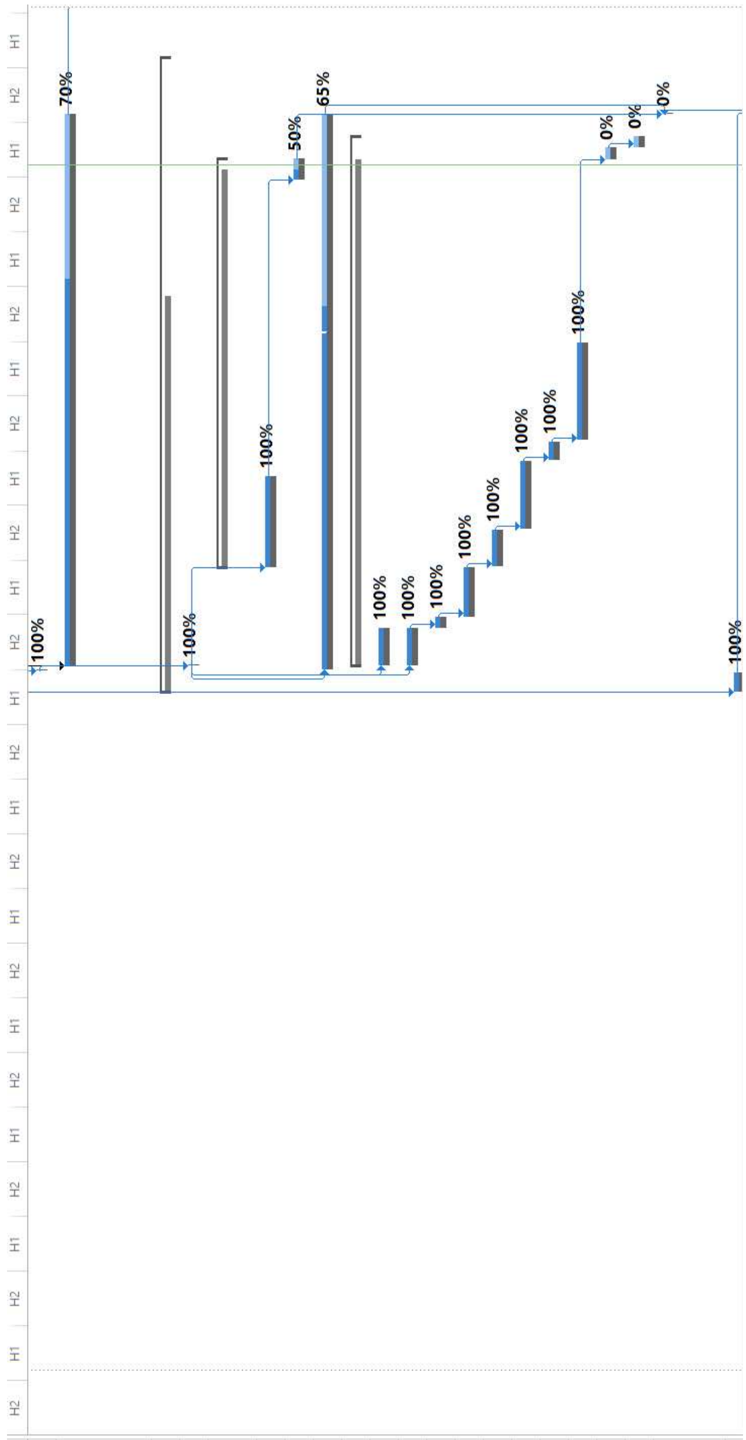
The simplified network visualization is included in the annexes and reflects the present state of the project, helping to focus control efforts on the most time-sensitive elements moving forward.

Table 8 Gantt Chart



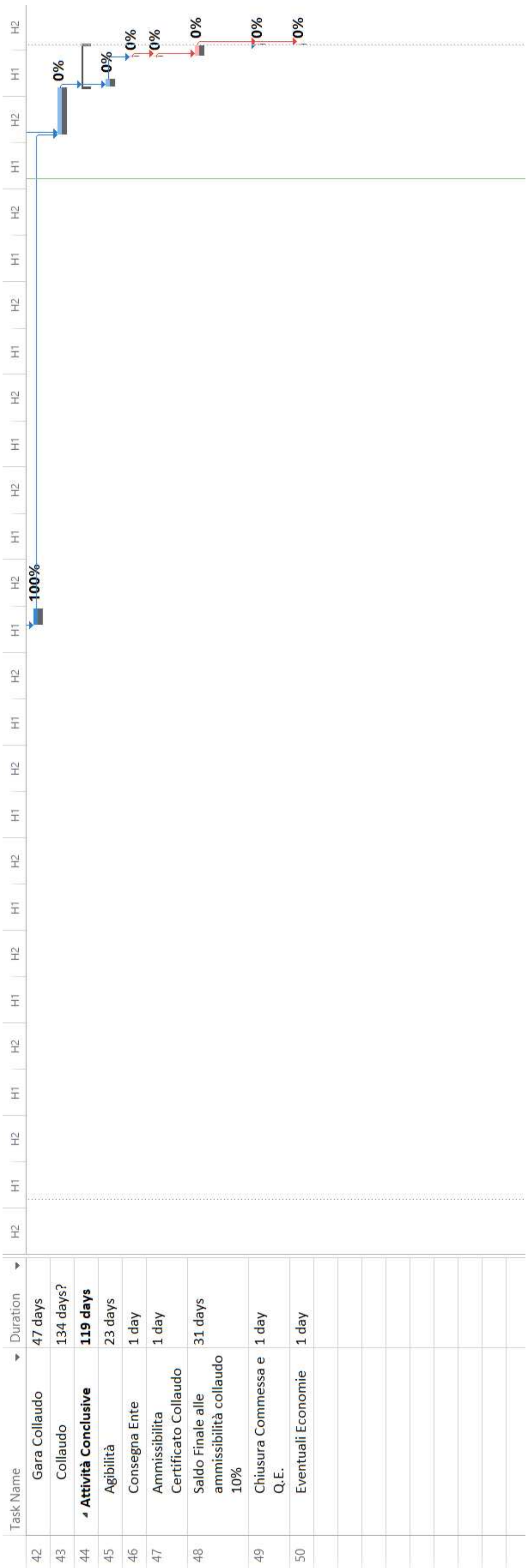
	Task Name	Duration
1	Project	3252 days?
2	Attività Preliminari	511 days?
3	Studio di Fattibilità SdF	75 days
4	Redazione DIP del RUP	23 days?
5	Gara Progettazione,DL e CSE	233 days?
6	Gara verifica PP,PD,PE	72 days
7	Fase PP (progetto preliminare)	168 days?
8	Redazione PP	134 days?
9	Approvazione PP	26 days
10	Fase PD	634 days?
11	Redazione PD	105 days?
12	Approvazione PD	61 days?
13	Conferenza dei servizi CdV	102 days
14	Approvazione PD	37 days?
15	Faze Progetto Esecutivo PE	1760 days?
16	Redazione PE	18 days?
17	Verifica e validazione	104 days
18	Verifica	64 days
19	Validazione	1 day
20	Approvazione PE	38 days
21	Gara Lavori	58 days
22	Stipula del Contratto	1 day?

Table 9 Gantt Chart



	Task Name	Duration
22	Stipula del Contratto	1 day?
23	Gestione Imprevisti (Incremento materiali,Richiesta nuovo finanziamento)	1318 days
24	**Esecuzione Lavori**	**1516 days?**
25	Inizio Lavori	1 day
26	**PdV Perizie di Variante**	**975 days?**
27	PdV 1	217 days?
28	PdV 2	51 days?
29	Esecuzione Lavori 2	1318 days
30	**Pagamento SAL**	**1264 days?**
31	Anticipazione 20%	89 days
32	SAL 1	89 days
33	SAL 2	26 days
34	SAL 3	119 days?
35	SAL 4	88 days?
36	SAL 5	162 days?
37	SAL 6	44 days?
38	SAL 7	232 days?
39	SAL 8	30 days
40	SAL 9	27 days
41	Fine Lavori e Certificato Ultimazione Lavori	1 day
42	Gara Collaudo	47 days

Table 10 Gantt Chart



Economic Planning

The economic planning of the project was conducted based on a revised version of the original financial framework (quadro economico). Given the confidentiality of the project, specific figures and breakdowns cannot be disclosed. However, the overall approach followed standard project control practices, ensuring that financial resources were allocated and monitored throughout the various phases of the project lifecycle.

The financial distribution was organized according to the same structure used in the Work Breakdown Structure (WBS), allowing each macro-phase to be associated with a proportional share of the project's total budget. This segmentation facilitated targeted monitoring of costs and supported the application of Earned Value Management.

The development of the revised financial plan was carried out in close collaboration with the thesis company supervisor and the RUP (Responsabile Unico del Procedimento), ensuring technical consistency and alignment with the real progression of the works. Their guidance was instrumental in maintaining the reliability of the planning model while respecting confidentiality requirements.

Although the detailed economic figures cannot be published, the methodology applied ensures transparency in how financial planning was integrated into project scheduling and monitoring processes. This provided a clear foundation for tracking performance against the planned value and supported more accurate forecasting throughout the remainder of the project.

Step 2: Calculation of Earned Value Management Metrics

Overall Project Performance

To evaluate the project's cost and schedule performance, an Earned Value Management (EVM) analysis was conducted using Microsoft Project. This tool allowed for the continuous tracking of task progress, resource use, and cost accumulation throughout the lifecycle of the project. EVM provided a quantitative framework to assess how much value was generated compared to the planned and actual investments at each stage.

The primary EVM metrics used in this analysis include:

- **Planned Value (PV):** the authorized budget assigned to scheduled work.
- **Earned Value (EV):** the measured value of work actually performed.
- **Actual Cost (AC):** the real costs incurred for the work performed.
- **Cost Performance Index (CPI):** EV / AC, measuring cost efficiency.
- **Schedule Performance Index (SPI):** EV / PV, measuring schedule adherence.
- **Cost Variance (CV):** EV - AC, indicating over or under-budget status.
- **Schedule Variance (SV):** EV - PV, indicating if the project is ahead or behind schedule.

At the time of this analysis, the overall project progress was recorded at 78%. The calculated CPI was 0.89, indicating that for every euro spent, only €0.89 worth of work was earned. This reflects a moderate but notable cost inefficiency. The SPI was 0.75, highlighting a significant schedule delay, as only 75% of the planned work had been completed for the given timeframe.

These figures translate to a Cost Variance (CV) of approximately -€280,797 and a Schedule Variance (SV) of -€783,099. Both variances are negative, signaling that the project is both over budget and behind schedule.

The EVM analysis, anchored in the data structure and scheduling logic of Microsoft Project, enabled precise tracking and real-time variance calculations across all project phases. This approach established a reliable basis for ongoing monitoring, allowing for early identification of deviations and supporting informed decision-making.

Table 11 EVM Values

		Task Mode	Task Name	Duration	% Complete	SPI	CPI	CV	SV	CV%	SV%
1			**Project**	**3252 days?**	**78%**	**0,75**	**0,89**	**-280.797,33 €**	**-783.098,89 €**	**-12%**	**-25%**
2	✓		**Attività Preliminari**	**511 days?**	**100%**	**1**	**1,06**	**3.103,76 €**	**0,00 €**	**6%**	**0%**
3	✓		Studio di Fattibilita SdF	75 days	100%	1	0,93	-936,96 €	0,00 €	-7%	0%
4	✓		Redazione DIP del RUP	23 days?	100%	1	1,13	4.040,72 €	0,00 €	11%	0%
5	✓		Gara Progettazione,DL e CSE	233 days?	100%	1	1	0,00 €	0,00 €	0%	0%
6	✓		Gara verifica PP,PD,PE	72 days	100%	1	1	0,00 €	0,00 €	0%	0%
7	✓		**Fase PP (progetto preliminare)**	**168 days?**	**100%**	**1**	**1,17**	**10.163,04 €**	**0,00 €**	**15%**	**0%**
8	✓		Redazione PP	134 days?	100%	1	1,13	4.040,72 €	0,00 €	11%	0%
9	✓		Approvazione PP	26 days	100%	1	1,23	6.122,32 €	0,00 €	19%	0%
10	✓		**Fase PD**	**634 days?**	**100%**	**1**	**1,05**	**5.881,84 €**	**0,00 €**	**4%**	**0%**
11	✓		Redazione PD	105 days?	100%	1	1,13	4.040,72 €	0,00 €	11%	0%
12	✓		Approvazione PD	61 days?	100%	1	1,23	6.122,32 €	0,00 €	19%	0%
13	✓		Conferenza dei servizi CdV	102 days	100%	1	0,94	-2.140,60 €	0,00 €	-7%	0%
14	✓		Approvazione PD	37 days?	100%	1	0,94	-2.140,60 €	0,00 €	-7%	0%
15			**Faze Progetto Esecutivo PE**	**1760 days?**	**74%**	**0,73**	**0,88**	**-299.945,97 €**	**-783.098,89 €**	**-14%**	**-27%**
16	✓		Redazione PE	18 days?	100%	1	1,13	4.040,72 €	0,00 €	11%	0%
17	✓		**Verifica e validazione**	**104 days**	**100%**	**1**	**1,21**	**6.122,32 €**	**0,00 €**	**17%**	**0%**
18	✓		Verifica	64 days	100%	1	1	0,00 €	0,00 €	0%	0%
19	✓		Validazione	1 day	100%	0	0	0.00 €	0.00 €	0%	0%

Table 12 EVM Values

		Task Mode	Task Name	Duration	% Complete	SPI	CPI	CV	SV	CV%	SV%
19	✓		Validazione	1 day	100%	0	0	0,00 €	0,00 €	0%	0%
20	✓		Approvazione PE	38 days	100%	1	1,23	6.122,32 €	0,00 €	19%	0%
21	✓		Gara Lavori	58 days	100%	1	1	0,00 €	0,00 €	0%	0%
22	✓		Stipula del Contratto	1 day?	100%	1	1,05	3.870,58 €	0,00 €	5%	0%
23			Gestione Imprevisti (Incremento materiali,Richiesta nuovo finanziamento)	1318 days	70%	0,84	0,86	-26.000,00 €	-29.520,49 €	-17%	-16%
24			**Esecuzione Lavori**	**1516 days?**	**75%**	**0,71**	**0,86**	**-287.979,59 €**	**-753.578,40 €**	**-16%**	**-29%**
25	✓		Inizio Lavori	1 day	100%	0	0	0,00 €	0,00 €	0%	0%
26			**PdV Perizie di Variante**	**975 days?**	**90%**	**0,91**	**0,95**	**-20.000,00 €**	**-37.431,37 €**	**-5%**	**-9%**
27	✓		PdV 1	217 days?	100%	1	1	0,00 €	0,00 €	0%	0%
28			PdV 2	51 days?	50%	0,79	0,88	-20.000,00 €	-37.431,37 €	-14%	-21%
29			Esecuzione Lavori 2	1318 days	65%	0,66	0,84	-267.979,59 €	-716.147,03 €	-19%	-34%
30			**Pagamento SAL**	**1264 days?**	**94%**	**0**	**0**	**0,00 €**	**0,00 €**	**0%**	**0%**
31	✓		Anticipazione 20%	89 days	100%	0	0	0,00 €	0,00 €	0%	0%
32	✓		SAL 1	89 days	100%	0	0	0,00 €	0,00 €	0%	0%
33	✓		SAL 2	26 days	100%	0	0	0,00 €	0,00 €	0%	0%
34	✓		SAL 3	119 days?	100%	0	0	0,00 €	0,00 €	0%	0%
35	✓		SAL 4	88 days?	100%	0	0	0,00 €	0,00 €	0%	0%
36	✓		SAL 5	162 days?	100%	0	0	0,00 €	0,00 €	0%	0%
37	✓		SAL 6	44 days?	100%	0	0	0,00 €	0,00 €	0%	0%

Table 13 EVM Values

		Task Mode	Task Name	Duration	% Complete	SPI	CPI	CV	SV	CV%	SV%
37			SAL 6	44 days?	100%	0	0	0,00 €	0,00 €	0%	0%
38			SAL 7	232 days?	100%	0	0	0,00 €	0,00 €	0%	0%
39			SAL 8	30 days	0%	0	0	0,00 €	0,00 €	0%	0%
40			SAL 9	27 days	0%	0	0	0,00 €	0,00 €	0%	0%
41			Fine Lavori e Certificato Ultimazione Lavori	1 day	0%	0	0	0,00 €	0,00 €	0%	0%
42			Gara Collaudo	47 days	100%	1	1	0,00 €	0,00 €	0%	0%
43			Collaudo	134 days?	0%	0	0	0,00 €	0,00 €	0%	0%
44			**Attività Conclusive**	**119 days**	**0%**	**0**	**0**	**0,00 €**	**0,00 €**	**0%**	**0%**
45			Agibilità	23 days	0%	0	0	0,00 €	0,00 €	0%	0%
46			Consegna Ente	1 day	0%	0	0	0,00 €	0,00 €	0%	0%
47			Ammissibilita Certificato Collaudo	1 day	0%	0	0	0,00 €	0,00 €	0%	0%
48			Saldo Finale alle ammissibilità collaudo 10%	31 days	0%	0	0	0,00 €	0,00 €	0%	0%
49			Chiusura Commessa e Q.E.	1 day	0%	0	0	0,00 €	0,00 €	0%	0%
50			Eventuali Economie	1 day	0%	0	0	0,00 €	0,00 €	0%	0%

Step 3: Analysis

Preliminary Activities This phase included feasibility studies and initial administrative preparations. It shows a CPI of 1.06, indicating slight cost savings, with an SPI of 1.00, reflecting perfect alignment with the schedule. This result is expected given the limited complexity and duration of this stage, and the fact that all activities were completed prior to the start of this analysis.

Preliminary Design (PP) This design phase also performed efficiently, with a CPI of 1.17 and SPI of 1.00. The high CPI suggests that this phase was executed under budget, largely due to streamlined design procedures and timely validation. There were no significant delays reported in this phase.

Definitive Design (PD) Performance during this phase began to show early signs of inefficiencies. The CPI dropped to 1.05, while the SPI declined to 0.94. While still within acceptable bounds, these figures reflect increasing complexity, particularly in the coordination of external stakeholder approvals.

Executive Design (PE) This phase marked the first substantial deviation, with a CPI of 0.88 and an SPI of 0.73. The negative cost and schedule variances here (CV: -€299,946; SV: -€783,099) suggest both higher-than-expected design costs and delays in contract finalization. These inefficiencies had a cascading effect on the subsequent execution phases.

Table 14 EVM For Ongoing Phases

Name	% Complete	CPI	CV%	SPI	SV%
Gestione Imprevisti	70%	0,86	-17%	0,84	-16%
PdV 2	50%	0,88	-14%	0,79	-21%
Esecuzione Lavori 2	65%	0,84	-19%	0,66	-34%

Construction and Execution (Esecuzione Lavori) At 75% completion, this is the most critical and cost-intensive phase. The SPI of 0.71 and CPI of 0.86 confirm substantial underperformance. Key contributors to these delays include interruptions due to funding reviews (Gestione Imprevisti) and complex coordination for design modifications (PdV 2). Cost variance in this segment exceeds -€267,000.

Payments (SALs) The SAL (Stato Avanzamento Lavori) section is 94% complete, with neutral CPI and SPI values, as it serves more as a payment record than a performance measure. Most activities here are administrative, reflecting progress already captured in the execution phase.

Closure Activities These have not yet begun, so no EVM metrics are available. However, they are scheduled and monitored for real-time analysis once initiated.

Earned Cost Over Time – S-Curve Analysis

The S-curve chart visually represents the cumulative performance of the project over time, comparing three essential metrics: Actual Cost of Work Performed (ACWP), Budgeted Cost of Work Performed (BCWP or EV), and Budgeted Cost of Work Scheduled (BCWS or PV). The x-axis displays the project timeline in years, while the y-axis represents cumulative costs.

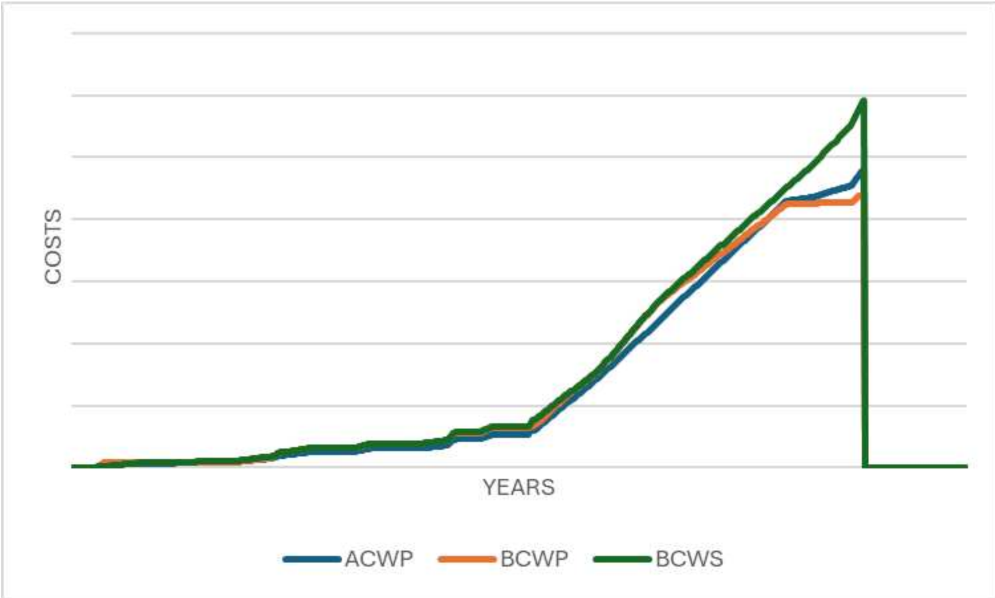
Initially, all three curves rise in unison, reflecting well-aligned early project phases with minimal deviation between planned, earned, and actual costs. However, as the project progresses into the more resource-intensive phases, the BCWS (green line) continues to increase steadily while the BCWP (orange line) begins to lag, indicating a delay in the completion of scheduled work. This delay is confirmed by a Schedule Performance Index (SPI) below 1.0.

Simultaneously, the ACWP (blue line) trends slightly above the BCWP, signifying cost overruns—actual expenditures are higher than the value of work completed, consistent with a Cost Performance Index (CPI) below 1.0. The gap between ACWP and BCWP confirms that the project is currently over budget.

According to standard S-curve interpretation models (De Marco, 2018), the current project situation corresponds most closely with the A1 scenario (explained in the theoretical background) : a project that is both behind schedule and over budget. This configuration reflects the most unfavorable condition from a project control perspective, requiring immediate managerial attention and corrective measures.

In summary, the S-curve analysis reinforces the quantitative EVM indicators and highlights the dual challenge of schedule delays and cost overruns that have emerged in the later phases of the project.

Table 15 EARNED COST OVER TIME



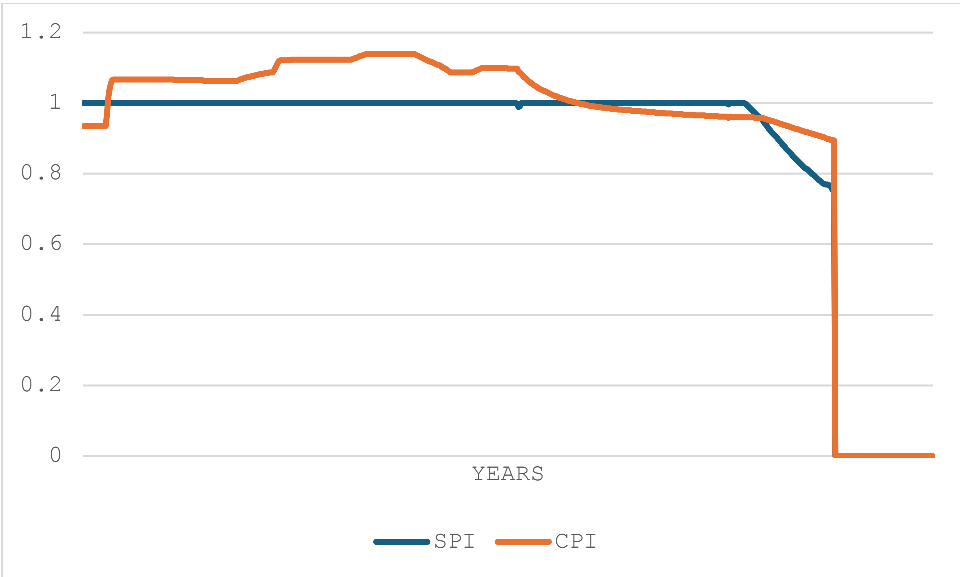
The earned cost of the project based on the status date. If the actual cost (ACWP) is greater than the earned cost (BCWP), the project is over budget. If the planned value (BCWS) is greater than the earned cost, the project is late.

Indices Over Time

SPI remains near 1.0 in the early phases, indicating adherence to schedule. This stability is expected, as the durations for these early activities were entered in line with the planned schedule. Since these phases had already been completed at the time of analysis, the actual durations were assumed to match the planned ones for consistency and reconstruction purposes. However, in the second half, it declines steadily, dropping below 0.8—signalling that actual progress began to significantly lag behind planned progress. This trend confirms the project's growing delay over time.

The CPI curve shows a similar dynamic. Initially above 1.0, suggesting cost efficiency, it begins to decline as the project enters more complex phases. Eventually, it falls below 0.9, reflecting that costs are increasingly exceeding the value of the work performed.

Table 16 INDEXES OVER TIME



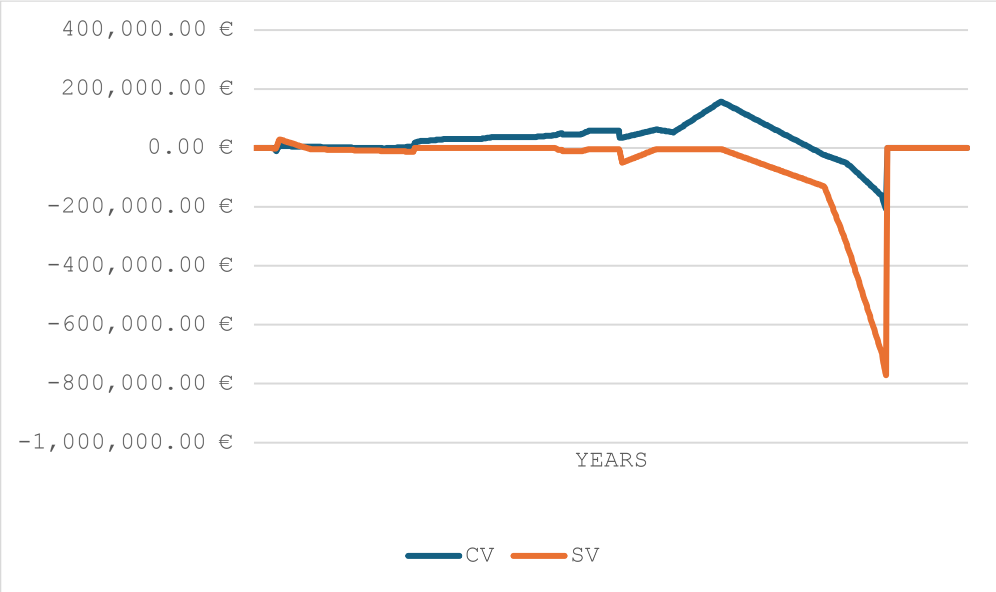
Indices of execution of the planned work and the actual cost for the project based on the status date. The higher the performance index, the more punctual the project is and the costs are low.

Variance Over Time

The second chart displays Cost Variance (CV) and Schedule Variance (SV) over time. In the early stages, both remain near zero, suggesting a balanced performance. As the project advances, SV drops steeply below -€800,000, indicating increasing delays. Meanwhile, CV also trends negative, peaking at around -€280,000, confirming that the project has become increasingly expensive relative to its earned value.

These negative variances align with the performance index curves and the S-curve, reinforcing the critical need for targeted interventions in the ongoing phases.

Table 17 TIME VARIATION



Cost and schedule variances for the project based on the status date. If CV is negative, the project is over budget. If SV is positive, the project is ahead of schedule in terms of costs.

Forecasting and Cost Control Analysis

To complement performance and variance metrics, forecasting analysis was conducted using EVM indicators to estimate the total expected cost at project completion and assess the efficiency required for future performance.

The two key forecasting metrics applied are:

- **BAC (Budget at Completion):** the original total budget allocated to the project.
- **EAC (Estimate at Completion):** the forecasted total cost of the project based on current performance trends.

Due to confidentiality constraints, the actual monetary values of these indicators are not disclosed. However, the relationships between them are illustrated in the bar chart, where EAC exceeds BAC, confirming that the project is projected to finish over budget.

The EAC is calculated using the following standard EVM formula:

EAC = BAC / CPI

This formula assumes current cost performance (CPI) will continue throughout the remainder of the project. Given that CPI < 1, the EAC is higher than the original BAC, highlighting cost overruns.

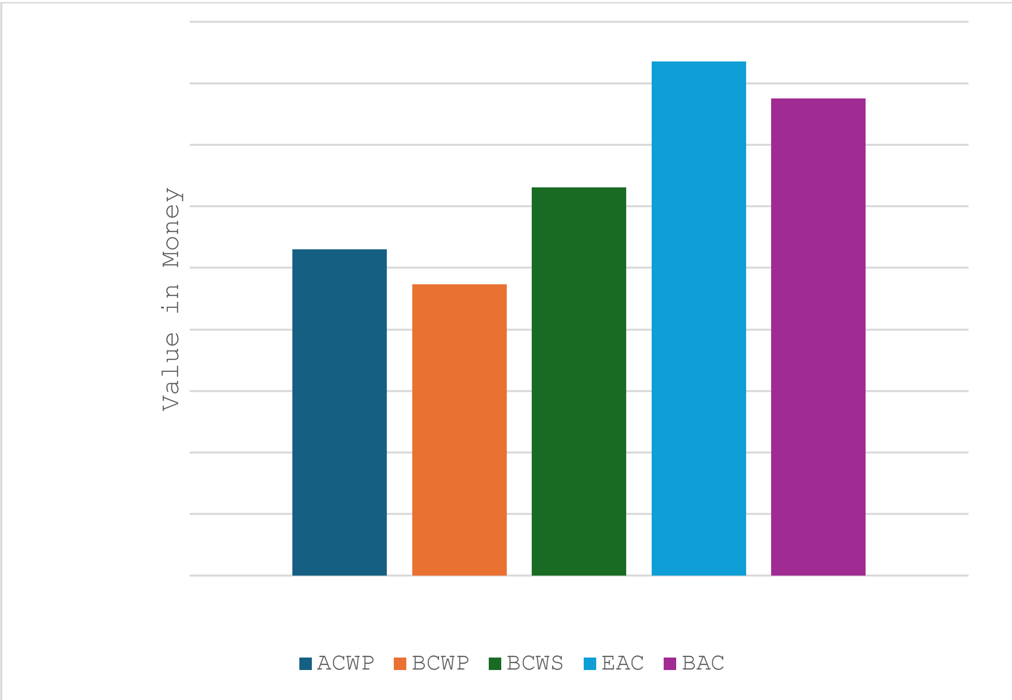
Additionally, the **To-Complete Performance Index (TCPI)** is used to determine the cost efficiency required for the remaining work to meet a specific goal:

TCPI = (BAC - EV) / (BAC - AC)

If the TCPI is greater than 1, it means the remaining work must be performed more efficiently than the current performance. A significantly higher TCPI would indicate that meeting the original budget is unlikely without corrective actions.

In this case, the comparison between BAC, EAC, and actual progress (EV) reinforces the need for enhanced cost control and strategic resource management in the remaining project phases. The calculated TCPI of 1.26 confirms this urgency: it indicates that to meet the original budget, the remaining work would have to be executed with 26% greater cost efficiency than has been achieved so far, which is a considerable challenge.

Table 18 Forecasting EVM



Step 4: Qualitative Insights

Planning and Design Phases These phases—including feasibility studies, preliminary and detailed design, and the final executive project plan—were completed with a reported 100% execution rate. EVM data shows SPI = 1.0, suggesting that from a strictly metric-based standpoint, these activities were completed as scheduled. However, project documentation and interviews reveal that the phases encountered substantial bureaucratic and administrative delays. These include long approval processes and inter-agency coordination issues that affected project momentum.

This highlights a known limitation of SPI, which tends to converge to 1.0 as tasks reach full completion—even if delayed. Therefore, while SPI reports no delay, real-world evidence points to slippage that contributed to pushing back subsequent procurement and construction activities.

Procurement and Contracting Phase This phase included tendering and contracting processes such as "Gara Lavori" and contract stipulation. While the contractual activities reached 100% completion, delays were encountered due to the procedural complexity of the tendering process. Furthermore, the onset of the COVID-19 pandemic disrupted administrative workflows, postponing the commencement of construction.

Construction and Execution Phase Currently in progress, this phase includes "Gestione Imprevisti," "Esecuzione Lavori," and the two "Perizie di Variante". Completion rates range from 50% to 80%. This is the phase where the most significant issues emerged. Technical challenges such as weak soil conditions and the unexpected presence of underground infrastructure required unplanned design changes and additional stabilization measures.

Simultaneously, global events like the COVID-19 pandemic, supply chain disruptions, and the Ukraine conflict triggered delays and price volatility in construction materials, necessitating repeated price revisions and requests for additional funding.

These disruptions are clearly reflected in EVM metrics. The SPI ranged from 0.63 to 0.83, indicating serious schedule delays, while CPI values ranging from 0.84 to 0.88 revealed cost overruns. The rising Estimate at Completion (EAC) further confirmed the project's overall upward cost trend.

Payment and Financial Management While 94% of payment processes (SAL) are reported as completed, this phase experienced significant financial adjustments. Funding delays—partly due to inflation-driven cost increases—required repeated government approvals for revised budgets. This was accompanied by changes in scope and budgetary structure via multiple perizie di variante.

EVM showed persistent cost overruns, indicated by negative Cost Variance (CV < 0), and a higher-than-expected Estimate at Completion (EAC > BAC), projecting the project's final cost above initial estimates.

Finalization and Closeout Phase This phase is still pending execution. It includes the finalization of works, certification, and project closure. While no EVM data is yet available due to non-initiation, earlier delays and unresolved issues pose risks. Modifications made during construction may complicate compliance checks, while known delays in municipal approval processes suggest the potential for extended handover and closure timelines.

Based on current trends, a projected SPI below 1 during this phase could be anticipated, risking further schedule slippage if proactive interventions are not implemented.

Summary of Problems Identified per Phase & EVM Role:

Table 19 Summary of Problems

Phase	**Key Problems Identified**
Planning & Design	Bureaucratic delays, slow approvals, coordination challenges
Procurement	Delayed contract signing, COVID-19 disruptions
Construction	Technical modifications, supply chain issues, cost overruns, multiple project extensions
Financial Management	Budget increases, funding delays, frequent cost adjustments
Finalization & Closeout	Compliance risks, administrative delays in approvals and certification

- **Key Takeaways:**
- EVM has effectively highlighted schedule delays (SPI < 1), cost overruns (CPI < 1), and financial inefficiencies (EAC, CV).
- Construction phases suffered the most due to unforeseen technical and material availability challenges.
- The procurement and financial phases were affected by administrative inefficiencies, requiring better forecasting and risk management.
- Future risks remain in the project closeout phase, as compliance and final approvals may experience delays.

Conclusions

This thesis set out to explore the applicability and effectiveness of Earned Value Management (EVM) as a tool for improving cost and schedule monitoring in Italian public procurement. Through an in-depth literature review and a detailed case study of the SCR Piemonte sporting site project, the research aimed to assess both the theoretical foundations and the practical implementation of EVM in a complex public sector context.

The final analysis draws from both the academic discourse and empirical evidence gathered throughout the project lifecycle, synthesizing key insights into the benefits, challenges, and limitations of EVM. These findings not only validate much of the existing literature but also offer a grounded perspective on how EVM functions in real-world public procurement environments—where regulatory complexity, stakeholder diversity, and project unpredictability often impede standardized monitoring.

The following sections present the core conclusions of the study, organized around the main thematic pillars that emerged from the research: the benefits of EVM adoption, the challenges and barriers encountered, the inherent limitations of the methodology, and strategic recommendations for enhancing its future application in public sector projects.

1. Benefits of Applying EVM in Public Procurement

The application of Earned Value Management in the SCR Piemonte case study revealed substantial benefits that reinforce its value as a performance monitoring tool in public procurement. In line with the theoretical framework established by PMI (2005) and NDIA (2022), EVM provided an integrated approach to monitoring cost, schedule, and scope simultaneously—enabling a clearer and more structured view of project performance than traditional reporting methods.

One of the most significant advantages observed was the early detection of deviations in both cost and schedule. The project's overall CPI of 0.96 and SPI of 0.76 served as early indicators of inefficiencies, allowing decision-makers to intervene before these issues escalated. This proactive insight aligns with the literature's emphasis on EVM's capacity to function as an early warning system, improving the timeliness and effectiveness of managerial responses.

Additionally, the use of EVM encouraged greater transparency and accountability throughout the project lifecycle. By quantifying performance metrics and aligning them with established baselines, stakeholders were better equipped to assess progress objectively. This supports the findings of Sportello Appalti Imprese (2021), which underscore the critical role of clearly defined monitoring practices in public sector projects.

Another notable benefit was the incorporation of qualitative insights to complement quantitative findings. Interviews with project stakeholders, particularly the Responsabile Unico del Procedimento (RUP), added interpretive depth to the metrics—offering explanations for variances that raw numbers alone could not provide. This integration of stakeholder input helped contextualize the data, reinforcing the importance of qualitative evaluation in EVM's practical application.

Overall, the SCR Piemonte project confirmed that EVM, when appropriately applied, can significantly enhance project control, foster accountability, and support more informed decision-making in public procurement settings.

2. Challenges in Implementing EVM in Public Procurement

Despite its benefits, the implementation of Earned Value Management in the SCR Piemonte project also exposed several challenges, many of which mirror the structural and organizational issues identified in the literature. These obstacles highlight the complexities of adapting EVM to the context of Italian public procurement and underscore the importance of tailoring its application to fit public sector realities.

One of the most prominent challenges was the difficulty in establishing accurate and consistent performance measurement baselines. As discussed by Fleming and Koppelman (2016), EVM requires a well-defined Work Breakdown Structure (WBS), clear scope, and reliable data inputs. However, the fragmented nature of project planning in the public sector—exacerbated by decentralized data systems and incomplete records—posed significant barriers to creating a cohesive baseline. This issue was particularly evident in the early phases of the SCR Piemonte project, where legacy systems and administrative silos hindered real-time data integration and delayed performance tracking.

Administrative delays and prolonged approval procedures emerged as another major challenge, directly contributing to schedule slippage and reduced SPI values. This reflects Flyvbjerg's (2009) insights into the systemic inefficiencies that plague large-scale public projects. In the SCR case, key phases such as "Perizia di Variante 2" were significantly impacted by slow bureaucratic processes, making timely project control difficult even when EVM metrics indicated performance issues.

Moreover, the cultural and organizational readiness for EVM adoption proved to be limited. As Svejvig and Andersen (2015) noted, successful EVM implementation often requires a fundamental shift in mindset—away from reactive monitoring and toward proactive, metric-driven management. In the SCR project, initial unfamiliarity with EVM among project staff and stakeholders led to resistance and underutilization of its full capabilities. While training and stakeholder engagement eventually improved data interpretation, this challenge highlighted the need for broader capacity building.

Together, these challenges suggest that while EVM is a powerful tool, its success in public procurement depends not only on its technical application but also on overcoming institutional inertia, improving data systems, and fostering a culture of performance-based project management.

3. Limitations of EVM in Complex Public Projects

In addition to its challenges, the SCR Piemonte case study highlighted key limitations of the Earned Value Management methodology, particularly when applied to dynamic and unpredictable public sector projects. While EVM offers a structured framework for performance measurement, certain project realities expose its constraints—many of which were also discussed in the literature.

One of the central limitations observed was EVM's difficulty in forecasting performance under uncertain or changing conditions. Public procurement projects, especially those in the construction sector, often face unforeseen issues such as regulatory shifts, environmental constraints, or technical surprises. In the SCR Piemonte case, unexpected challenges—such as soil stabilization problems and the discovery of underground utilities—disrupted progress and impacted costs in ways that EVM metrics could not predict. This limitation is consistent with Flyvbjerg's (2009) critique that traditional planning tools often fall short in the face of "unknown unknowns" common in large-scale public initiatives.

Another technical limitation of EVM lies in the interpretation of the Schedule Performance Index (SPI). As the project nears completion, the SPI tends to converge toward 1.0 regardless of earlier delays, potentially giving a misleading sense of schedule recovery. This phenomenon was evident in the final phases of the SCR Piemonte project, where SPI values improved mechanically due to nearing completion, despite real-time delays still impacting deliverables. This reinforces the importance of supplementing EVM metrics with qualitative assessments and phase-specific analysis to avoid misinterpretation.

Furthermore, EVM assumes a level of project stability that is often absent in public procurement. Frequent scope changes, shifting funding approvals, and the need for contract revisions challenge the static nature of EVM baselines. While baseline redefinition is technically possible, in practice it is rarely conducted in real time within public agencies due to administrative complexity and rigid approval chains.

These limitations emphasize that while EVM is a valuable component of a project control system, it should not be viewed as a standalone solution. Instead, it must be complemented by flexible project governance, scenario-based planning, and contextual judgment to truly support effective decision-making in public procurement.

4. Recommendations for Enhancing EVM Implementation

Drawing from the practical experience of the SCR Piemonte case study and insights from the literature, several strategic recommendations can be proposed to enhance the effectiveness of Earned Value Management in public procurement contexts. These recommendations address both technical and organizational aspects, aiming to overcome the challenges and limitations identified while reinforcing the benefits of EVM adoption.

1. Enhanced Data Integration

To address the issue of fragmented and inconsistent data sources, public procurement authorities should invest in integrated digital platforms that support real-time data collection, visualization, and reporting. Tools such as Microsoft Project and Power BI, when linked to centralized project databases, can facilitate the continuous tracking of EVM metrics and reduce manual errors. This aligns with NDIA's (2022) call for improved digital infrastructure to support performance measurement.

2. Capacity Building and Stakeholder Training

The successful adoption of EVM requires not only technical tools but also skilled professionals who can interpret and act on performance data. It is therefore essential to implement targeted training programs for key stakeholders, especially the Responsabile Unico del Procedimento (RUP) and project managers. These programs should cover EVM fundamentals, practical application, and data interpretation. As highlighted by Sportello Appalti Imprese (2021), such training supports both methodological alignment and cultural readiness.

3. Streamlined Administrative Processes

To reduce delays that compromise schedule adherence, administrative procedures—especially those related to approvals, design changes, and contract modifications—should be reviewed and streamlined. Drawing from Fleming and Koppelman (2016), improving process agility would help maintain alignment with baseline targets and make EVM a more responsive tool for real-time decision-making.

4. Continuous and Integrated Monitoring

EVM should not be treated as a one-time analysis but as part of an ongoing project monitoring process. Establishing periodic review cycles—where EVM data is updated and evaluated in conjunction with qualitative feedback—will promote more adaptive project management. This recommendation echoes PMI's (2005) emphasis on continuous performance assessment and proactive control.

5. Complement Quantitative Analysis with Contextual Insights

Given the limitations observed in interpreting metrics like SPI and CPI in isolation, it is recommended that EVM outputs be consistently interpreted alongside qualitative data such as stakeholder feedback, site reports, and risk assessments. This dual approach ensures that performance deviations are understood in context, enabling more informed and nuanced management responses.

5. Summary

In conclusion, this thesis has demonstrated that while Earned Value Management holds significant promise for enhancing project monitoring in public procurement, its success depends on thoughtful adaptation to the specific conditions of the public sector. The case study of SCR Piemonte provided real-world validation of EVM's strengths—chiefly its ability to generate timely, data-driven insights into cost and schedule performance. At the same time, it exposed structural and cultural challenges that must be addressed to unlock the methodology's full potential.

The findings reinforce the consensus in the literature: EVM is not a plug-and-play solution, but a strategic framework that requires robust data systems, organizational buy-in, and ongoing capacity development. Its limitations in forecasting under uncertainty and interpreting progress near project completion further highlight the need for complementary qualitative evaluation.

By synthesizing theoretical knowledge with practical application, this thesis contributes to a growing body of research advocating for more sophisticated project control mechanisms in the public sector. The proposed recommendations—ranging from digital integration to stakeholder training—offer actionable pathways for improving EVM effectiveness in Italy's procurement landscape.

Ultimately, the research affirms that the strategic and properly supported use of EVM can lead to more transparent, accountable, and efficient public project delivery—goals that are especially critical in the context of public spending and infrastructure development.

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