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Case study: **Study and implementation of a standard high school for 1000\200 students in ELGANTRA, ANNABA province by "DIB SALAH" company.**

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بسم الله الرحمن الرحيم

وآخر دعوانا أن الحمد لله رب العالمين

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Abstract

This thesis explores the application of Earned Value Management (EVM) as a performance monitoring tool in construction projects, with a focus on Algeria's educational infrastructure sector. The study aims to assess how EVM can improve cost control, schedule adherence, and overall project performance. Structured into three parts, the research begins with a theoretical framework that introduces EVM, its key components (Planned Value, Earned Value, Actual Cost), and performance indicators (CPI, SPI), along with its benefits and challenges in construction. The methodological approach examines the context of the construction company DIB SALAH and the case study project—a standard high school in ELGANTRA, ANNABA—covering technical data, site analysis, and project planning. The managerial application demonstrates the use of EVM metrics to evaluate real-time data, detect deviations, and propose corrective strategies. The findings reveal that EVM, though underutilized in Algeria, is highly effective when adapted to local conditions, enabling early detection of delays and budget overruns, informed decision-making, and more transparent project management. Recommendations include staff training, digital tool integration, and regulatory support to promote broader EVM adoption. This study offers practical insights to improve construction project efficiency in Algeria.

Key words:

Earned Value Management (EVM), Project Performance, Construction Management, DIB SALAH company, educational construction.

Résumé

Cette thèse explore l'application de la gestion de la valeur acquise (EVM) en tant qu'outil de suivi de la performance dans les projets de construction, en se concentrant sur le secteur des infrastructures éducatives en Algérie. L'étude vise à évaluer comment la gestion de la valeur acquise (EVM) peut améliorer le contrôle des coûts, le respect des délais et la performance globale des projets. Structurée en trois parties, la recherche commence par un cadre théorique qui introduit l'EVM, ses composants clés (Valeur Planifiée, Valeur Acquise, Coût Réel), et les indicateurs de performance (CPI, SPI), ainsi que ses avantages et défis dans la construction. L'approche méthodologique examine le contexte de l'entreprise de construction DIB SALAH et le projet d'étude de cas—un lycée standard à ELGANTRA, ANNABA—couvrant les données techniques, l'analyse du site et la planification du projet. L'application managériale démontre l'utilisation des métriques EVM pour évaluer les données en temps réel, détecter les écarts et proposer des stratégies correctives. Les résultats révèlent que l'EVM, bien que sous-utilisée en Algérie, est très efficace lorsqu'elle est adaptée aux conditions locales, permettant une détection précoce des retards et des dépassements de budget, une prise de décision éclairée et une gestion de projet plus transparente. Les recommandations incluent la formation du personnel, l'intégration d'outils numériques et le soutien réglementaire pour promouvoir une adoption plus large de l'EVM. Cette étude offre des perspectives pratiques pour améliorer l'efficacité des projets de construction en Algérie.

Mots-clés :

Gestion de la valeur acquise (EVM), performance de projet, gestion de la construction, entreprise DIB SALAH, construction éducative.

ملخص

تستكشف هذه الأطروحة تطبيق إدارة القيمة المكتسبة (EVM) كأداة لمراقبة الأداء في مشاريع البناء، مع التركيز على قطاع البنية التحتية التعليمية في الجزائر. تهدف الدراسة إلى تقييم كيفية تحسين إدارة القيمة المكتسبة (EVM) للتحكم في التكاليف، والالتزام بالجدول الزمني، والأداء العام للمشروع. مقسم إلى ثلاثة أجزاء، يبدأ البحث بإطار نظري يقدم نظام القيمة المكتسبة(EVM) ، ومكوناته الرئيسية (القيمة المخططة، القيمة المكتسبة، التكلفة الفعلية)، ومؤشرات الأداءCPI) ، (SPI، بالإضافة إلى فوائده وتحدياته في البناء. النهج المنهجي يفحص سياق شركة البناء DIB SALAH ومشروع دراسة الحالة—مدرسة ثانوية نموذجية فيELGANTRA ، —ANNABAمغطياً البيانات التقنية، وتحليل الموقع، وتخطيط المشروع. التطبيق الإداري يُظهر استخدام مقاييس إدارة القيمة المكتسبة (EVM) لتقييم البيانات في الوقت الفعلي، واكتشاف الانحرافات، واقتراح استراتيجيات تصحيحية. تكشف النتائج أن إدارة قيمة المكتسبات، على الرغم من عدم استخدامها بشكل كافٍ في الجزائر، تكون فعالة للغاية عند تكييفها مع الظروف المحلية، مما يمكّن من الكشف المبكر عن التأخيرات وتجاوزات الميزانية، واتخاذ قرارات مستنيرة، وإدارة مشاريع أكثر شفافية. تشمل التوصيات تدريب الموظفين، ودمج الأدوات الرقمية، والدعم التنظيمي لتعزيز تبني نظام إدارة القيمة المكتسبة بشكل أوسع. تقدم هذه الدراسة رؤى عملية لتحسين كفاءة مشاريع البناء في الجزائر.

الكلمات الرئيسية :

إدارة القيمة المكتسبة(EVM) ، أداء المشروع، إدارة البناء، شركة ديب صلاح، البناء التعليمي.

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List of Abbreviations

Abbreviation	Meaning
AC	Actual Cost
ACWP	Actual Cost of Work Performed
BAC	Budget at Completion
BIM	Building Information Modeling
CBS	Cost Breakdown Structure
CNERIB	Centre National d'Études et de Recherches Intégrées du Bâtiment (National Center for Integrated Building Studies and Research)
CPI	Cost Performance Index
CTC	Centre de Contrôle Technique (Technical Control Center)
CV	Cost Variance
DEP	Direction de l'Équipement Public (Public Equipment Directorate)
EAC	Estimate at Completion
ETC	Estimate to Complete
EV	Earned Value
EVM	Earned Value Management
EVMS	Earned Value Management System
GDP	Gross Domestic Product
HTS	High Tensile Strength
IANOR	Institut Algérien de Normalisation (Algerian Institute for Standardization)
IBC	International Building Code
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
KPI	Key Performance Indicator
ODS	Ordre de Service (Service Order)
PMBOK	Project Management Body of Knowledge
PV	Planned Value
RPA	Règles Parasismiques Algériennes (Algerian Seismic Regulations)
RM	Risk Management

SPI	Schedule Performance Index
SV	Schedule Variance
UDS	Unité de Dépistage Scolaire (School Screening Unit)
VAC	Variance at Completion
VO	Variation Order
WBS	Work Breakdown Structure

General Introduction

Globally, the construction process consists of several planned stages and tasks designed to create buildings and infrastructure. Preconstruction, construction, and post-construction are the three primary phases of this process. To achieve a successful project completion, particular duties at each step need to be properly managed. The same procedure is implemented in Algeria; however, High levels of administrative quality are required for the admissions and construction processes.[1]

Effective project performance evaluation involves a combination of structured techniques and methodologies that provide insights into a project's progress and outcomes, like: Clear objectives are essential; defining specific, measurable, attainable, relevant, and time-bound (SMART) goals establishes benchmarks for assessment. Various evaluation methods can be employed, including qualitative techniques that capture stakeholder experiences and quantitative methods that analyze numerical data to measure performance against established criteria. Common techniques include earned value analysis, which integrates scope, cost, and schedule metrics to assess project health, and trend analysis, which identifies patterns over time to anticipate future performance. Regular performance reviews help detect variances early, allowing for timely corrective actions. Ultimately, a systematic approach to data collection and analysis ensures that project evaluations are objective and comprehensive, facilitating informed decision-making and enhancing overall project success.[2-7]

Studies show that the implementation of EVM in Algerian companies requires an approach tailored to their organizational maturity. A research project proposed a specific implementation methodology that takes into account the needs and constraints of local companies. This methodology includes an analysis of existing processes and an organizational audit to determine the best implementation strategy.[8, 9]

The choice of case study is focused on the project of study and implementation of a standard high school for 1000 students at site 1077 LLV in ELGANTRA, SIDI AMAR municipality, ANNABA province (integrated housing project 2022) by the company of "DIB SALAH".

This case study thus provides a robust foundation for assessing the benefits of EVM and its potential to enhance project performance in Algeria's construction sector.

This research investigates how the EVM approach may be used to meet the particular difficulties Algerian construction businesses experience. This thesis attempts to show how EVM may promote better performance measures, increase project discipline, and support long-term industry growth by examining its use and advantages.

Problematic

Effective project management is crucial for ensuring on-time delivery, cost control, and high-quality outcomes in the fast-paced and competitive construction industry. Algerian companies, like their international counterparts, face challenges such as delays, resource inefficiencies, and budget overruns, which undermine their profitability and competitiveness.

Earned Value Management (EVM), a well-known project management tool, integrates cost, time, and scope indicators to provide a comprehensive view of project performance. By enabling real-time progress tracking and early detection of deviations, EVM offers project managers valuable insights to support decision-making. For Algerian construction enterprises, where project complexity and uncertainty are common, EVM can serve as a strategic framework to boost stakeholder confidence, optimize resource utilization, and enhance planning accuracy.

Furthermore, a good understanding of the method EVM must pass by a good analysis and application, its why this study encompasses the application of EVM during the construction process of high school for 1000 students. at this stage several questions arise but the most important one is the next:

- **How can the application of the EVM method improve the performance of Algerian companies on construction projects?**

Hypothesis

Based on these key questions, a hypothesis can be formulated as follows:

- **"The application of the Earned Value Management (EVM) method can significantly improve the management of costs and time in the case study compared to the current work context by enhancing project cost control, schedule adherence, and overall resource efficiency."**

Research objectives

1. Create a theoretical and management background based on the case study;
2. Examine the state of the project to determine the part of project in which the study;
3. Recognize the content, the project process; to determine the problems with the project's implementation;
4. Determine and evaluate how the changes and repercussions affect the Cost-Time-Content project performance triangle;
5. Offer suitable fixes for the issues that have been discovered.

Work structure

To accomplish our goals and address the research questions, the following structured approach is adopted:

- The introduction provides a comprehensive overview of the study's topic, research questions, and methodology. It is followed by three main parts structured as follows:

Part I: Theoretical Approach

Any scientific study must include this part, which is based on documentary and bibliographic research as well as cutting-edge methods that offer a more thorough understanding of the main ideas of the subject—specifically, company performance. There are two chapters: one on construction companies and the other on the definition of concepts for the EVM method.

Part II: Methodological Approach

This part contains two main chapters. The first one covers all aspects of the selected company, including its background, presentation, structure, work, roles and duties, and, lastly, a list of its material and human resources. Also, relies on the case study project presentation: study and implementation of a standard high school for 1000 students at site 1077 LLV in ELGANTRA, SIDI AMAR municipality, ANNABA province (integrated housing project 2022).

The method that will be used for the case study is presented in the second chapter.

Part III: Managerial Approach

In this final part, the study shifts focus toward the managerial dimension of the project. It applies the Earned Value Management (EVM) methodology in a real-world setting, using both quantitative and qualitative data collected from the case study of the standard high school

construction in Elgantra. This part is critical for translating theoretical concepts and contextual understanding into actionable insights that can enhance project control and decision-making.

This part comprises one core chapter, which covers the practical application of EVM, followed by simulation and recalculations to test alternative strategies. Through this analysis, the strengths and limitations of the current project management approach are evaluated, and concrete recommendations are formulated to improve performance and efficiency.

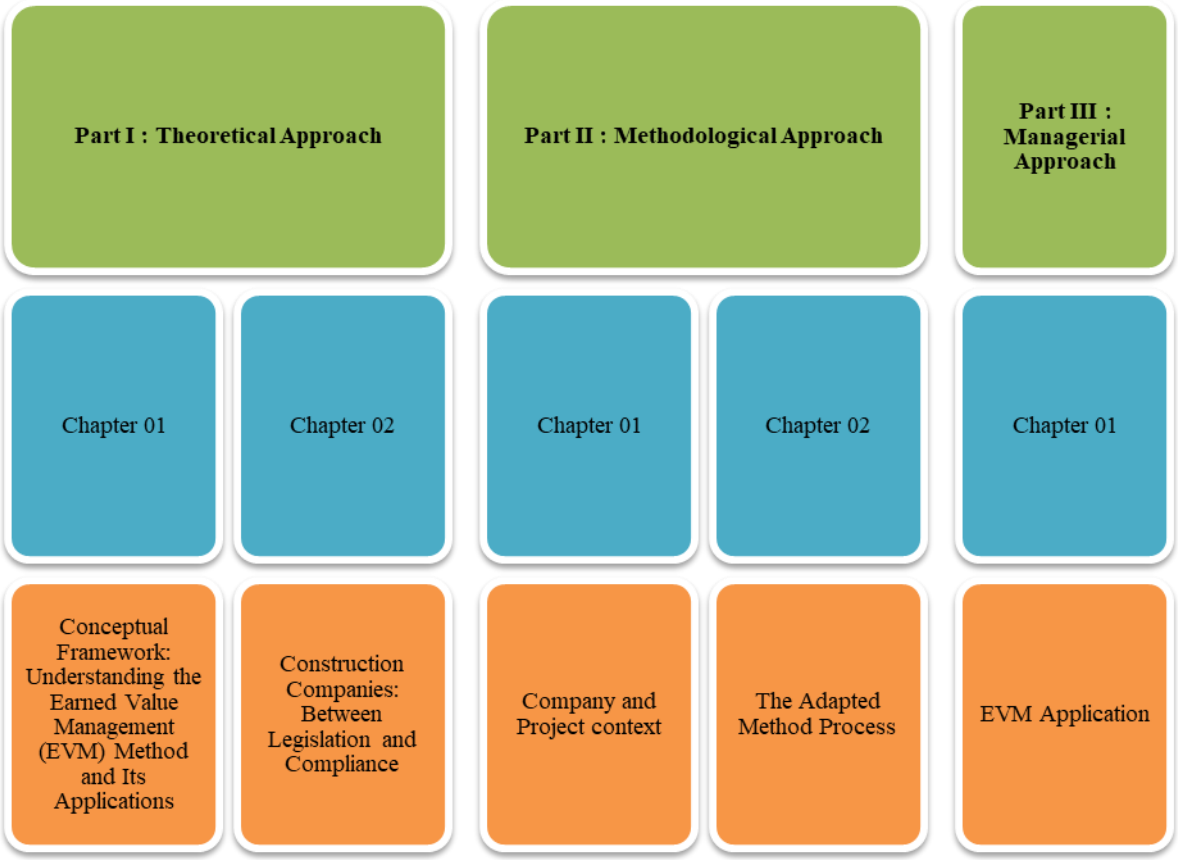


Figure 1 : Work structure

Source: Author

Part I:

Theoretical Approach

Chapter 01: Conceptual Framework: Understanding the Earned Value Management (EVM) Method and Its Applications

Introduction

In the realm of project management, the ability to accurately monitor and control project performance is crucial for ensuring successful outcomes. One of the most effective tools for achieving this is Earned Value Management (EVM), a systematic approach that integrates scope, schedule, and cost metrics to provide a comprehensive view of a project's health. EVM enables project managers to track progress, identify deviations from the plan, and make informed decisions to keep projects on track.

This chapter delves into the conceptual framework of EVM, exploring its origins, key components, and the benefits it offers in managing construction projects. By understanding the fundamental principles of EVM, project managers can leverage this methodology to enhance project performance, improve resource allocation, and mitigate risks. Additionally, this chapter will address the challenges associated with implementing EVM and provide insights into its practical applications within the construction sector.

Through a detailed examination of EVM, this chapter aims to equip readers with the knowledge needed to apply this method effectively, particularly in the context of complex construction projects like the case study of the standard high school in ELGANTRA, SIDI AMAR municipality, ANNABA province. By the end of this chapter, readers will have a solid understanding of how EVM can be used to improve project management practices and achieve better outcomes in the construction industry.

1. State of the Art in Earned Value Management (EVM) Methodology

Table 1 : State of art in EVM methodology,

Source: Author

The title and the author	The type of document and year	Objective	Method	Results
Integrating risk management and earned value framework to detect early warning signs – Case study by Ehab Soliman, Khaled A. Alrasheed, Saqer Alghanim, Eshrak Morsi	Journal article 2024	The primary objective of this research is to examine, assess, and measure the advantages derived from implementing and merging the principles of risk management and earned value techniques in a critical infrastructure project in Kuwait.	The research proposes a framework integrating risk management and earned value techniques for a Kuwaiti infrastructure project. The framework involves a dedicated panel of experts, who brainstorm and evaluate potential risks. The panel's results are used to develop risk management procedures and recommend measures to mitigate potential impacts. Earned value techniques are also used to assess project time and cost performance, providing an early warning system for project performance status.	A panel of experts identified eight major risk elements affecting the project, including unforeseen utilities, new governmental requirements, relocation of utilities, delays in work area handover, third-party obstructions, external uncontrollable factors, economic condition changes, and lack of stakeholder coordination. The project experienced significant delays and cost overruns.
A Case Study on BIM Object-Based Earned Value and Process Management in Highway Construction by Yun-ok Kim a, Dong-hyuk	Journal article 2021	Develop a standardized framework for real-time monitoring and decision-making in civil engineering projects, integrate cost and schedule data using BIM object properties, and propose	The study analyzed EVM and process management in construction projects, identified challenges like cost and schedule data management, and developed a BIM object-based framework for	BIM integration reduces dual management, automates quantity calculations, and improves performance monitoring. Challenges include data volume and standardization needs. Solutions include simplified work types and a

Lee b, and Du-hee Park		a working manual for non-experts.	3D modeling and project application.	unified code system. Future directions include expanding BIM-based EVM.
Méthode d'implantation du pilotage de projet par la valeur acquise en entreprise by Quentin Panquet	Thesis 2020	This research project aims to develop a method for implementing Earned Value Management (EVM) in companies, considering the company's maturity, strategy, and the mandatory elements of the MEM, to address the challenges faced in its implementation.	This project aims to integrate existing standards with a strategy analysis to help industrialists select suitable process modifications for their company's maturity and vision. The choice of methodology is limited by the project duration and the quality of implementation depends on factors like resources and skills. The DRM methodology consists of four steps: clarifying research, conducting an initial descriptive study, developing a normative study, and applying the model to the partner's case. The project employs the DRM methodology, with the first descriptive study being an integral part of the practical case.	Strategy T1T1 reduces investment cost, execution time, and cycle time, while Strategy T2T2 optimizes processes, improves communication, standardization, and comparative database, resulting in reduced cycle time.
Strategies for Improved Earned Value Management Use by Defense Business Leaders by Kevin Robert Rhodes	Doctorat thesis 2017	This qualitative case study examines EVM strategies used by Washington, D.C. defense contractor business leaders to improve cost and schedule goal accomplishment, highlighting the potential for social change	This study explores EVM strategies used by Washington, D.C. area defense contractor business leaders to improve cost and schedule goal accomplishment. Qualitative research focuses on experiences and usefulness, aligning with strategy analysis. Quantitative	Defense contractor business leaders are leveraging EVM data to improve cost and schedule goals, with four critical strategies identified: focused use, data comprehension, addressed issues, and continuous monitoring.

		by focusing on environmental improvements.	methodology analyzes variable relationships and hypothesis testing, but lacks focus on experience and use of EVM. Mixed methods, which combine qualitative and quantitative approaches, can support triangulation but may be unmanageable for single studies.	
CONSTRAINTS TO IMPLEMENTING EARNED VALUE MANAGEMENT (EVM) AS A TOOL FOR PROJECT PLANNING AND CONTROL – A SOLUTIONS PERSPECTIVE - A CASE STUDY AMONG NIGERIAN CONSTRUCTION PROJECT MANAGERS by Gbolahan Opeyemi Ola	Master thesis 2019	The thesis aims to optimize project control in Nigeria by promoting the adoption of Electronic Vehicle Management (EVM) by construction managers.	The author conducts exploratory research using literature reviews, surveys, and focus groups/interviews to analyze project management control and earned value management in construction projects.	This thesis explores the earned value method (EVM) in Nigerian construction projects, focusing on project contracts, accountability culture, and performance recording methods for effective organizational management.

Key Takeaways:

- EVM is versatile, applicable across sectors (construction, defense, infrastructure) with proper adaptation.
- Technology (BIM, automation) enhances EVM accuracy and efficiency.
- Success factors: Organizational maturity, risk integration, and leadership commitment.

2. Introduction to Earned Value Management (EVM)

2.1. Definition and historical background

Earned Value Management (EVM) is a project management technique used for measuring project performance and progress in an objective way by integrating scope, time, and costs. It provides project managers with real-time insights into project progress and budgeted costs, enabling them to make informed decisions and take corrective actions when necessary.[10, 11]

2.1.1. Historical Background:

- EVM originated in the late 1960s when the U.S. Department of Defense sought a better way to measure project management performance.[10]
- The cost/schedule control systems criteria policy (CSCSCP) was the precursor to EVM and measured project performance based on time, cost, and scope.[10]
- EVM has evolved and improved over time, becoming an essential tool for managing projects across various industries.[10]

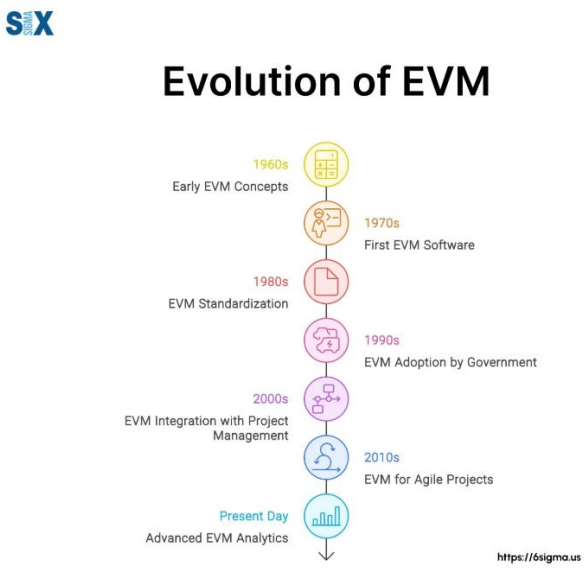


Figure 2 : Evolution of EVM

Source: (https://www.6sigma.us/project-management/earned-value-management-evm/)

2.1.2. Definition:

- EVM is a management approach that gives all management levels early visibility into cost and time-related problems.[12]
- It assesses work progress against a baseline plan and relates technical, time, and cost performance.[12]
- EVM supplies managers with summarized data for effective decision-making1.
- The basic principle of EVM is that the value of work is equal to the amount of funds budgeted to complete it.[12]
- EVM relies on maintaining a time-phased budget baseline in measurable units.[13]

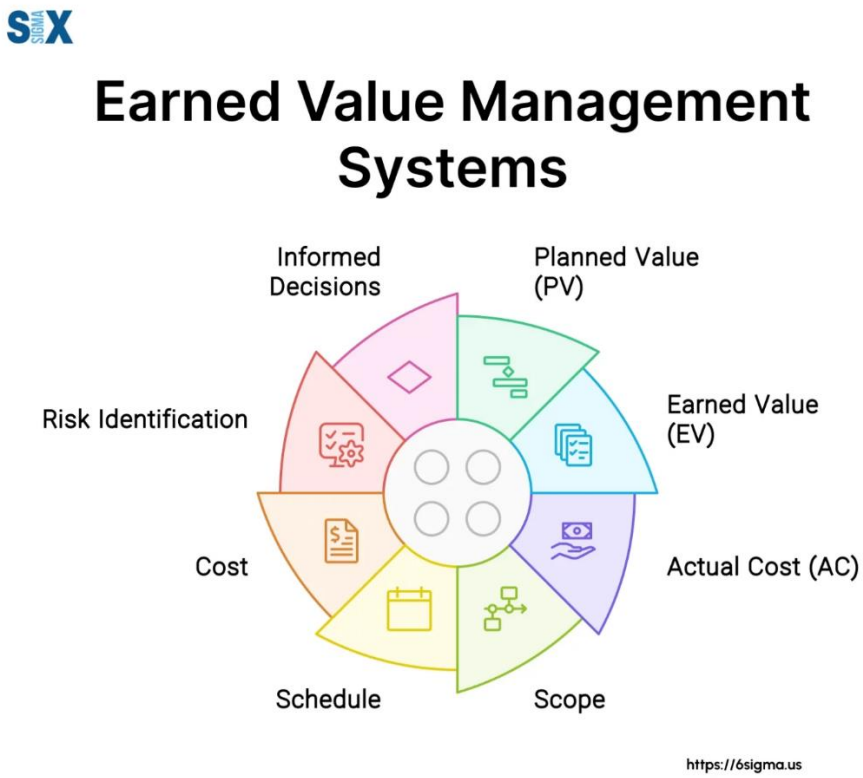


Figure 3 : EVM Systems

Source: (https://www.6sigma.us/project-management/earned-value-management-evm/)

2.2. Importance of EVM in project management

Earned Value Management (EVM) is a systematic approach to project management that objectively measures project performance and progress by integrating scope, time, and costs. It is a versatile tool adaptable to various project types and sizes. EVM helps project managers make informed decisions and take corrective actions when necessary.[11, 14]

2.3. Key benefits of using EVM in project management:

- **Performance Measurement and Accountability:** EVM offers a standardized method to measure a project's performance objectively. By comparing Planned Value (PV), Earned Value (EV), and Actual Cost (AC), project managers can determine if the project is on, ahead, or behind schedule and budget. This information is valuable for holding team members and stakeholders accountable.[11]
- **Early Issue Detection:** EVM enables the early detection of issues or deviations from the project plan. It allows project managers to take corrective actions promptly, preventing minor problems from escalating.[11]
- **Cost and Schedule Control:** EVM helps managers control project costs and schedules by forecasting the final cost and completion date based on current performance. Project managers can make informed decisions about resource allocation, schedule adjustments, or scope changes to keep the project on track.[11]
- **Improved Communication:** EVM provides a common language for project stakeholders, fostering better communication and understanding of project progress. It allows project managers to present data clearly and concisely.[11]
- **Accurate Project Forecasting:** EVM allows for accurate forecasting of project outcomes. By calculating the Estimate at Completion (EAC) based on current performance, project managers can estimate the final cost and duration of the project. This helps manage stakeholder expectations and make informed decisions about resource allocation and project adjustments.[11]
- **Holistic Project Performance Monitoring:** EVM provides coverage of the entire project’s metrics, including scope, for more insightful decision-making.[15]
- **Enforces Up-Front Planning:** EVM requires clearly defining the project’s scope, schedule, and budget from the outset, which keeps the project organized and enables the identification of potential issues early on.[14]
- **Increased Visibility:** Clear metrics provided by EVM improve project visibility and raise accountability among all stakeholders.[16]
- **Better Financial Control:** EVM helps find out how much budget has been spent relative to the work completed, allowing for better financial control in projects. It also highlights discrepancies between planned and actual performance, which allows project managers to quickly enact corrective action.[15]

EVM is an essential tool for successful project management, particularly in waterfall projects, as it provides an accurate and objective view of how close a project is to completion. It is most effective when project managers track EVM metrics throughout the course of a project, looking for deviations to spot issues and implement corrective actions.[10, 16]

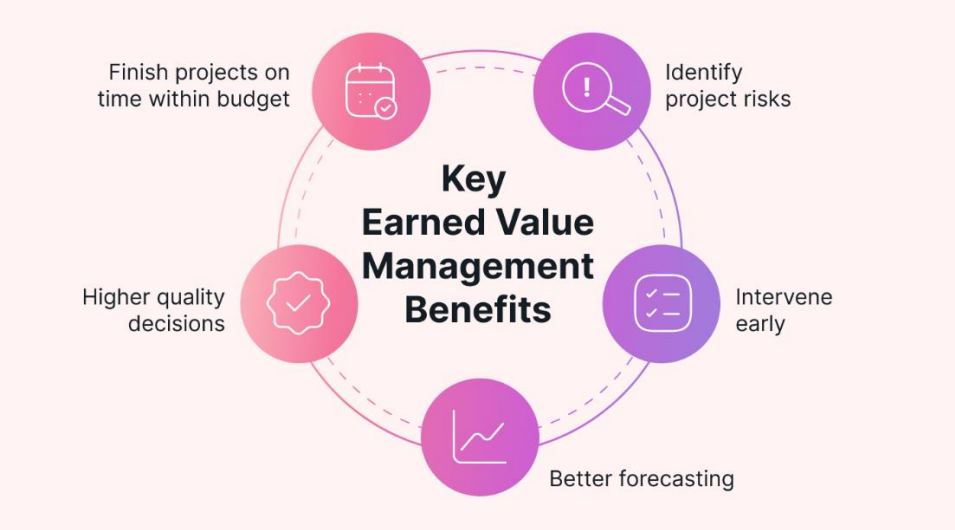


Figure 4 : Key EVM Benefits

Source: (https://www.usemotion.com/blog/earned-value-management)

3. Key Components of EVM

3.1. Planned Value (PV), Earned Value (EV), and Actual Cost (AC)

Earned Value Management (EVM) hinges on three fundamental components that provide the basis for measuring project performance: Planned Value (PV), Earned Value (EV), and Actual Cost (AC). Understanding these components is essential for effective project monitoring and control.[17-19]

3.1.1. Planned Value (PV)

- **Definition:** Planned Value (PV), also known as the Budgeted Cost of Work Scheduled (BCWS), represents the approved budget for the work scheduled to be completed by a specific date. It is the authorized budget assigned to scheduled work.[20-22]
- **Purpose:** PV is the baseline against which actual project performance is measured. It indicates how much work *should* have been completed based on the project schedule and budget.[21]
- **Calculation:** To determine PV, you need to know the planned start and finish dates for each task and the budgeted cost for each task. PV is the sum of the approved budget for the work scheduled to be completed up to a specific point in time.[21, 23]

- **Example:** If a project task is scheduled to be completed by the end of Week 4 and has a budget of $10,000, the Planned Value at the end of Week 4 would be $10,000.[21]

3.1.2. Earned Value (EV)

- **Definition:** Earned Value (EV), also known as the Budgeted Cost of Work Performed (BCWP), represents the approved budget for the work actually completed by a specified date. It is the value of the work completed expressed in terms of the approved budget assigned to that work.[11, 24]
- **Purpose:** EV measures the amount of work that has been accomplished. It provides an objective measure of project progress.[20, 21]
- **Calculation:** To determine EV, you need to assess how much of the planned work has been completed and then assign the corresponding budgeted cost to that completed work. The formula to calculate EV is:

  EV = % of Work Completed * Budgeted Cost of Task[11, 20, 21]
- **Example:** If, by the end of Week 4, only 75% of the task budgeted at $10,000 is complete, the Earned Value would be: 0.75 * $10,000 = $7,500.[21]

3.1.3. Actual Cost (AC)

- **Definition:** Actual Cost (AC), also known as the Actual Cost of Work Performed (ACWP), represents the actual costs incurred for the work completed by the specified date. It includes all direct and indirect costs spent to accomplish the work.[20, 21]
- **Purpose:** AC tracks the actual expenses incurred on the project. It is used in conjunction with PV and EV to determine cost variances and overall project cost performance.[20, 21]
- **Calculation:** AC is the sum of all costs actually spent to complete the work, including labor, materials, equipment, and overhead.[20, 21]
- **Example:** If, by the end of Week 4, the actual costs spent on the task are $9,000, the Actual Cost would be $9,000.[21]

3.1.4. Using PV, EV, and AC Together

These three components are used together to calculate variances and performance indices that provide insights into project performance:

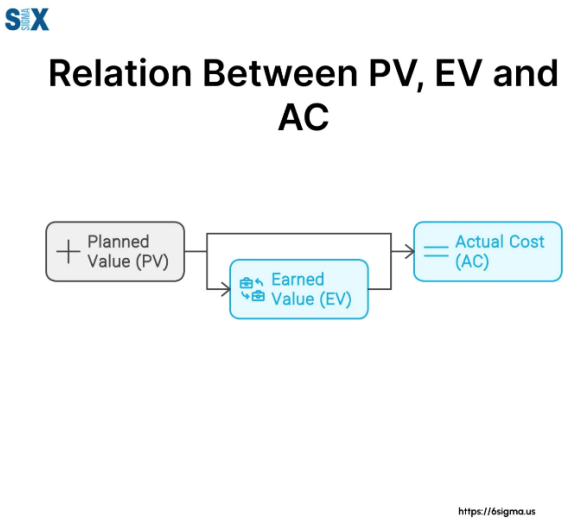


Figure 5 : Relation Between PV, EV and AC

Source : (https://www.6sigma.us/project-management/earned-value-management-evm/)

3.2. Key performance indicators: Schedule Variance (SV), Cost Variance (CV), SPI, and CPI

3.2.1. Cost Variance (CV)

- CV indicates whether a project is on, over, or under budget[11]. It is the difference between the earned value (EV) and the actual cost (AC). [22]
- The formula is: CV=EV–AC. [22]
- A positive CV indicates the project is under budget, while a negative CV indicates it is over budget.[22]

3.2.2. Schedule Variance (SV)

- SV indicates whether a project is ahead, on, or behind schedule[11]. It is calculated as the difference between the earned value (EV) and the planned value (PV). [22]
- The formula is: SV=EV–PV.[22]
- A positive SV indicates the project is ahead of schedule, while a negative SV indicates it is behind schedule.[22]

Considering cost deviation or schedule deviation alone does not properly analyse the actual status of the project. When the CV is negative, it is a direct response that the actual cost spent exceeds the planned cost. However, there are two cases in this state, one is that the project is progressing more than expected and the actual work done exceeds the work planned to be done, in this case the negative CV cannot represent the bad progress of the project. The other case is that the project is not progressing as expected and the costs are overspent. In this case,

the project manager needs to find the problems in the project and make timely adjustments. Three possible conditions in the project process are shown in the following figures. For Fig. 6, the project is moving ahead of schedule and it can be forecast that the project will be completed on schedule and under budget, and the project manager can allocate resources appropriately. For Fig. 7, The project manager can reasonably arrange the duration according to the current situation of the project. For Fig.8, If necessary, the project manager should eliminate unnecessary project activities and reschedule subsequent projects to ensure the project budget. [25]

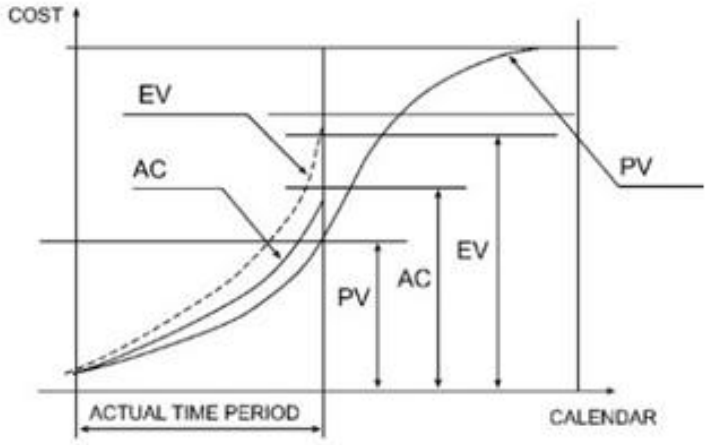


Figure 6 : Under budget & ahead of schedule.

Source: Proceedings of the 2023 International Conference on Management Research and Economic Development DOI: 10.54254/2754-1169/20/20230178

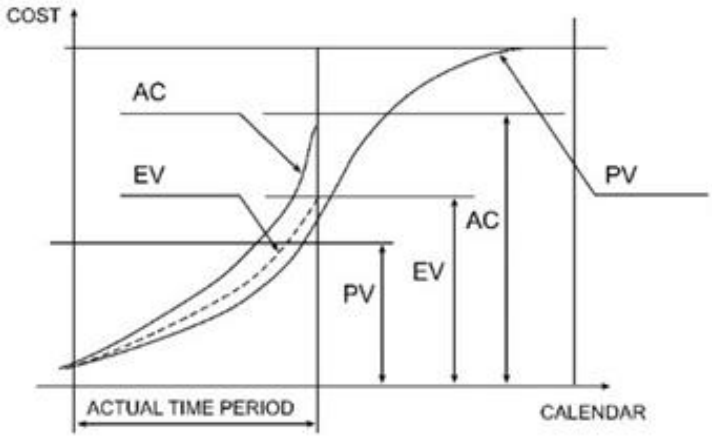


Figure 7 : Over budget & ahead of schedule.

Source: Proceedings of the 2023 International Conference on Management Research and Economic Development DOI: 10.54254/2754-1169/20/20230178

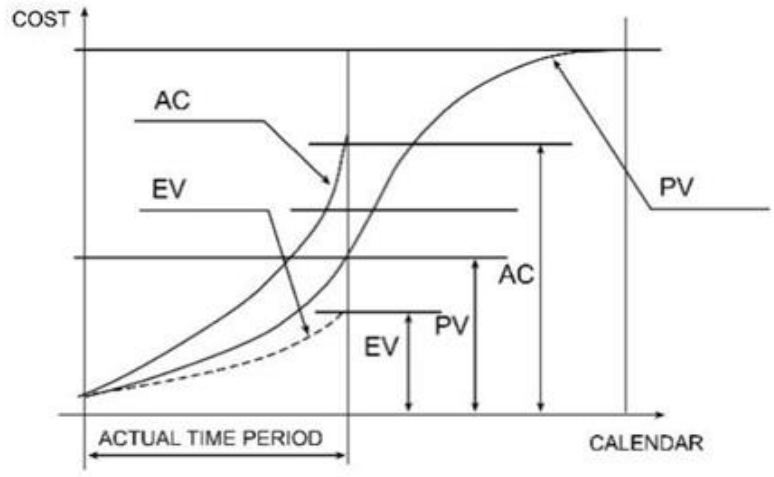


Figure 8 : Over budget & behind of schedule.

Source: Proceedings of the 2023 International Conference on Management Research and Economic Development DOI: 10.54254/2754-1169/20/20230178

3.2.3. Cost Performance Index (CPI)

- CPI measures the cost efficiency of a project.[26]
- It is derived from variance calculations.[26]
- The formula is: CPI=EV/AC.
- A CPI greater than 1 indicates the project is under budget[11]. A CPI less than 1 indicates the project is over budget.[11]

3.2.4. Schedule Performance Index (SPI)

- SPI measures the schedule efficiency of the project.[26]
- It is derived from variance calculations.[26]
- The formula is: SPI=EV/PV.
- An SPI greater than 1 indicates the project is ahead of schedule. An SPI less than 1 indicates the project is behind schedule.[11]

4. Forecasting Indicators

The future state of a project is estimated and projected using forecasting methodologies based on the information that is now accessible, and the forecast results are created and updated depending on the work performance data that is available as Shannon executes and develops. Performance data is knowledge about how a project has performed in the past and how it could perform in the future.

Table 2 displays the budget parameters and formulae.

Table 2: Forecasting Indicators.

Source: Proceedings of the 2023 International Conference on Management Research and Economic Development DOI: 10.54254/2754-1169/20/20230178

Name	Definition	Formula
Estimate To Completion (ETC)	How much the remaining work will cost in addition.	(1) At the present CPI, if the remaining work is still completed: ETC= (BAC EV)/CPI (2) Complete the remaining work at planned CPI (CPI=1): ETC=BAC-EV (3) If the project is strictly required to be completed by the planned time (with additional costs to meet the schedule): ETC=(BAC-EV)/(CPI*SPI)
Estimate At Completion (EAC)	Estimate the project's overall cost at a specific point in time.	The actual cost already spent plus ETC: EAC=AC+ETC At the present CPI, if the remaining work is still completed: EAC=BAC/CPI
Variance At Completion (VAC)	The total project cost deviation at the time of completion is known at a certain point in time.	VAC=BAC-EAC

Based on the different project completion cost forecasting methods shown in Table 2, the diagram can be seen in Fig. 9.

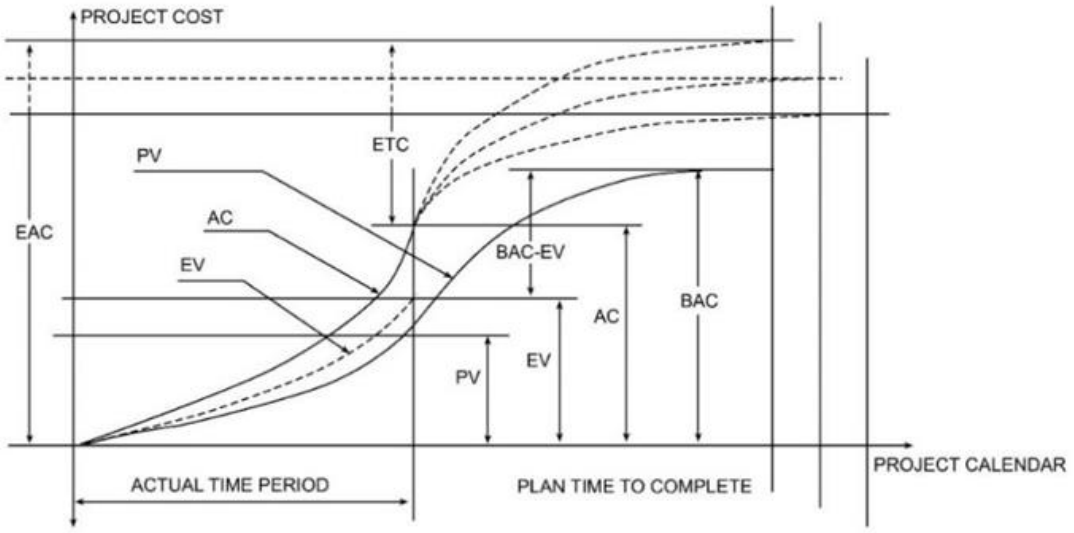


Figure 9: Forecasting with different formulars.

Source: Proceedings of the 2023 International Conference on Management Research and Economic Development DOI: 10.54254/2754-1169/20/20230178

In fact, most project cost and schedule plans can be adjusted, forecast, and scheduled according to certain correlations. Few projects can be planned well from the beginning and not require changes and adjustments at a later stage. In this forecasting method, the project duration and cost should be integrated to achieve the rational allocation and integration of project cost and duration. In some specific cases, to make sure the project can be finished on time, the project manager must employ additional costs and assure the project's length. Another scenario is where the project budget is highly constrained. In this case, the project manager must use the defined project budget as the basis for integrating the management of project cost and schedule through the sensible scheduling of project activities and duration. When the actual project cost is higher than the planned project cost and it can be inferred that the project completion cost will exceed the project budget, it is necessary to re-forecast and re-arrange the subsequent project duration and activities by reducing the project activities to ensure the total cost is under budget.[25]

5. Benefits of EVM in Construction Projects

5.1. Early detection of cost and schedule deviations

EVM in construction offers several key benefits:

- **Early Identification of Issues:** EVM processes allow project managers to identify inconsistencies early, such as the earned value lagging behind the planned value, which can indicate task delays or potential cost overruns. This early warning system helps to highlight potential issues before they become critical, allowing for swift corrective actions that minimize delays and cost overruns.[27, 28]
- **Data-Driven Insights:** By implementing EVM processes, project stakeholders can gain valuable, data-driven insights that inform decisions and improve the project management pipeline. This can optimize resource allocation, risk management, and project priorities.[28]
- **Better Cost and Schedule Control:** EVM provides an early overview of the differences between planned and actual costs, enabling project managers to identify cost overruns and take corrective actions. It also helps identify schedule slippages, allowing for amendments to avoid situations where earned value significantly lags behind the planned value.[28]
- **Improved Performance Tracking:** EVM offers a quantifiable measurement of a project's performance, enabling project managers and stakeholders to track and identify discrepancies in project management costs and schedules.[28]
- **Enhanced Communication and Transparency:** EVM translates complex project data into easy-to-understand metrics, simplifying the communication of project status to clients, investors, and team members. This clarity builds trust and ensures everyone is aligned, leading to smoother project execution and improved stakeholder satisfaction.[27]
- **Real-time data for decision-making:** Real-time data from the field feeds EVM's cost, schedule, and scope metrics, which helps project managers to make informed decisions. With objective details, there's more confidence and transparency in reporting, fostering trust, accountability, and better-managed expectations between the project owner and the contractor.[29]

5.2. Improved decision-making and resource allocation

5.2.1. Improved Decision-Making:

- **Data-Driven Insights:** EVM provides data-driven insights that support informed decision-making throughout the project lifecycle. By implementing EVM processes, project stakeholders gain valuable insights that inform their decisions to improve the

entire project management pipeline. EVM offers real-time data to project managers, helping them make informed decisions before issues escalate.[28, 30, 31]

- **Actionable Insights:** EVM processes enable project managers to identify inconsistencies, such as the earned value lagging behind the planned value, which give early warning signs of task delays or cost overruns.[28]
- **Faster and More Effective Decisions:** EVM's functionality allows for faster and more effective decisions, supported by concrete data about the reality of the work executed.[32]
- **Improved Communication:** Benchmarking project status against the baseline could help identify critical paths and enable decision-making.[33]

5.2.2. Resource Allocation:

- **Optimized Resource Allocation:** EVM can help optimize resource allocation by identifying areas where resources may be over- or underutilized. EVM also simplifies project forecasting and resource allocation, helping managers make informed decisions to avoid delays and resource shortages.[14, 30]
- **Strategic Adjustments:** EVM enables proactive management and adjustments by tracking project performance against planned metrics.[30]
- **Risk Management and Project Priorities:** EVM processes help optimize resource allocation, risk management, and project priorities.[28]

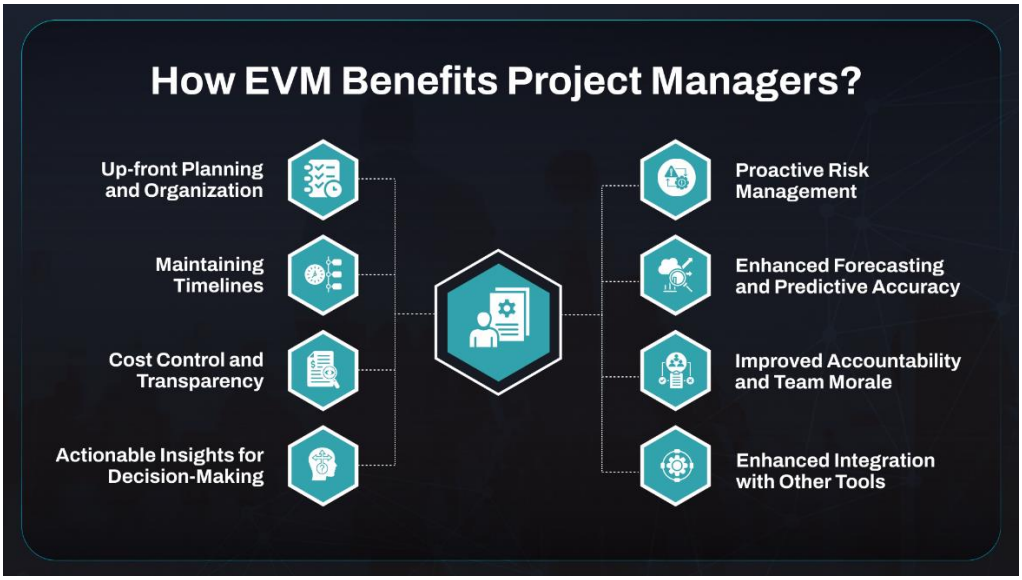


Figure 10 : Benefits of EVM in Construction Projects

Source : (https://www.probodata.com/blog/benefits-of-earned-value-management/)

6. Challenges in Implementing EVM

6.1. Complexity of calculations and data collection

Implementing Earned Value Management (EVM) presents several challenges that organizations should be aware of.[34, 35]

6.1.1. Data Collection and Management:

- **Data Accuracy and Integrity:** The accuracy of EVM relies heavily on the data collected. Inaccurate or incomplete data can lead to misleading performance indicators and incorrect decisions.[35]
- **Acquiring Project Progress Data:** Project performance data may not be consistently available at fixed periods. Inconsistent data can lead to errors in reporting and incorrect analysis of project performance. Manual data collection, especially when a project manager handles multiple projects, accentuates this problem.[34]
- **Availability of Actual Cost Data:** Access to actual cost data for work packages can be challenging. A time lag often exists between the completion of activities and the availability of actual cost data, especially for procurement and manufacturing activities with long delivery lead times.[34]
- **Data Structure Complexity:** Projects that exceed a 10% level of effort tracking show significant measurement inaccuracies.[24]

6.1.2. Complexity and Implementation:

- **Learning Curve:** EVM requires significant training and understanding to implement effectively, which can be challenging for teams unfamiliar with the methodology.[35]
- **Initial Setup:** The initial setup and continuous data collection can be resource-intensive and time-consuming. Successful earned value analysis requires detailed planning, including baselines for project scope, schedule, and budget. It's essential to know what work is being done and have resources and costs allocated to that work.[35, 36]
- **Complexity of Calculations:** Calculations can be complex.[35]
- **Project Suitability:** EVM may not be suitable for all projects, especially those with high uncertainty or innovation where performance metrics are less predictable.[35]
- **Adaptation Challenges:** Adapting EVM to agile or iterative project management frameworks can be challenging due to differing underlying principles.[35]

6.1.3. Organizational and Cultural Challenges:

- **Resistance to Change:** Teams and organizations may resist adopting EVM due to perceived complexity and the shift from traditional management methods.[35]
- **Management Influence:** Performance data manipulation due to leadership pressure can undermine EVM effectiveness.[24]
- **Senior and Team Member Support:** Gaining buy-in can be difficult because EVM implementations can fail if the management team isn't prepared to share the actual costs with the customer. Data can expose where things are going wrong and highlight poor decisions, so transparent reporting is essential.[34, 36]

6.1.4. Cost and Resource Intensive:

- **Resource Allocation:** Implementing and maintaining an EVM system can be costly and resource-intensive, particularly for smaller projects or organizations with limited budgets.[35]
- **Ongoing Maintenance:** Continuous monitoring and data entry require dedicated resources and can increase overhead costs.[35]

6.1.5. Other Challenges:

- **Measuring Procurement Activities:** Accurately measuring procurement work packages poses major challenges, especially when the procured material needs transportation and installation at the construction site.[34]
- **Overemphasis on Quantitative Metrics:** EVM may overemphasize quantitative metrics at the expense of qualitative factors, such as team morale and stakeholder satisfaction.
- **Inflexibility:** The focus on rigid metrics can sometimes lead to inflexibility in adapting to unforeseen changes or new project dynamics.[35]
- **Outdated Estimates:** Failure to maintain monthly Estimate to Complete (ETC) updates can lead to errors.[24]
- **Timing Misalignment:** Disconnected actual cost and earned value reporting periods can also lead to errors.[24]

Addressing these challenges requires a strategic approach that includes comprehensive training, robust data management practices, organizational support, and a willingness to adapt EVM to the specific needs of the project and organization.[35, 36]

6.2. Resistance to change and lack of expertise

6.2.1. Resistance to Change:

- **Cultural Resistance:** Teams and organizations may resist adopting EVM because they perceive it as complex and a shift from traditional management methods. EVM requires a cultural shift toward more disciplined and data-driven project management practices. Resistance to change is also driven by fear of increased transparency and accountability.[35, 36]
- **Adoption Challenges:** Organizations may resist adopting EVM due to perceived complexity, a shift from traditional management methods, and more disciplined, data-driven project management practices. Concerns that it is too expensive or difficult to work out baselines in advance when the project is evolving can stall an EVM implementation.[35, 36]
- **Senior and Team Member Support:** Gaining buy-in can be difficult because EVM implementations can fail if the management team isn't prepared to share the actual costs, as data can expose where things are going wrong. Managers have to be willing to share and talk about progress openly in a supportive culture.[34, 36]

6.2.2. Lack of Expertise:

- **Learning Curve:** EVM requires significant training and understanding to implement effectively, which can be challenging for teams unfamiliar with the methodology. Approximately 14% of respondents identified a lack of knowledge and experience as a barrier to implementing EVM.[35, 37]
- **Training Requirements:** Team training is required to understand and correctly implement EVM.[24]
- **Detailed Planning:** Successful earned value analysis requires detailed planning and baselines for project scope, schedule, and budget. It also requires knowing what work is being done and having resources and costs allocated to that work.[36]

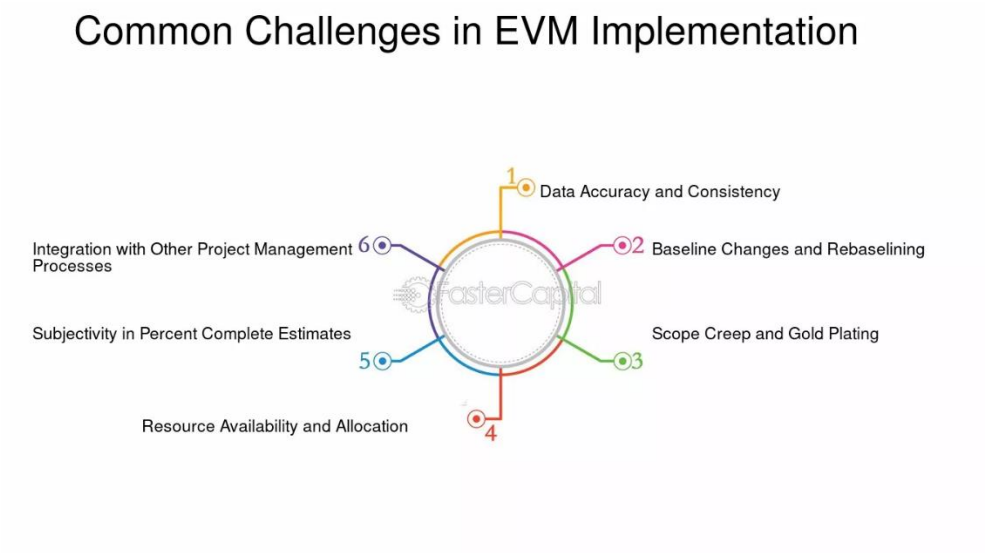


Figure 11 : Challenges in Implementing EVM

Source: (https://fastercapital.com/content/Earned-Value-Management--How-to-Measure-and-Improve-Your-Expenditure-Estimation-Performance.html)

7. Best practices

7.1. Best Practices for Successful EVM

- **Clear Project Planning and Goal Setting:** Define clear project objectives and deliverables to ensure everyone understands the goals. Establish realistic budgets and schedules with achievable milestones and deadlines to guide progress.[38]
- **Work Breakdown Structure (WBS):** Use a WBS to organize the project scope. Break down the project into smaller tasks with specific timelines and allocated resources. A best practice is to keep the WBS at the highest level possible while still providing adequate detail for scope definition and planning.[38-40]
- **Cost and Schedule Integration:** Integrate cost and schedule to provide a comprehensive view of project performance.[40]
- **Hands-on Budget Management:** Actively manage the budget, ensuring costs are allocated to time-boxed sections of the project.[39]
- **Measuring Progress:** Determine how you will measure progress to calculate indicators effectively and consistently.[39]
- **EVM System Description:** Maintain a system description that defines the management processes and detailed procedures for specific steps.[40]
- **Use EVM on Every Project:** Implement EVM on every project so it becomes part of the organizational culture, ensuring it is scalable.[40]

- **Data-Driven Culture:** Foster a culture of data-driven decision-making, encouraging team members to rely on EVM data for more informed choices.[38]

7.2. Training and Education

- **Provide EVM Training:** Educate team members on EVM concepts, metrics, and the effective use of EVM tools.[38]

7.3. Essential Elements of EVM

- Scope, cost, and schedule/time management.[39]
- Change control procedures.[39]

EVM implementation depends on the ability to discretely define the work, a defined deliverable, and the need for insight into progress and performance.[40]

Conclusion

In conclusion, the Earned Value Management (EVM) method stands as a powerful and systematic approach to project performance evaluation, integrating scope, cost, and schedule metrics to provide a comprehensive view of progress. Its ability to offer early warnings of cost overruns and schedule deviations makes it an invaluable tool for project managers, particularly in the construction sector. By analyzing key components such as Planned Value (PV), Earned Value (EV), and Actual Cost (AC), as well as performance indicators like Cost Performance Index (CPI) and Schedule Performance Index (SPI), EVM enables data-driven decision-making and effective resource allocation.

Despite its numerous advantages, EVM implementation is not without challenges. The complexity of calculations, the need for accurate and consistent data collection, and resistance to change among stakeholders can hinder its adoption. However, with proper training, technological support, and a commitment to continuous improvement, these barriers can be overcome.

The application of EVM in construction projects, including the case study examined in this research, highlights its potential to enhance project efficiency, reduce financial risks, and improve overall performance. As the construction industry in Algeria and beyond moves towards more structured project management methodologies, EVM remains a critical tool for ensuring project success, meeting deadlines, and optimizing budgetary control.

Chapter 02: Construction Companies: Between Legislation and Compliance

Introduction

The construction sector is a crucial part of economic development, shaping infrastructure and the built environment. It involves various activities, from planning to demolition. In Algeria, the construction sector operates under strict regulations to ensure safety, quality, and compliance. Balancing compliance with efficiency and profitability is a challenge for companies. This chapter explores the laws, codes, and standards governing the sector, both internationally and within Algeria, and how they influence project management practices. By understanding the interplay between legislation and compliance, companies can optimize their operations while adhering to legal requirements. This understanding can help them navigate the complexities of the construction industry and improve their project management techniques.

1. Introduction to the Construction Sector

The construction industry is a crucial sector worldwide, significantly contributing to the economic growth of countries. It encompasses a wide array of activities, including planning, design, construction, alteration, maintenance, repair, and demolition of buildings and infrastructure.[41]

1.1. Overview of the construction sector

The construction industry can be divided into three main categories based on the type of work involved:

- **Building Construction** This includes residential, farm, industrial, and commercial buildings.
- **Infrastructure Construction** This covers heavy construction projects such as highways, roads, bridges, railways, and marine construction.
- **Special Trade Construction** This includes specialized projects like electrical work, plumbing, and painting.[41]

1.2. Importance of the Construction sector

The construction industry is important to the economy because of its scale, the different sectors it encompasses, and its impact on employment, investment, and government initiatives [1]. In the U.S. alone, the construction industry is valued at $1.8 trillion and contributes 4% to the country's GDP[3].[41, 42]

1.3. Key challenges in the sector

The construction industry faces numerous challenges that can affect project goals and economic stability. These challenges include:[41]

- **Labor Shortages** Many markets are facing difficulties in finding skilled workers .[42, 43]
- **Rising Costs** Increasing costs of materials and labor are major concerns for construction firms.[43]
- **Delays Complex** projects involving many stakeholders can lead to delays, often caused by supply chain disruptions and other factors.[41, 44]
- **Competition** The construction industry is highly competitive, requiring companies to continuously improve productivity.[43, 45]
- **Environmental Concerns** The construction industry is responsible for a significant percentage of global CO2 emissions, making green building practices essential.[42]
- **Corruption** Corruption can lead to poor quality buildings and vulnerability to natural hazards.[44]
- **Health and Safety** Maintaining occupational health and safety is a critical concern, requiring effective risk management.[41, 44]
- **Market Instability** Long-term market instability and current economic conditions pose ongoing threats to the construction industry.[41]
- **Regulatory Issues** New rules and regulations, such as OSHA guidelines and building codes, require constant monitoring.[43]
- **Waste and Resource Consumption** Rapid construction growth leads to high amounts of waste and excessive resource consumption, impacting the environment.[44]

2. Regulatory Framework for Construction Companies

The regulatory framework for construction companies involves a combination of international and local laws, codes, and standards that govern various aspects of construction projects. These regulations aim to ensure quality, safety, sustainability, and compliance across different jurisdictions.[46-48]

Figure 12 : Types of Construction Compliance Requirements

Source : (https://alp.consulting/construction-compliance-requirements/)

2.1. International Standards and Codes

- **International Building Code (IBC)** The IBC is a model code used as a foundation for ensuring public health and safety in the built environment. It addresses the design and installation of innovative materials while meeting or exceeding safety goals. The principles of the IBC focus on protecting public health, safety, and welfare, promoting efficient designs, and encouraging the use of new technologies.[49]
- **International Organization for Standardization (ISO)** ISO develops and maintains rules, specifications, and recommendations that enhance the quality, safety, and sustainability of construction projects.[50, 51]
- **International Electrotechnical Commission (IEC)** The IEC also develops and maintains international construction standards.[50]

2.2. National Standards and Codes

Algeria has a series of standards and codes that regulate construction, with the goal of ensuring safety, quality, and risk prevention. These standards are continuously updated to reflect advances in earthquake engineering and the specific experiences of Algerian professionals.[52, 53]

2.2.1. Key Components of the Algerian Construction Standards and Codes:

- **National Technical Control of Construction Centre (CTC):** The CTC is responsible for increasing safety levels within the Algerian construction industry through the standardization of risk prevention. All new building projects in Algeria are legally required to involve the CTC. The CTC oversees projects from conception and design

to execution, ensuring that work complies with approved plans. They also conduct unannounced on-site inspections and issue certificates of compliance with legal and regulatory frameworks.[52]

- **Règles Parasismiques Algériennes (RPA):** The RPA, particularly RPA 99 and its updated drafts, sets rules for earthquake-resistant design and construction in seismic-prone areas. The aim is to protect human lives and constructions from seismic events through appropriate design and detailing. The RPA assigns a coefficient based on building materials, construction type, load redistribution possibilities, and deformation capacities in the post-elastic domain.[53, 54]
- **Algerian Institute for Standardization (IANOR):** IANOR develops Algerian standards for execution and provides a catalog of these standards.[55]
- **Technical Regulations:** These regulations aim to provide acceptable protection for human lives and constructions against the adverse effects of seismic actions through appropriate design. They offer guidelines regarding materials (such as construction steel, reinforced concrete, and various masonries), and building technologies.[53, 54]
- **Référentiel Technique Réglementaire:** This includes: Documents Techniques Réglementaires de Conception, Documents Techniques Réglementaires d'exécution and Référentiel Technique Normatif.[55]
- **CNERIB's Role:** The Centre National d'Etudes et de Recherches Intégrées du Bâtiment (CNERIB) has been involved in construction technical regulations since 1993, publishing technical guides and recommandations.[56]

2.2.2. Key Focus Areas:

- **Seismic Design:** Algerian seismic building codes emphasize providing structures with sufficient strength and stiffness to limit non-structural damages and avoid structural damage during moderate seismic events. They also ensure adequate ductility and energy dissipation capacity to allow structures to undergo inelastic displacements with limited damage, preventing collapse or loss of stability during more significant seismic events.[54]
- **Materials and Construction:** The regulations address structures made with construction steel, reinforced concrete, and various types of masonry. The seismic behavior of materials is considered in relation to the type of structure.[54]

- **Quality Control:** The CTC Centre monitors the quality of materials used in construction, especially concrete, focusing on solidity, stability, and water resistance. They maintain a central database to track and check samples.[52]
- **Energy Efficiency:** There are regulations and standards that govern the construction, renovation, and operation of buildings, including building codes, energy performance certificates, and labeling schemes.[57]

These codes and standards are crucial for minimizing risks associated with civil engineering works and preventing building malfunctions and collapses.[52]

3. Impact of Legislation on Project Management

3.1. Legal constraints and their influence on project execution

Legal constraints significantly impact project management, encompassing a wide array of regulations that projects must adhere to. These constraints can affect project schedules, planning, and progress.[58, 59]

3.1.1. Specific Impacts of Legal Constraints:

- **Project Delays:** Projects may face delays due to the need to await procedural approvals or comply with regulations that prohibit certain construction activities during specific times, such as Sundays and public holidays.[58]
- **Planning and Progress Alterations:** Legal constraints like traffic ordinances and excavation permits necessitate approvals before work commencement, which can alter project planning and progress.[58]
- **Compliance with Regulations:** Projects must continuously update their schedules to comply with new regulations, which can be frequent due to industry reforms.[58]
- **Project Definition Stage:** Economic, legal, and environmental constraints primarily surface during the planning and definition phase, influencing the project's proposal and design.[58]
- **Construction and Design:** Legal constraints in architecture and design are rules and regulations that architects must follow when designing and constructing buildings.[60]
- **Agreements:** Project constraints can come from agreements including contracts, internal service agreements, policies, regulations, and standards.[61]

To manage legal constraints effectively, project managers should document all identified constraints during the planning stages. Allocating sufficient time and resources to address these constraints is crucial for successful project outcomes.[58]

3.2. Case studies of non-compliance and their consequences

Search results provide insights into instances of non-compliance within Algeria's construction and urban planning sectors, along with the resulting consequences:

- **Non-Compliance with Urban Planning Directives:** A study examining the colonial neighborhood POS N° 02 of Biskra between 2000 and 2022 revealed a near-total non-compliance of new constructions with the architectural regulations. New buildings often lacked any reference to the facade components inherited from older structures.[62]
- **Fragility of Heritage Conservation Mechanisms:** The announcement of Law 15/08 on property regularization and compliance after 2008 highlighted the fragility of mechanisms designed to conserve cultural and built heritage. It also exposed a lack of expertise in built heritage preservation among professionals like architects and archaeologists.[62]
- **Impact of Delays:** Delays in Algerian construction projects lead to constraints that negatively affect the country's economy.[63]
- **Incomplete Construction:** A study notes that Algeria, like other developing countries with rapid population growth, has faced a housing crisis. Intensive housing production efforts have often fallen short of expectations, resulting in unfinished and poor-quality construction.[64]
- **Causes of Schedule Delays:** Research has been conducted using case studies to analyze the causes of delays in construction projects in Algeria.[65, 66]
- **Cost Overruns:** Project delays in Algeria's construction sector are a primary cause of cost overruns.[67]

Figure 13 : Legal Best Practices for Construction Project Management

Source : (https://hzlegal.ae/legal-best-practices-for-construction-project/)

4. Balancing Compliance and Efficiency

4.1. Strategies for aligning legal requirements with project goals

To effectively balance compliance and efficiency in project management and align legal requirements with project goals, consider these strategies:

- **Develop a Compliance Plan:** Create a plan outlining processes that ensure compliance with relevant laws. This should include employee training, regular audits, and ongoing monitoring.[68]
- **Employ Technology:** Automate processes to streamline operations and increase efficiency while ensuring compliance. Use software for compliance tracking, reporting, and document management to reduce human error and meet regulatory requirements. Project management tools can centralize project data, making it easier to track compliance-related tasks and responsibilities.[68, 69]
- **Conduct Risk Assessments:** Identify areas where compliance is a top priority and areas where the company can optimize for efficiency. Understanding these risks helps in making better decisions about where to focus resources. Integrate risk management into the project planning phase.[68]
- **Provide Employee Training:** Ensure workers are well-informed through regular training, fostering a culture of compliance and efficiency. Encourage collaboration, promote open communication, and recognize employees who succeed in both areas.[68]

- **Perform Ongoing Evaluations:** Continuously monitor and evaluate operations through performance reviews, regular audits, and evaluations of technology and compliance processes to identify areas for improvement and make necessary changes. Regularly review relevant laws and regulations to stay up-to-date with compliance requirements.[68, 69]
- **Stay Informed:** Regularly review relevant laws and regulations to ensure you're up-to-date with compliance requirements.[69]
- **Utilize Project Management Techniques:** Implement effective project planning by setting realistic timelines, defining clear objectives, and identifying resource requirements upfront. Use techniques like Work Breakdown Structure (WBS) and Gantt charts to visualize project timelines and resource allocation.[70]
- **Establish Adaptable Guidelines:** Implement flexible management frameworks that set foundational guidelines that are both clear and adaptable, allowing project scopes to evolve without frequent administrative hurdles.[71]
- **Real-Time Adjustments:** Adopt real-time adjustments and feedback loops to maintain resource elasticity and react swiftly to changes without derailing the project.[71]
- **Continuous Monitoring:** Regularly review project progress and make necessary adjustments to the scope and resources. Use project management tools for real-time monitoring to provide insights into both scope progress and resource utilization, enabling quick adjustments.[72]
- **Engage with Experts:** Consult with legal or compliance experts to provide valuable insights and guidance tailored to specific project needs.[69]

4.2. Role of technology in ensuring compliance

Technology plays a crucial role in ensuring compliance by improving efficiency, accuracy, and adaptability to evolving regulatory landscapes. It helps businesses streamline processes, reduce risks, and meet regulatory requirements. Key functions of technology in compliance:[73, 74]

- **Automation:** Automates repetitive, rule-based tasks, reducing manual effort and ensuring consistency in compliance processes. Compliance management software can automate workflows, provide real-time visibility into compliance status, and generate reports.[73, 75]

- **Data Analytics:** Identifies patterns and anomalies in large datasets to detect potential compliance issues and fraud. Data analytics can monitor employee behavior, detect fraud, and identify areas where compliance training is needed.[73, 75]
- **Real-time Monitoring:** Monitors transactions and activities in real-time, enabling prompt identification and response to compliance risks. Compliance software can monitor data in real-time, flagging potential issues before they become a problem.[73, 75]
- **RegTech (Regulatory Technology):** Dedicated compliance software and tools help businesses stay updated on changing regulations and ensure processes align with the latest requirements. AI-driven platforms provide real-time updates on regulatory changes, helping organizations proactively adapt to new compliance standards.[73]
- **Cloud Computing:** Cloud computing helps organizations store and manage compliance data more efficiently, providing access to compliance data from anywhere, at any time. Cloud-based compliance solutions also help organizations scale their compliance programs and reduce infrastructure costs.[75]
- **Blockchain Technology:** Enhances transparency and traceability in transactions, ensuring a secure and auditable trail of compliance-related activities.[73]
- **AI (Artificial Intelligence):** AI can automate compliance tasks, such as monitoring employee behavior, detecting anomalies, and identifying potential compliance risks.[75]
- **Document Management:** Streamlines the creation, storage, retrieval, and tracking of compliance-related documents, making it easier to manage and update regulatory information.[73]
- **Risk Assessment:** Streamlines the formal risk assessment process by centralizing data, conducting analyses, and facilitating prioritization.[76]

By leveraging technology, businesses can enhance their compliance management processes, reduce the risk of non-compliance, avoid potential fines and penalties, protect their reputation, and build trust with stakeholders. Technology also helps in implementing robust cybersecurity measures to protect sensitive information and ensure compliance with data protection laws. The use of technology also provides scalability, allowing organizations to easily adapt their compliance processes to accommodate growth and changing regulatory landscapes.[73, 74]

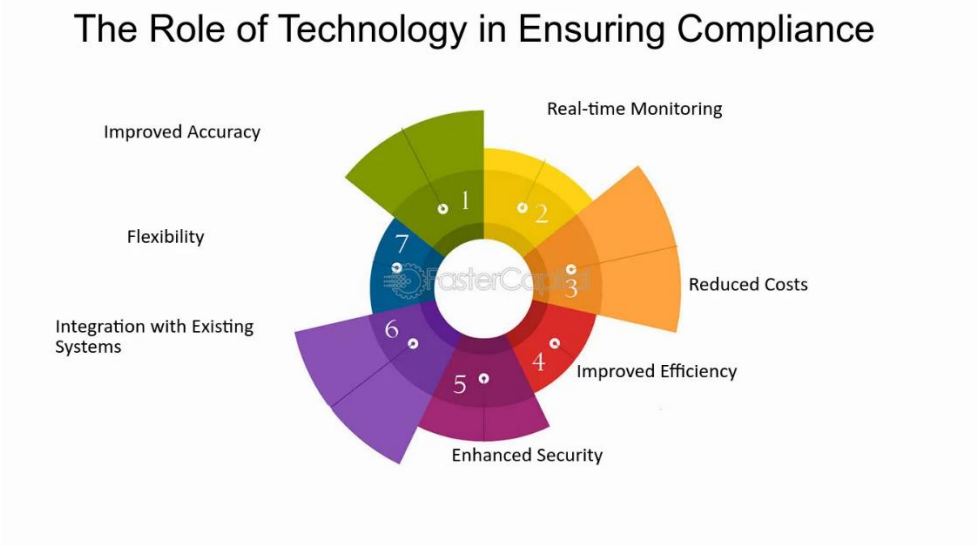


Figure 14 : Role of technology in ensuring compliance

Source : (https://fastercapital.com/topics/role-of-technology-in-ensuring-data-integrity-and-compliance.html)

Conclusion

Through an analysis of legal constraints and their impact on project execution, it becomes evident that successful construction management depends on integrating compliance measures into project planning and execution. Case studies of non-compliance highlight the severe consequences of regulatory violations, including project delays, financial penalties, and compromised structural integrity.

To navigate these complexities, construction companies must leverage technology, adopt proactive compliance strategies, and invest in continuous monitoring and employee training. Effective regulatory alignment not only mitigates risks but also enhances project efficiency and long-term sustainability in the industry. Ultimately, a well-structured approach to compliance can serve as a competitive advantage, ensuring project success while upholding safety and legal standards.

Part II:

Methodological Approach

Chapter 01: Company and Project context

Introduction

Understanding the organizational and project environment in which the Earned Value Management (EVM) approach is being used is crucial for its effective application. This chapter gives a detailed overview of the construction project, which entails designing and building a typical high school for 1,000 pupils in Elgantra, Annaba province, as well as the business carrying out the project, "DIB SALAH."

This chapter attempts to evaluate the company's preparedness to use cutting-edge project management methodologies like EVM by examining its background, organizational structure, and operational capabilities. Additionally, a thorough analysis of the chosen case study's site environment, technological features, and execution schedule will aid in establishing the prerequisites for EVM use.

This contextual basis is essential for analyzing the performance data gathered later in the study process as well as for assessing if EVM is suitable in this particular scenario. Finally, by laying the groundwork for a systematic examination of project performance in an actual Algerian construction situation, this chapter closes the gap between theoretical frameworks and real-world application.

1. Company context

1.1. Choice justifications

Our choice of case study is focused on the project of study and implementation of a standard high school for 1000 students at site 1077 LLV in ELGANTRA, SIDI AMAR municipality, ANNABA province (integrated housing project 2022) by the company of "DIB SALAH", a choice justified by:

1.1.1. *Social and Educationnel Necessity*

- High Demand for Schools: The integrated housing project in Elgantra, Sidi Amar, will attract many families, increasing the need for educational infrastructure.
- Reduction of School Overcrowding: A new high school for 1,000 students will alleviate pressure on existing institutions in Annaba province.
- Alignment with National Education Policies: Supports Algeria's strategy to improve access to quality education in growing urban areas.

1.1.2. Economic Justification

- Cost Efficiency Through EVM: Implementing Earned Value Management (EVM) ensures budget control, tracks progress, and minimizes financial risks.

- Job Creation: The project will generate employment during construction and later for teachers and administrative staff.
- Long-Term Economic Benefits: An educated workforce contributes to regional development and attracts further investments.

1.1.3. Technical Feasibility

- Optimal Site Selection: Site 1077 LLV is strategically located within the housing project, ensuring accessibility for students.
- Standardized Design: Using pre-approved high school blueprints reduces design costs and accelerates implementation.
- Infrastructure Integration: The school will be part of a planned urban ecosystem, with utilities (water, electricity, roads) already considered in the housing project.

1.1.4. Compliance with Legal and Regulatory Requirements

- Adherence to Algerian Construction Standards: The project follows national norms for educational buildings (safety, accessibility, capacity).
- Environmental Regulations: The design will incorporate sustainable practices (energy efficiency, waste management) as per Algerian environmental laws.
- Public Procurement Transparency: The selection of **DIB SALAH** as the contractor follows legal tendering procedures.

1.1.5. Project Management Efficiency (EVM Focus)

- Performance Measurement: EVM provides real-time tracking of Planned Value (PV), Earned Value (EV), and Actual Cost (AC), ensuring the project stays on schedule and budget.
- Risk Mitigation: Early detection of deviations (schedule delays, cost overruns) allows corrective actions.
- Stakeholder Accountability: Clear EVM reporting ensures transparency for the government, investors, and the public.

1.1.6. Sustainability and Future-Readiness

- Scalability: The school’s design allows future expansion if student numbers increase.
- Green Building Potential: Possibility of integrating solar panels, rainwater harvesting, and energy-efficient lighting.

- Community Impact: The school will serve as a hub for cultural and extracurricular activities, strengthening social cohesion.

1.2. General presentation of the company

Table 3 : General presentation of the company

Source: "DIB SALAH" company

Company title	"DIB SALAH" company
Address:	Real Estate Cooperative "AMEL" Bainen land -MILA-
Leader:	Mr. Dib Salah.
Legal form	Private
Mission:	He obtained his approval in 1989 from the Minister of Housing for the management of studies and execution as well as the supervision of the works of their projects located in the Municipality of MILA and its surroundings.
Office hours:	From Sunday to Thursday: 8:30 AM - 12:00 PM / 1:30 PM - 4:00 PM

1.3. Company history

The company, whose manager is Mr. Dib Salah, established their own office in 1989, after obtaining approval from the Minister of Housing for the management of studies and execution as well as the supervision of the works for their projects located in the Municipality of MILA and its surroundings.

1.4. The company today

The company's team works on various stages of the design of state projects such as (implementation of all types of equipment; outdoor arrangements of squares, outdoor arrangements: mechanical pathways, pedestrian pathways, rural housing in subdivisions, schools, etc.), as well as individual houses and villas.
The company also monitors various projects to ensure proper execution and compliance of the work with the studies.

1.5. Structure and internal organization of the company

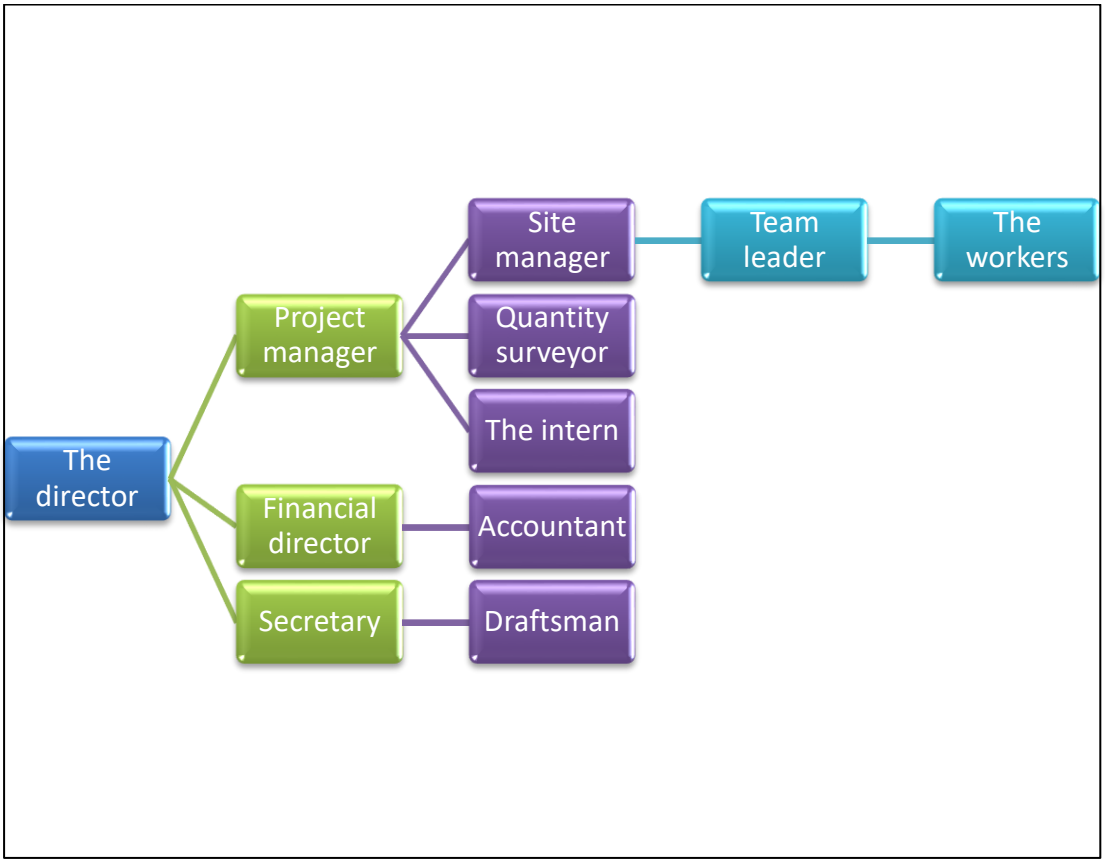


Figure 15: The organization chart of the company

Source: "DIB SALAH" company

-The company consists of a room in a single-family house, which includes a printing area where printing is done at the entrance of the room with a tracing table, a printer, and a filing cabinet.

- The big boss is Dib Salah with his assistant the architect Louhi Ala Eddine.

The company consists of 3 groups:

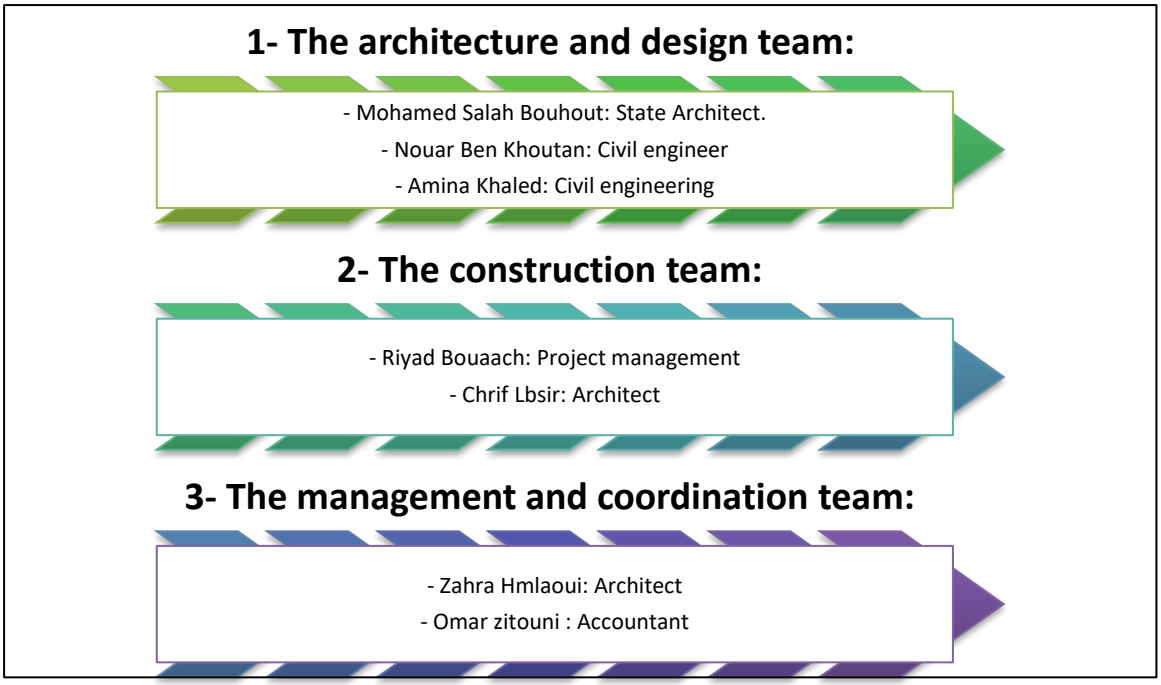


Figure 16 : Company structure

Source: "DIB SALAH" company

2.2. The means

1.6.1. *Human resources*

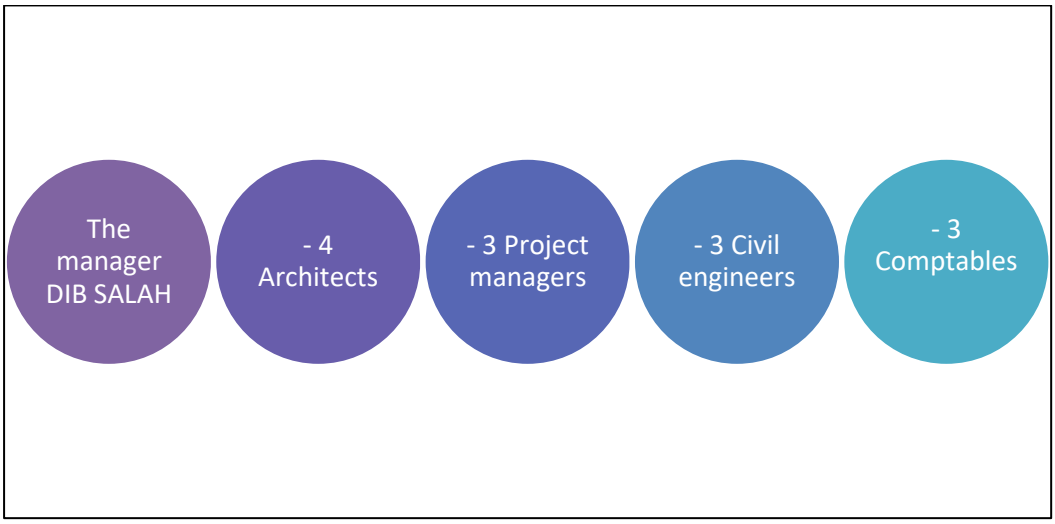


Figure 17 : Human resources of compony

Source: "DIB SALAH" company

1.6.2. *The material resources*

The company contains:

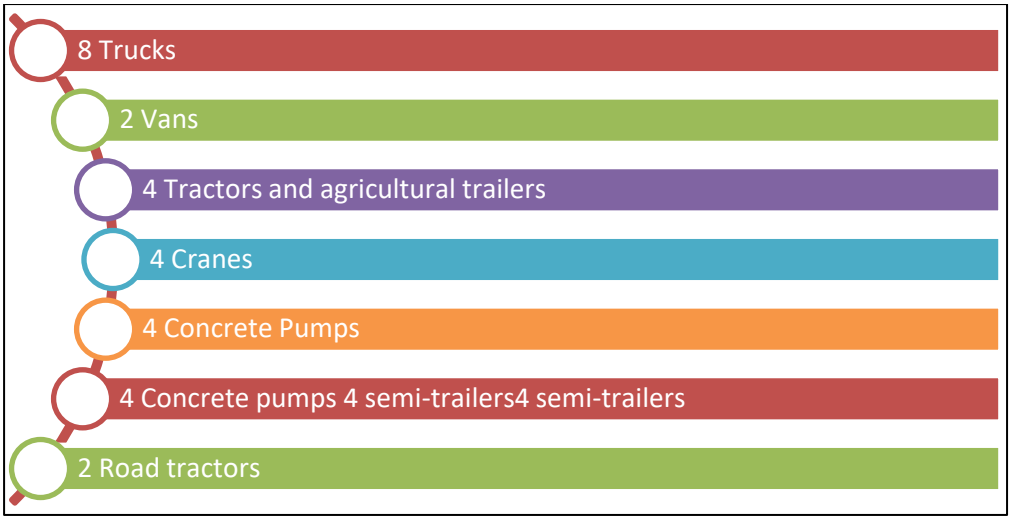


Figure 18 : Material resources of company

Source: "DIB SALAH" company

1.7. Services

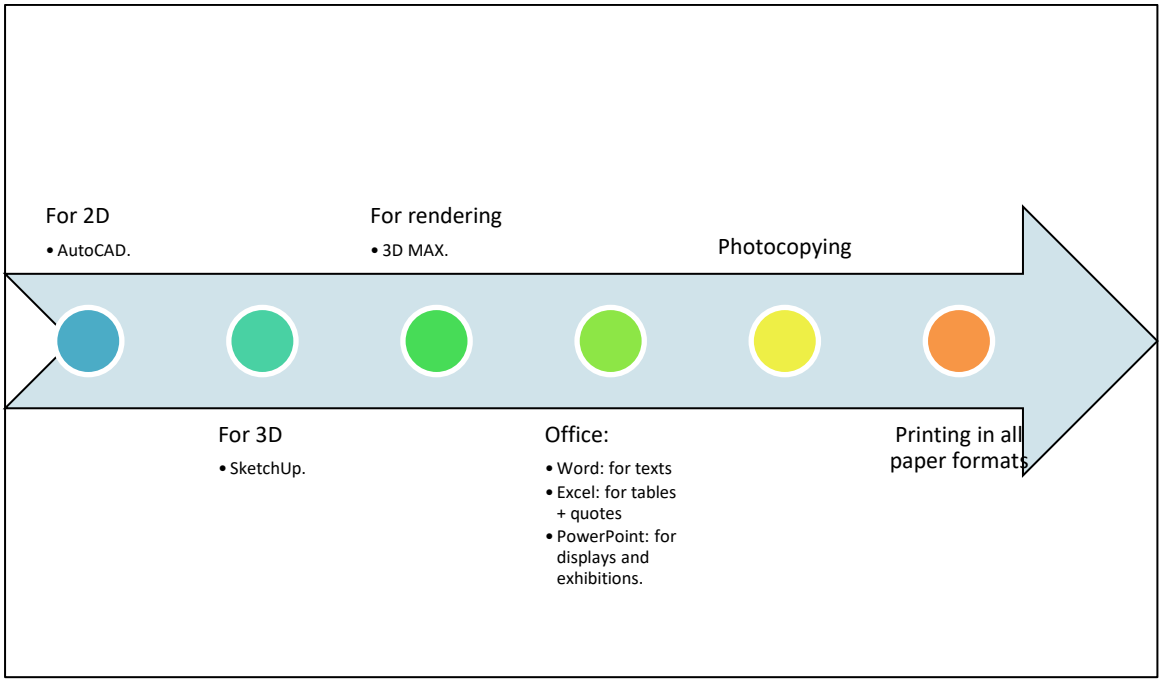


Figure 19 : Services company

Source: "DIB SALAH" company

1.8. Some projects carried out by company

- Construction of a standard high school with 800/200 capacity in MILA.
- Construction of a polyclinic in BERRAHAL ANNABA.
- Construction of a polyclinic in Terraiat Annaba
- Construction of a polyclinic in AIN ELBARDA ANNABA.
- Construction of 56 villas in BERRAHAL ANNABA.

- Construction of the district headquarters in SIDI Mareouan MILA.
- Construction of a police station in CHELGHOUM AID.
- Rehabilitation of Polyclinic Lot No. 5: Rehabilitation of the Polyclinic Larbi Khrouf…. etc.

1.9. Situation of the design office

The company's team works on different stages of the implementation of state projects such as:

- The exterior developments of squares, exterior developments: the mechanical road, the pedestrian road, rural housing in subdivisions, schools, etc., and individual houses and villas.

As well as the work of:

- Civil engineering
- printing of plans
- Decoration

The company also ensures the monitoring of various projects to guarantee proper execution and compliance of the implementation with the studies.

1.10. Function organizational chart of design office

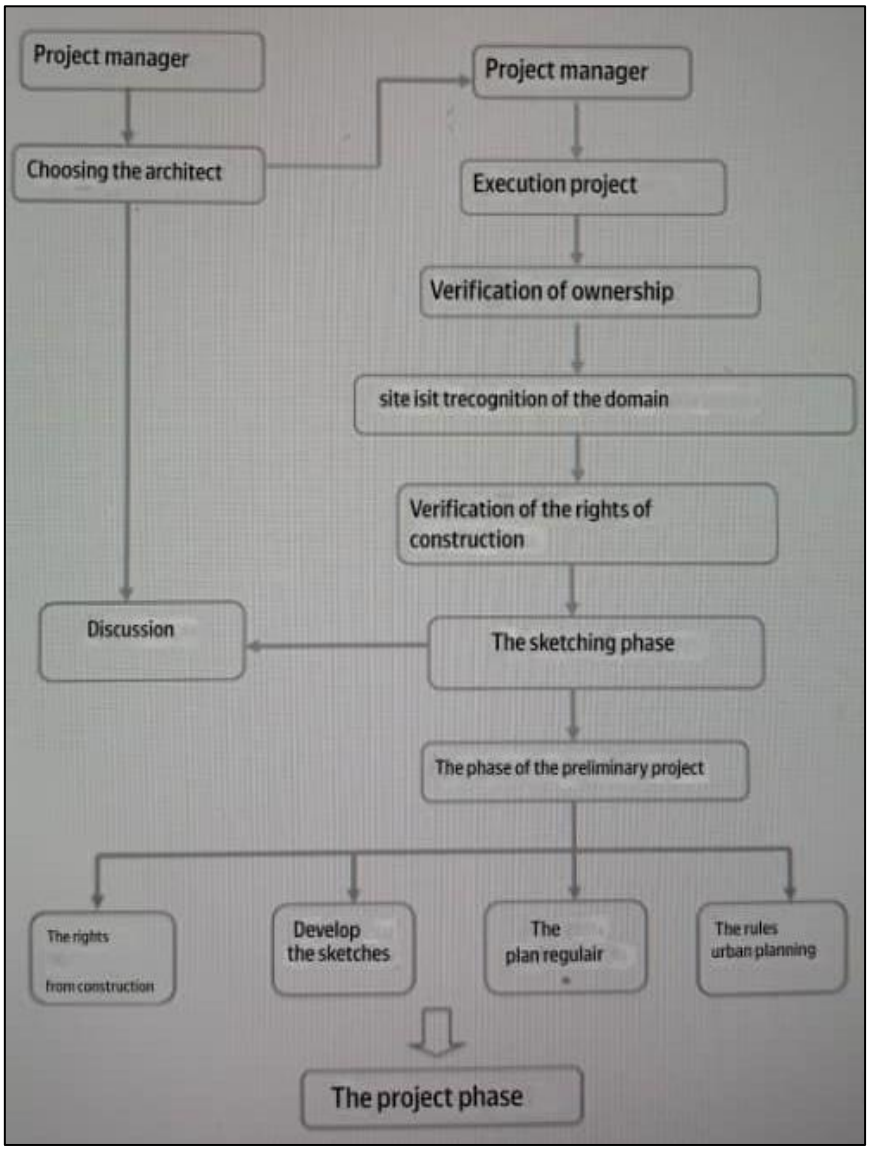


Figure 20 : Function organizational chart of design office

Source: "DIB SALAH" company

2. Project context

2.1. Project technical sheet

Table 4 : Project technical sheet

Source: "DIB SALAH" company

Title of the operation	Study and construction of a standard 1000-student high school at site 1077 LLV in ELGANTRA, SIDI AMAR municipality, ANNABA province (integrated housing program 2022)
Operation number	N10210820120230000232210 9
Project Owner	Public Equipment Directorate ANNABA
Project manager	B.E.T BOUABAZE. CH
Implementation company	DIB SALAH
Technical inspection	CTC EST ANNABA
Soil Study Laboratory	National Laboratory of Housing and Construction
Procurement method	Open national tender with minimum capacity requirement
Contract amount	438 329 029.18 DA
Contract number	N° 149/2024
Execution time	12 months
ODS Date	24/06/2024
ODS Number	N° 17/00/01/2024

2.2. Site analysis

Project study and construction of a type 1000 high school located in an urban area, site 1077 LLV in ELGANTRA, municipality of SIDI AMAR, wilaya ANNABA (integrated housing site program 2022).

The project is located in the northwest of the site. Opposite the polyclinic to the north, and the housing to the south, to the west a primary school and to the north a middle school.

Figure 21 : 3D Picture of Project

Source: B.E.T BOUABAZE. CH

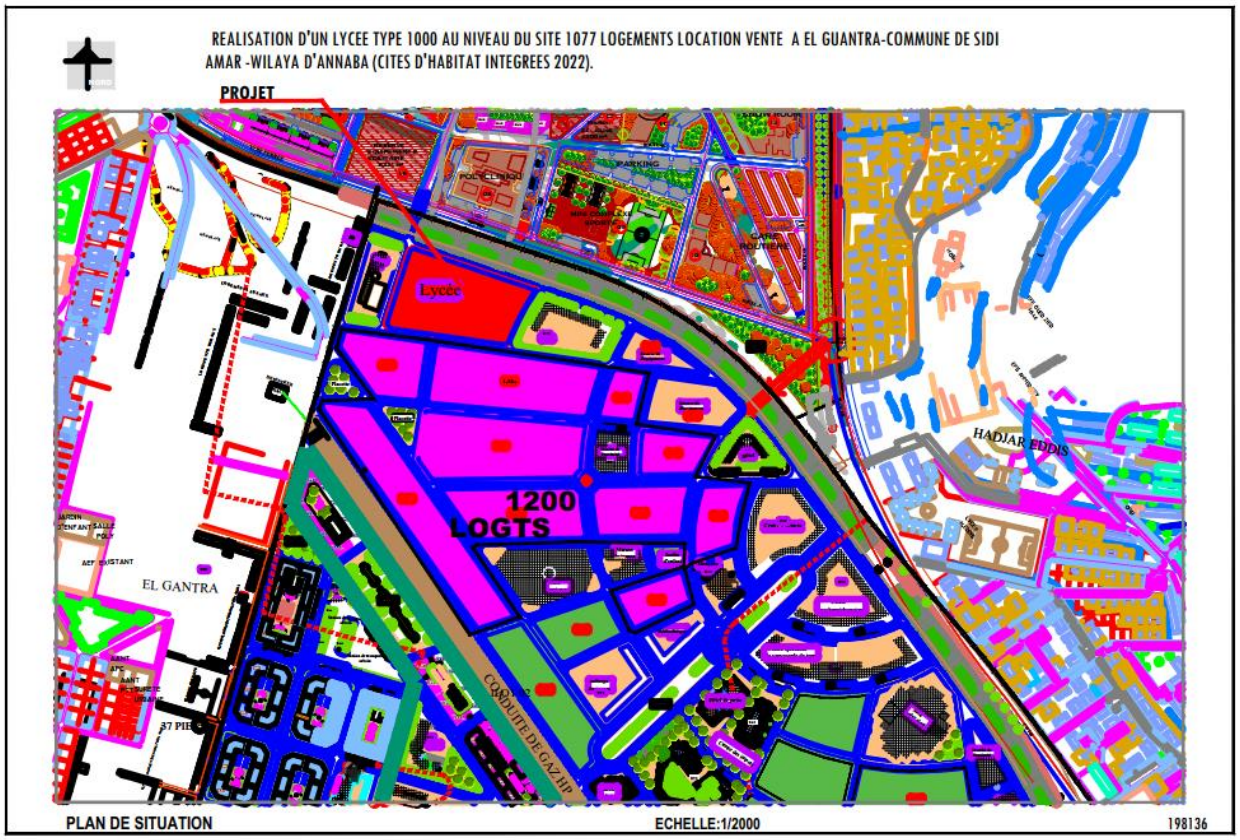


Figure 22: Situation plan

Source: B.E.T BOUABAZE. CH

The figure represents an overall view of the project, it includes student access and service access, it consists of 05 blocks and 05 staff quarters, a sports field, and a playground. On a built-up area of 3180.00 m² with outdoor facilities and a total land area of 11752.00 m².

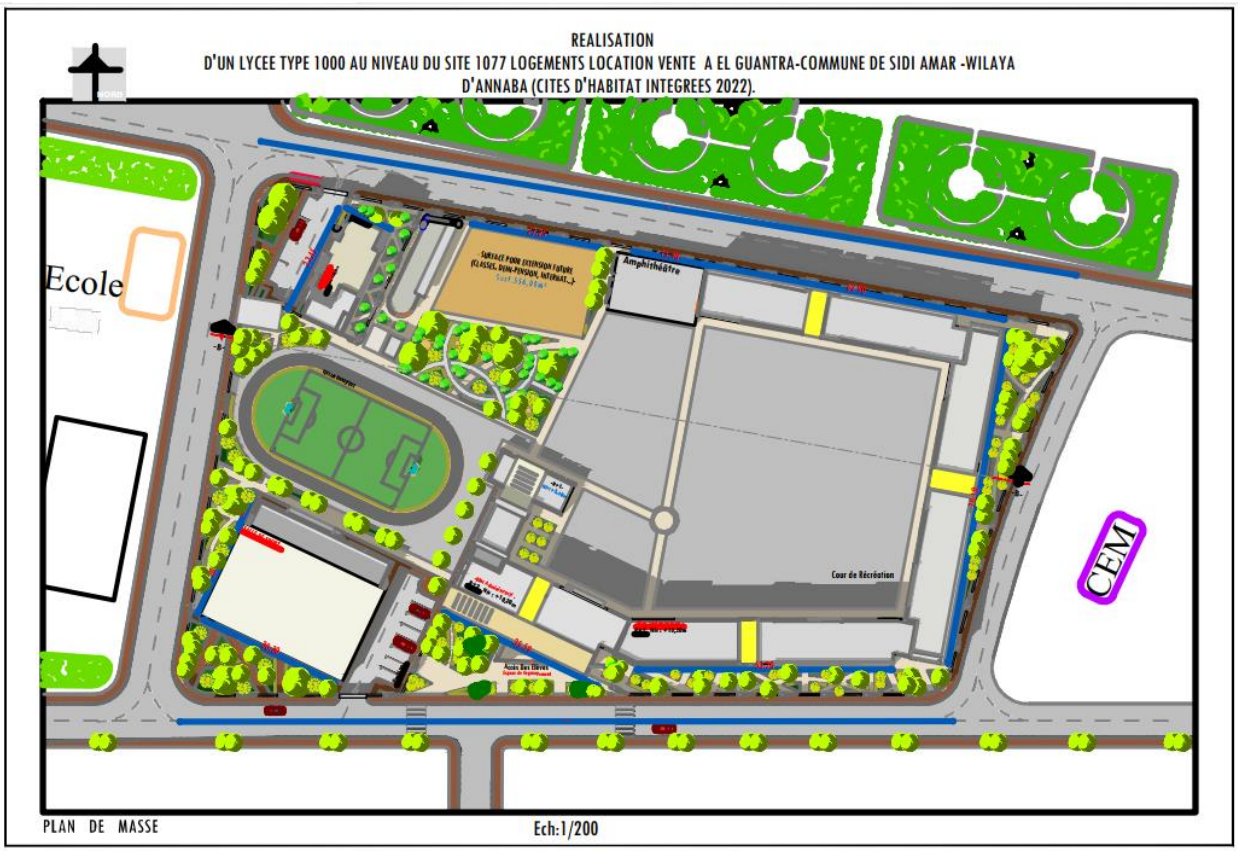


Figure 23 : Ground plan

Source: B.E.T BOUABAZE. CH

2.3. Planning schedule

Planning is the backbone of successful project execution, ensuring that resources, time, and activities are effectively coordinated. In construction, it provides a structured roadmap to deliver projects on time, within budget, and to quality standards.

Objective: Deliver a fully operational high school for the 2025 school year, in accordance with technical specifications and safety standards.

	Nom de tâche	Durée	Progression
1	**Projet**	**262 jours**	**35%**
2	Terrassement (Planifie)	4 sem	0%
3	Réel (Retard)	5 sem	100%
4	Infrastructure (Planifie)	12 sem	0%
5	Réel (Retard)	41 sem	95%
6	Superstructure (Planif...	26 sem	0%
7	Réel (Retard)	35 sem	80%
8	Maçonnerie Enduit (P...	20 sem	0%
9	Réel (Retard)	29 sem	70%
10	Revêtement (Planifie)	24 sem	0%
11	Réel (Retard)	25 sem	50%
12	Étanchéité (Planifie)	5 sem	0%
13	Réel (Avance)	5 sem	20%
14	Menuiserie (Planifie)	6 sem	0%
15	Réel (Retard)	6 sem	30%
16	Plomberie et chauffag...	8 sem	0%
17	Réel (Avance)	8 sem	10%
18	Électricité (Planifie)	6 sem	0%
19	Réel (Avance)	6 sem	40%
20	Peinture (Planifie)	6 sem	0%
21	Réel (Avance)	6 sem	50%
22	VRD (Planifie)	11 sem	0%
23	Réel (Retard)	11 sem	10%
24	Aménagement extérie...	12 sem	0%
25	Réel (Retard)	12 sem	20%

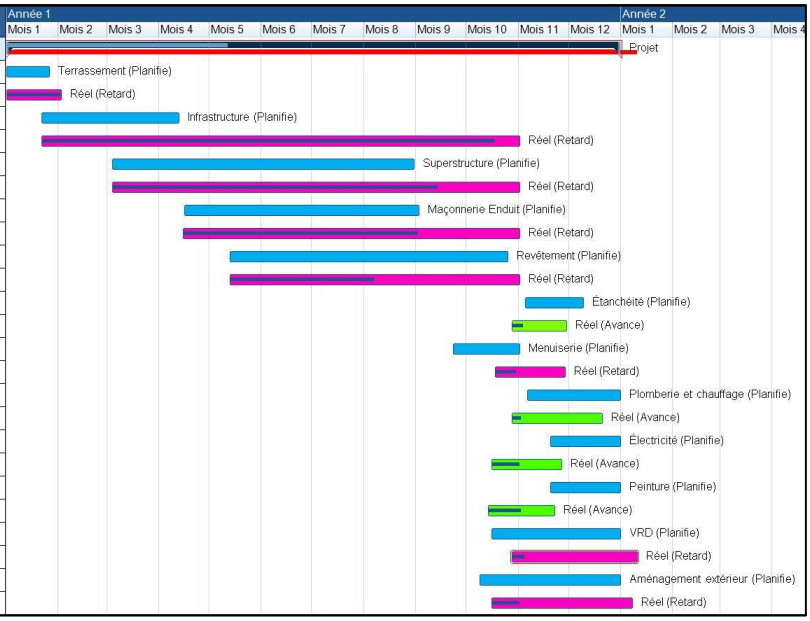


Figure 24 : Planning of execution phase

Source: « DIB SALAH « company + Author

❖ **Overall project execution time:**

The project must be fully completed within a contractual period of 12 months from the start date of the works.

❖ **Key details:**

- Date of issuance of the ODS (Service Order): 06/24/2024 (marking the official start of the deadline)
- Expected delivery date: June 2025
- Calendar challenges:
  - Respect for key phases (earthworks, structural work, finishing work, equipment)
  - Coordination with inclement weather and seasonal constraints
  - Management of suppliers and subcontractors

❖ **Observations:**

- Frequent delays: The majority of tasks are delayed ("Actual (Delay)"),
- particularly for critical phases such as Infrastructure (41 weeks instead of the planned 12) and Superstructure (35 weeks instead of 26).
- Occasional advances: Some tasks are ahead of schedule ("Actual (Advance)"), such as Waterproofing, Plumbing and Heating, Electricity, and Painting.

- Uneven progress: Some tasks have high progress despite delays (e.g., Infrastructure at 95%), while others are significantly delayed with low progress (e.g., VRD at 10%).
- Inconsistencies: For example, the task "Waterproofing" is marked as ahead with 20% progress, but its actual duration (5 weeks) matches the planned duration. This suggests a possible data entry or tracking error.

❖ **Associated constraints:**

- Late penalties provided in the contract in case of overruns
- Rigorous monitoring by the project owner (Public Equipment Directorate of Annaba) and the technical control (CTC EST Annaba)

→ ***This tight deadline requires meticulous planning and flawless execution by the company DIB SALAH.***

2.4. Progress state of project

➢ On the first visit to the construction site on 28-10-2024 the work progress was 30%, where the project was still in the stages of infrastructures and superstructures, as shown in the following pictures:

Figure 25 : Reinforce the foundations of the Amphitheatre block

Source: « DIB SALAH « company

Figure 26 : Pouring the wall and the anchor columns for the Amphitheatre block

Source: « DIB SALAH « company

Figure 27 : Reinforcement and formwork for slab LEVEL+3.40 joint 2

Source: « DIB SALAH « company

Figure 28 : Reinforcement and formwork for slab LEVEL+3.40 joint 3

Source: « DIB SALAH « company

Figure 29 : Reinforcement and formwork for the columns at level +3.40 joint 6

Source: « DIB SALAH « company

Figure 30 : Pouring floor NIV 3.40 joint 02

Source: « DIB SALAH « company

Figure 31 : Panoramic view

Source: « DIB SALAH « company

- On the last visit the project progress is 65% on 30-04-2025, and it is noticeable progress within a short period (5 months), which indicates the efficiency of the institution, and therefore it is expected that the project will be completed early or within the agreed contractual period.

Figure 32 : Panoramic view

Source: "DIB SALAH" company

Figure 33 : Main facade of joint 1 and 2

Source: Author

Figure 34 : Single-layer floor covering

Source: Author

Figure 35 : Film coating in progress

Source: Author

Figure 36 : Sanitary earthenware

Source: Author

2.5. Summary table of project surfaces

2.5.1. *Characteristics:*

Table 5 : Characteristics

Source : "DIB SALAH" company

Number of students	1.000
Number of educational divisions	34
Size of the educational division	30

2.5.2. Nomenclature of surfaces :

Table 6 : Nomenclature of surfaces

Source: "DIB SALAH" company

No.	LOCATIONS	Quantity	Unit Area (m^2)	Total Area (m^2)
A	**Educational Block:**			
	- Classrooms	34	62.35	2,119.9
	- Science labs (natural & physical sciences)	6	64.16	384.96
	- Preparation room	3	30.15	90.45
	- Technology lab	3	48.25	144.75
	- Computer lab	2	72.50	145.00
	- Art workshop with storage	1	80.05	80.05
	- Music workshop with storage	1	80.05	80.05

	- Multipurpose room	1	80.00	80.00
	- Library and reading room	1	120.05	120.05
	- Amphitheater	1	160.00	160.00
	- Deputy education offices (per floor)	3	16.15	48.45
	- Student restrooms	2	75.00	150.00
	Subtotal	1,783.96		
	- Circulation area (20%)	356.79		
	Total Block A	**2,140.75**		
B	**Administrative Block:**			
	- Principal's office	1	29.92	29.92
	- Secretary's office	1	17.45	17.45
	- Vice principal's office	1	30.02	30.02
	- Education counselors' offices	2	16.02	32.04
	- Accountant's office	1	16.02	16.02
	- Administration office	1	16.05	16.05
	- Storage room	1	20.08	20.08
	- Career guidance office	1	16.20	16.20
	- Professional orientation office	1	40.12	40.12
	- Documentation and information room	1	80.60	80.60
	- Teachers' lounge with IT space	1	80.50	80.50
	- Meeting room	1	80.06	80.06
	- Archives room	1	40.12	40.12
	- Warehouse	1	98.10	98.10
	- Health screening unit (UDS)	1	16.05	16.05
	- Waiting room	1	6.62	6.62
	- Security booth	2	12.02	24.04
	- Staff restrooms	1		
	Subtotal			
	- Circulation area (10%)			
	Total Block B			
C	**Ancillary Services Block:**			
	- Professional workshop and storage	1	60.10	60.10
	- Boiler room	1	30.00	30.00
	- Transformer and generator room	1	40.00	40.00
	- Renewable energy equipment room	1	12.25	12.25
	- Water tank and machine room	1	24.00	24.00
	Total Block C	**166.35**		
D	**Sports Block:**			
	- Play area (30m x 20m)	1	600.00	600.00
	- Entrance hall	1	16.38	16.38
	- Student locker rooms	2	32.45	64.90
	- Teacher's office with locker	2	12.20	24.40
	- Equipment storage |	1	16.24	16.24
	- Covered area	1	16.05	16.05
	- Foot brush mat	1	8.00	8.00
	- Boiler room	1	16.24	16.24
	Total Block D	**762.21**		
E	**Staff Housing:**			
	- 5-room housing unit	1	100.04	100.04
	- 4-room housing units	2	85.02	170.04
	- 3-room housing units	4	70.195	141.39
	Total Block E	**553.00**		

	Total built-up area (T1 + T2 + T3 + T4 + T5)	**6,417.00**		
F	**Outdoor Areas:**			
	- Playground (3m² per student)	1	3,180.00	3,180.00
	- Multi-sport field	1	1,280.00	1,280.00
	- Green space and gardening area (20m² per class) |	1	487.00	487.00
	Total Block F	**4,947.00**		
	Total land area (T1 + T2 + T3 + T4 + T5 + T6)	**11,198.00**		
	Area for future expansion (classes, cafeteria, dormitory, etc.)	**554.00**		
	Total land area including expansion	**11,752.00**		

Conclusion

The corporation "DIB SALAH" and the high school building project in Elgantra, Annaba, which serves as the study's basis, were thoroughly covered in this chapter. It is evident by examining the company's history, organizational structure, resources, and service offerings that "DIB SALAH" has the expertise and experience required to oversee challenging public infrastructure projects.

Social, pedagogical, economic, and technological justifications were used to support the chosen case study, which was a typical high school with 1,000 pupils. The chapter described the project's strategic significance in relation to its urban setting as well as how it aligns with the objectives of national development. To create a reasonable baseline for assessing performance, the project's schedule, progress, and difficulties were also evaluated.

Understanding the relevance and application of the Earned Value Management (EVM) method—which will be covered in the upcoming chapters—requires this contextual background. It lays the groundwork for a more thorough examination of the ways in which EVM might be modified and applied to improve project management effectiveness in the Algerian building industry.

Chapter 02: The Adapted Method Process

Introduction

Successful outcomes in construction project management depend heavily on the capacity to track and manage project performance. This chapter, "The Adapted Method Process," explores the methodology used to implement Earned Value Management (EVM) in the case study, which is the building of a conventional high school in ELGANTRA, ANNABA province, carried out by the business "DIB SALAH."

EVM is a methodical approach that provides a thorough understanding of project performance by combining scope, schedule, and cost indicators. Through its use, project managers may monitor developments, spot irregularities, and take proactive remedial action. However, the precision of data gathering, the strength of analytical techniques, and the capacity to convert both quantitative and qualitative insights into workable plans are what make EVM effective.

This chapter is structured into two main sections:

Quantitative Data: The procedure for gathering and evaluating numerical data, such as Planned Value (PV), Earned Value (EV), and Actual Cost (AC), is described in this section. Key performance indicators (KPIs) including Schedule Variance (SV), Cost Variance (CV), Schedule Performance Index (SPI), and Cost Performance Index (CPI) are also calculated in detail. To provide with a clear picture of the project's financial and temporal health, these indicators are displayed as graphs.

Qualitative Data: This section examines how surveys and interviews are used to gather and analyze stakeholder input. To find the underlying reasons of delays, cost overruns, and other difficulties, methods including Pareto analysis, SWOT analysis, and the 5W1H technique are used. Together with the quantitative data, the qualitative insights provide a comprehensive picture of the project's performance.

By the end of this chapter, readers will have a comprehensive grasp of how EVM may be modified and used in Algerian construction projects, emphasizing how it can increase productivity, reduce risks, and guarantee project success. The conclusions will serve as the foundation for the managerial strategy that follows, in which suggestions and remedial measures are put forth to maximize project results.

1. Quantitative Data

1.1. Data Collection

- **Data Source:** Records pertaining to construction project:
  - Planning.
  - Quantitative and estimated public market quote.
  - 2 situations (1 every 3 months).
- **Key Metrics to Collect:**
  - Planned Value (PV).
  - Actual cost (AC).
  - Budget at Completion (BAC).
  - Duration variance (Planned Vs Actual).

1.2. Data Analysis Methods

- **Excel software:**
  - Create the first table that includes the large tasks of the project, with the duration and planned costs for each one, then calculate the division of the total cost of the task by the number of weeks it takes to get the cost of one week.
  - Create the second table, which contains the main data (PV, AC and EV), where the planned value is calculated by adding the costs of all the work to be completed according to the planning per month and calculating the cumulative total until reaching the total amount of the project at the end of the month 12, while the other data is obtained through collaboration with project stakeholders.
  - Calculation of KPIs.
  - Graph drawing of curves (PV, AC and EV).
  - Analyze and discus/interpret results to examine the relationship between EVM implementation and project performance.
  - Synthesis.

2. Qualitative Data

2.1. Data Collection

- **Data Source:**
  - Surveys and interviews with stakeholders, engineers, and project managers formulate in a questionnaire contain 6 sections (Cost, Schedule, Quality, Performance and EVM) with 34 questions in three languages English, Arabic and French.

- **Key Topics:**
  - Project problems.
  - Advantages and obstacles of EVM.
  - Contentment with project results.
  - Experiences utilizing EVM for project modifications and decision-making.

2.2. Data Analysis Methods

- Analyze interview transcripts to quantify mentions of specific issues or problems (e.g., Over budget, behind of schedule).
- Highlighting the results of interviews and surveys related to advantages, challenges and recommendations for EVM in the company.

2.6.1. Pareto Analysis

Definition

Pareto analysis is a decision-making tool premised on the idea that 80% of a project's benefit can be achieved by doing 20% of the work—or, conversely, 80% of problems can be traced to 20% of the causes. In other words, it posits that not all inputs have the same or even proportional impact on a given output.

Pareto analysis will typically show that a disproportionate improvement can be achieved by ranking various causes of a problem and by concentrating on those solutions or items with the largest impact. It is a technique for getting the necessary facts to set priorities.

Pareto analysis is mainly used for business decision making, but also has applications in several different fields, from welfare economics to quality control. A common part of Pareto analysis is to graphically depict the occurrence of each variable being tracked. This depiction is called a Pareto chart.

Key Takeaways

- As a decision-making technique, Pareto analysis statistically separates a limited number of input factors, either desirable or undesirable, which have the greatest impact on an outcome.
- Each problem or benefit is given a numerical score based on the level of impact on the company; the higher the score, the greater its impact.
- Modern-day applications of Pareto analysis are used to determine which issues cause the most problems within different departments, organizations, or sectors of a business.

- By allocating resources to issues with higher scores, companies can use Pareto analysis to solve problems more efficiently because they can target those problems that have a greater impact on the business.

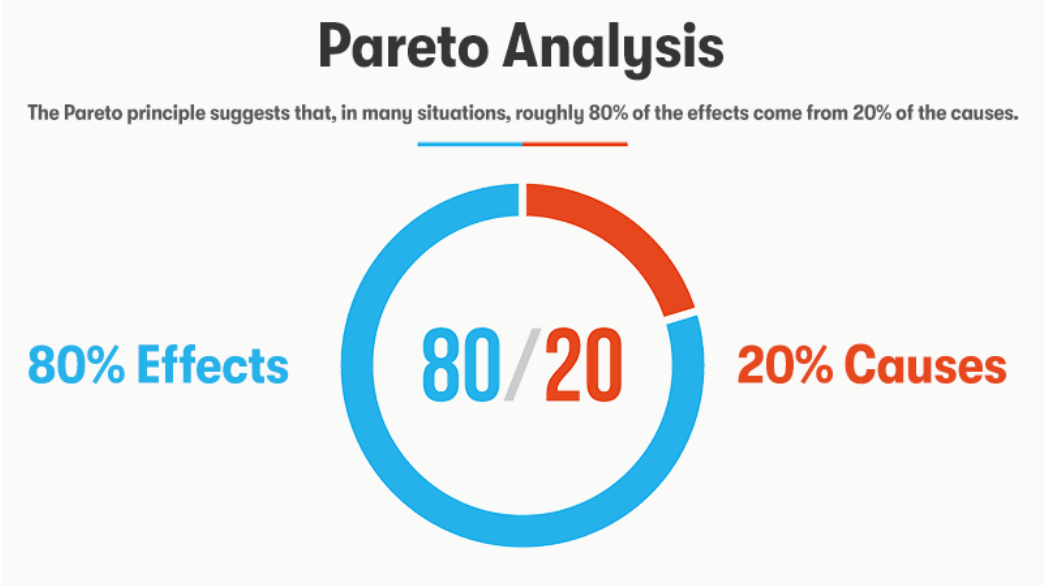


Figure 37 : Pareto Principe

Source : (https://purplegriffon.com/blog/pareto-analysis)

Understanding Pareto Analysis

In 1906, Italian economist Vilfredo Pareto discovered that 80% of the land in Italy was owned by just 20% of the people in the country. He extended his research and determined that this disproportionate wealth distribution was the same across Europe. The 80-20 rule was formally defined as follows: The top 20% of a country's population accounts for an estimated 80% of the country's wealth or total income.

Joseph Juran, a Romanian-American business theorist, discovered Pareto's research in 1937, approximately 40 years after it was published. Juran proceeded to rename the 80-20 rule as "Pareto's Principle of Unequal Distribution."

Juran extended Pareto's principle to the business world to understand whether the rule could be applied to problems faced by businesses. He observed that in quality control departments, most production defects resulted from a small percentage of the causes of all defects. So, by extension, 80% of the problems are caused by 20% of the defects; Juran's work implies that if you focus on fixing that 20%, you could have a big impact with minimal effort.

Modern-day applications of Pareto analysis are used to determine which issues cause the most problems within different departments, organizations, or sectors of a business.

Typically, Pareto analysis is employed by business managers, whose approach usually involves conducting a statistical analysis, such as a cause-and-effect analysis, to produce a list of potential problems and the outcomes of these problems.

Following the information provided by the cause-and-effect analysis, the 80-20 rule can be applied. Here are some scenarios relevant to businesses where Pareto analysis might be applicable:

- Sharing information about defects/errors with high-priority stakeholders.
- Prioritizing defects or tasks according to their severity, i.e., according to their impact on a system or business.
- Analyzing data or errors/defects.

Steps of Pareto Analysis

By applying the 80-20 rule, problems can be sorted based on whether they affect profits, customer complaints, technical issues, product defects, or delays and backlogs from missed deadlines. Each of these issues is given a rating based on the amount of revenue or sales and time lost, or the number of complaints received.

Here is a basic breakdown of the steps of Pareto analysis:

1. Identify the problem or problems.
2. List or identify the cause of the issues or problems, noting that there could be multiple causes.
3. Score the problems by assigning a number to each one that prioritizes the problem based on the level of negative impact on the company.
4. Organize the problems into groups, such as customer service or system issues.
5. Develop and implement an action plan, focusing on the higher-scored problems first, in order to solve the problems.

Not all problems will have a high score, and some smaller problems may not be worth pursuing initially. By allocating resources to high-impact issues or higher scores, companies can solve problems more efficiently by targeting the issues that have a major impact on profits, sales, or customers.

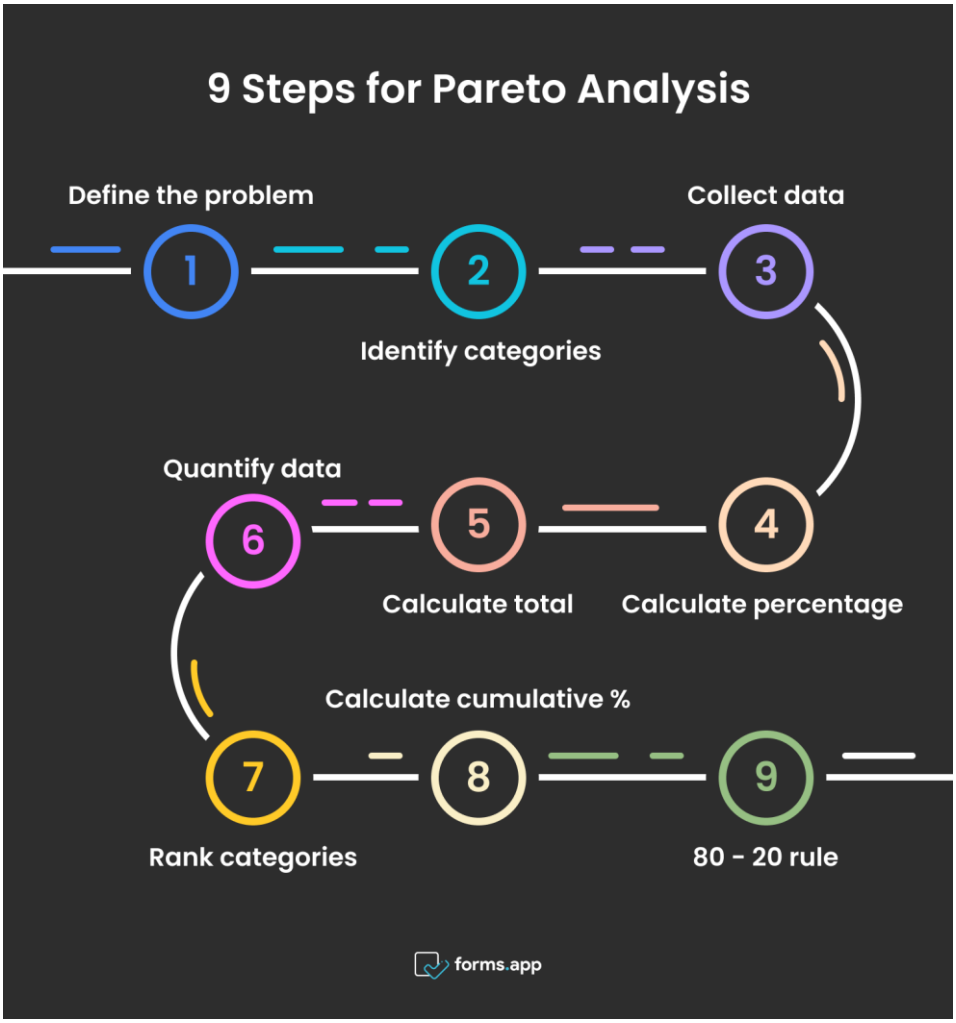


Figure 38 : Pareto Analysis Steps

Source : (https://forms.app/en/blog/pareto-analysis)

How to Create a Pareto Chart

A common part of Pareto analysis is to graphically depict the occurrence of each variable being tracked. This depiction is called a Pareto chart, and it organizes and displays information to show the relative importance of various problems or causes of problems.

It is similar to a vertical bar graph in that it puts items in order (from the highest to the lowest) relative to some measurable effect of interest: frequency, cost, or time. Here is the process of making a Pareto chart.

1. Develop a list of problems to be compared.
2. Develop a standard measure for comparing the items—for example, how often it occurs: frequency (e.g., utilization, complications, errors); how long it takes (time); and how many resources it uses (cost).
3. Choose a time frame for collecting the data.

4. For each item, tally how often it occurred (or cost or total time). Then, add these amounts to determine the grand total for all items.
5. Find the percent of each item in the grand total by taking the sum of the item, dividing it by the grand total, and multiplying by 100.
6. List the items being compared in decreasing order of the measure of comparison; e.g., the most frequent to the least frequent. The cumulative percent for an item is the sum of that item's percent of the total and that of all the other items that come before it in the ordering by rank.
7. List the items on the horizontal axis of a graph from highest to lowest. Label the left vertical axis with the numbers (frequency, time, or cost).
8. Label the right vertical axis with the cumulative percentages (the cumulative total should equal 100%).
9. Draw in the bars for each item.
10. Draw a line graph of the cumulative percentages. The first point on the line graph should line up with the top of the first bar.

The final step is analysis. You can analyze a Pareto chart by identifying those items that appear to account for most of the difficulty. In the example below, the Institute for Healthcare Improvement identified three vital types of errors discovered during surgical setup.

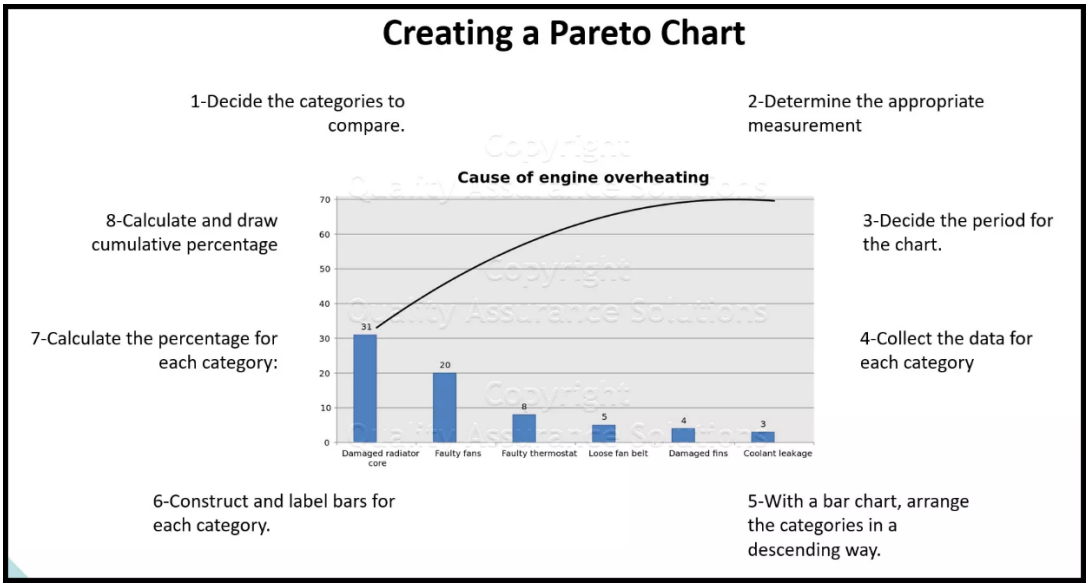


Figure 39 Creating Pareto Chart.

Source: (https://www.quality-assurance-solutions.com/Pareto-chart.html**)**

Advantages and Disadvantages of Pareto Analysis

Advantages of Pareto Analysis

- Helps to identify and determine the root causes of defects or problems.
- Save time and resolve defects or errors with the highest priority first.
- Determine the cumulative impact of a problem.
- Plan what measures or actions need to be taken in order to amend problems.
- Can sharpen problem-solving and decision-making skills.

Disadvantages of Pareto Analysis

- Does not provide solutions to issues.
- Only focuses on past data.
- Pareto charts only show qualitative data that can be observed; they cannot be used to represent quantitative data.

What Is Pareto Analysis Used For?

Pareto analysis is used to identify problems or strengths within an organization. As an overwhelming amount of impact is often tied to a relatively smaller proportion of a company, Pareto analysis strives to identify the more material issues worth resolving or the more successful aspects of a business.

What Is the Importance of Pareto Analysis?

Pareto analysis enables an entity to be more efficient with its resources. By quickly identifying a major issue or capitalizing on a major business success, the company can spend less time and resources focusing on less impactful aspects of the company.

How Is a Pareto Chart Different from a Standard Vertical Bar Graph?

A vertical bar graph is a type of graph that visually displays data using vertical bars going up from the bottom. In a vertical bar graph, the lengths are proportional to the quantities they represent. Vertical bar graphs are typically utilized when one axis cannot have a numerical scale.

A Pareto chart is a type of chart that contains both bars and a line graph. Individual values are represented in descending order by bars, and the cumulative total is represented by the line. A Pareto chart is different from a vertical bar graph because the bars are positioned in order of decreasing height, with the tallest bar on the left.

What Is Pareto Efficiency?

Pareto efficiency is a state of the economy where resources cannot be reallocated to provide more advantages for one individual without making at least one individual worse off. Pareto efficiency implies that resources are allocated in the most economically efficient manner. However, this state does not guarantee equality or fairness.[77]

2.6.2. SWOT Matrix

Definition

A SWOT analysis helps define a company's competitive position, assesses internal and external issues, and evaluates its current and future potential. It is a realistic, fact-based, data-driven analysis of an organization.

Key Takeaways

- A SWOT analysis is a strategic planning technique.
- It evaluates information from all sources that may have uncontrollable impacts on a company's decisions.
- A SWOT analysis works when diverse groups within an organization provide realistic data points rather than prescribed messaging.

Understanding SWOT Analyses

A SWOT analysis is a technique for assessing the performance, competition, risk, and potential of a business, as well as a part of a business, such as a product line or division, an industry, or other entity.

Using internal and external data, the technique can guide businesses toward strategies more likely to be successful, and away from those in which they have been (or are likely to be) less successful. Independent SWOT analysts, investors, or competitors can also guide them on whether a company, product line, or industry might be strong or weak and why.

Components of SWOT Analysis

Every SWOT analysis includes four categories. Though the elements and discoveries within these categories will vary from company to company, a SWOT analysis is not complete without each of the following elements:

- **Strengths:** Strengths describe what an organization excels at and what separates it from the competition: a strong brand, loyal customer base, a strong balance sheet, unique technology, and so on. For example, a hedge fund may have developed a proprietary

trading strategy that returns market-beating results. It must then decide how to use those results to attract new investors.

- **Weaknesses:** Weaknesses stop an organization from performing at its optimum level. These are areas where the business needs to improve to remain competitive: a weak brand, higher-than-average turnover, high levels of debt, an inadequate supply chain, or lack of capital.
- **Opportunities:** Opportunities are favorable external factors that could give an organization a competitive advantage. For example, if a country cuts tariffs, a car manufacturer can export its cars into a new market, increasing sales and market share.
- **Threats:** Threats refer to factors that can potentially harm an organization. For example, a drought is a threat to a wheat-producing company, as it may destroy or reduce the crop yield. Other common threats include things like rising costs for materials, increasing competition, tight labor supply, and so on.

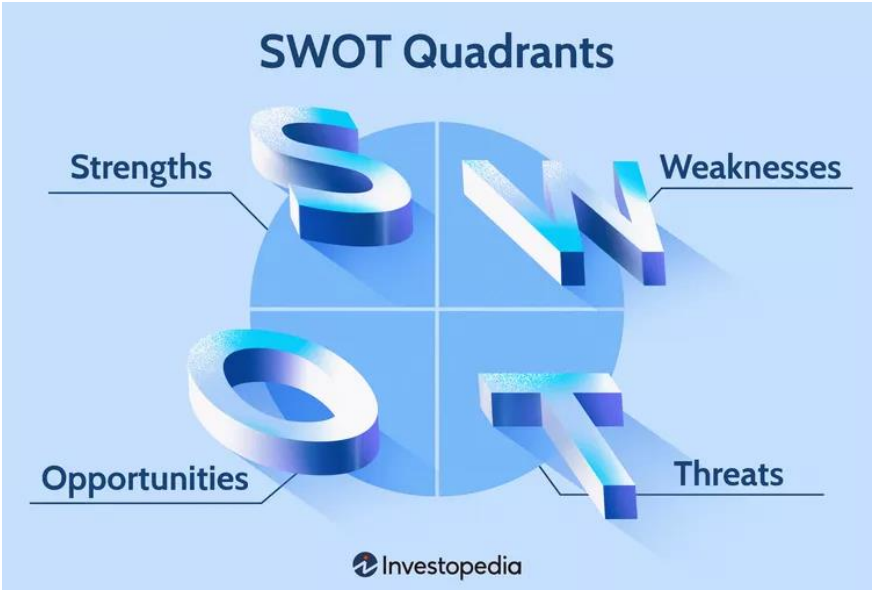


Figure 40 : SWOT Components

Source: (https://www.investopedia.com/terms/s/swot.asp)

SWOT Table

Analysts present a SWOT analysis as a square segmented into four quadrants, each dedicated to an element of SWOT. This visual arrangement provides a quick overview of the company's position. Although all the points under a particular heading may not be of equal importance, they all should represent key insights into the balance of opportunities and threats, advantages and disadvantages, and so forth.

The SWOT table is often laid out with the internal factors on the top row and the external factors on the bottom row. In addition, the items on the left side of the table are more positive/favorable aspects, while the items on the right are more concerning/negative elements.

How to Do a SWOT Analysis

A SWOT analysis can be broken into several steps with actionable items before and after analyzing the four components. A SWOT analysis generally involves the following steps:

Step 1: Determine Your Objective

A SWOT analysis can be broad, though more value will likely be generated if the analysis is pointed directly at an objective. For example, the objective of a SWOT analysis may be focused only on whether or not to perform a new product rollout.

With an objective in mind, a company will have guidance on what it hopes to achieve at the end of the process. In this example, the SWOT analysis should help determine whether or not the product should be introduced.

Step 2: Gather Resources

Every SWOT analysis varies and a company may need different data sets to support pulling together different SWOT analysis tables. A company should begin by understanding what information it has access to, what data limitations it faces, and how reliable its external data sources are.

A company must also have the right combination of personnel involved in the analysis. Some staff may be more connected with external forces, while others within the manufacturing or sales departments may have a better grasp of what is going on internally. Having a broad set of perspectives is also more likely to yield diverse, value-adding contributions.

Step 3: Compile Ideas

The group of people assigned to perform the analysis should begin listing ideas within each category. Examples of questions to ask or consider for each group are in the table below.

Internal factors serve as a great source of information for the strengths and weaknesses categories of the SWOT analysis. Examples include financial and human resources, tangible and intangible (brand name) assets, and operational efficiencies.

Potential questions to list internal factors are:

- (Strength) What are we doing well?
- (Strength) What is our strongest asset?
- (Weakness) What are our detractors?
- (Weakness) What are our lowest-performing product lines?

External factors are equally important to a company's success as internal factors. Influences like monetary policies, market changes, and access to suppliers are categories to pull from to create a list of opportunities and weaknesses.

Potential questions to list external factors are:

- (Opportunity) What trends are evident in the marketplace?
- (Opportunity) What demographics are we not targeting?
- (Threat) How many competitors exist, and what is their market share?
- (Threat) Are there new regulations that potentially could harm our operations or products?

Table 7 : SWOT Table

Source: (https://www.investopedia.com/terms/s/swot.asp)

Strengths	Weaknesses
1. What is our competitive advantage? 2. What resources do we have? 3. What products are performing well?	1. Where can we improve? 2. What products are underperforming? 3. Where are we lacking resources?
Opportunities	**Threats**
1. What new technology can we use? 2. Can we expand our operations? 3. What new segments can we test?	1. What regulations are changing? 2. What are competitors doing? 3. How are consumer trends changing?

Companies may consider performing this step as a white boarding or sticky note session. The idea is there is no right or wrong answer; all participants should be encouraged to share whatever thoughts they have. These ideas can later be discarded; in the meantime, the goal should be to come up with as many items as possible to invoke creativity and inspiration in others.

Step 4: Refine Findings

Clean up the ideas. By refining the thoughts that everyone had, a company can focus on only the best ideas or the largest risks to the company. This stage may require substantial debate among analysis participants, including bringing in upper management to help rank priorities.

Step 5: Develop the Strategy

Convert the SWOT analysis into a strategic plan. Members of the analysis team take the bulleted list of items within each category and create a synthesized plan that guides the original objective.

For example, the company debating whether to release a new product may have identified that it is the market leader for its existing product, and there is an opportunity to expand to new markets. However, increased material costs, strained distribution lines, the need for additional staff, and unpredictable product demand may outweigh the strengths and opportunities.

The analysis team develops the strategy to revisit the decision in six months, in hopes that costs decline and market demand becomes more transparent.[78]

- Advantages and disadvantages of the SWOT analysis

Consideration of any method, including the SWOT analysis, can only be complete if its advantages and disadvantages are taken into account. It is advisable to prepare the SWOT analysis in such a way that the disadvantages listed below are reduced to a minimum.

- The advantages of the SWOT analysis are as follows:

- The key element in formulating a strategic option is to align organizational strengths and weaknesses with the opportunities and threats that exist in the market.
- When used properly, the SWOT analysis can provide a good basis for formulating a strategy.
- The SWOT analysis is widely recognized in marketing and management literature as a systematic way to achieve goals.

- The disadvantages of the analysis are as follows:

- According to Mintzberg (1994), SWOT is rarely effective because it is rooted in the current perceptions of the organization. Nevertheless, it is still advocated as a powerful planning tool in all types of business activities.
- In practice, this is often an activity that is not well implemented. After identifying all the important «points», one does not know what to do with the generated data.
- In terms of using the data generated to formulate strategies, the SWOT analysis is not prescriptive. [79]

2.6.3. 5W1H Method (Often Mistyped as 5H)

- Definition

The 5W1H is a questioning approach and a problem-solving method that answers all the basic elements within a problem which are what, who, when, where, why, and how. It aims to view ideas from various perspectives and gain in an in-depth understanding of a specific situation. This method is commonly utilized as a continuous process-improvement technique in an organization.

The 5W1H, also known as the Kipling method—is a set of questions used by Rudyard Kipling to extensively answer existing questions and trigger ideas that could contribute to the resolution of a problem. The concept was eventually incorporated into business practices to eliminate mistakes, increase efficiency, and streamline processes.

The Kipling method is similar to other process improvement methods such as the root cause analysis, the 5S Lean, and the PDCA cycle.

Figure 41 : 5W1H Method

Source: (https://www.velaction.com/5w1h/)

- The 5Ws and 1H Questions

The elements included in the 5W1H method allows for a comprehensive analysis of the presented situation and enables you to spot opportunities for improvement. Answering the 5Ws and 1H questions, and being as detailed as possible, helps identify potential solutions that could be implemented and observed for their effectiveness.

They can be placed in different order but you should ensure that the following 5Ws and 1H questions are included:

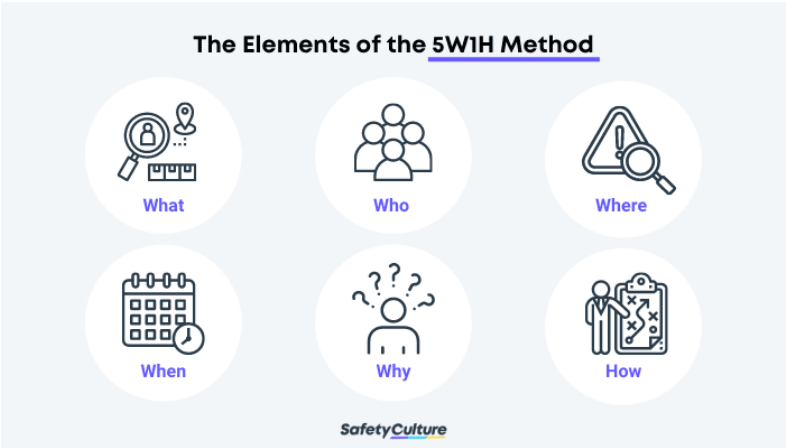


Figure 42 : The 5Ws and 1H Questions

Source : (https://safetyculture.com/topics/5w1h/)

- **What**

The *what* element should clearly describe the situation, the specific problem, or basically explain the purpose of the method usage. If possible, it should also state the overall goal for implementing the solution that would be identified.

- **Who**

Who refers to the specific people or group relevant to the issue or the situation? It should include the person who discovered the problem, who can possibly solve it, and who will be responsible for implementing the possible solution.

- **Where**

The *where* element should contain the exact location or position of the recognized issue. It can be a place, facility, or even a certain process where the solution is to be implemented.

- **When**

When should include all the components of the situation pertaining to anything related to dates? It should state the timeline, deadline, duration, or any other details that could help in the resolution of the problem.

- **Why**

Although each of them is vital in achieving an effective questioning approach, the *why* is probably one of the most important elements of the 5W1H method. It explains in detail the reason and objectives behind the need for action or why there's a need to do the 5W1H method in the first place. This last *W* is also often asked five times to discover the root cause of the situation and to prevent it from recurring. This approach is called the 5 Whys analysis.

- **How**

How, as the last element of the method, specifies the steps on how the identified plan/s should be carried out. It should also include all the resources, tools, methods, means, and even the expenditure needed for the endeavor to be effective.

To summarize, asking these questions enables those who will use the 5W1H method to get to the bottom of things by systematically structuring thoughts and emphasizing important information. Consequently, this can help recognize potential issues and possible solutions related to the scenario.[80]

The advantages of the 5W1H method

The 5W1H process is the ultimate example of an action plan. The main advantage of this analysis tool is its great simplicity. The 5W1H technique does not present any particular difficulty, either in its implementation in table form or in its concrete application. Versatile and flexible, it can be used in both the professional and private spheres. It is also a method for:

- A quick analysis of a given situation: depending on the questions asked, it allows to define the bases on which the action plan will be founded. For greater clarity, the responses can be grouped in a table.
- Constructive and comprehensive questioning: the open-ended questions characteristic of the 5W1H technique encourage reflection and mobilize the intellectual resources of each person.
- To launch the bases of a collaborative management as well as a co-construction: by thinking together, the members of a group develop a common vision essential to define priorities and obtain the expected results.

To be productive, however, the 5W1H technique must be used wisely and within the rules. Poorly formulated questions can be disruptive and counterproductive.[81]

3. Path summary

The next path summary provides a structured overview of the methodological steps followed throughout the case study. It outlines key phases, tools, and analyses applied to monitor and enhance project performance.

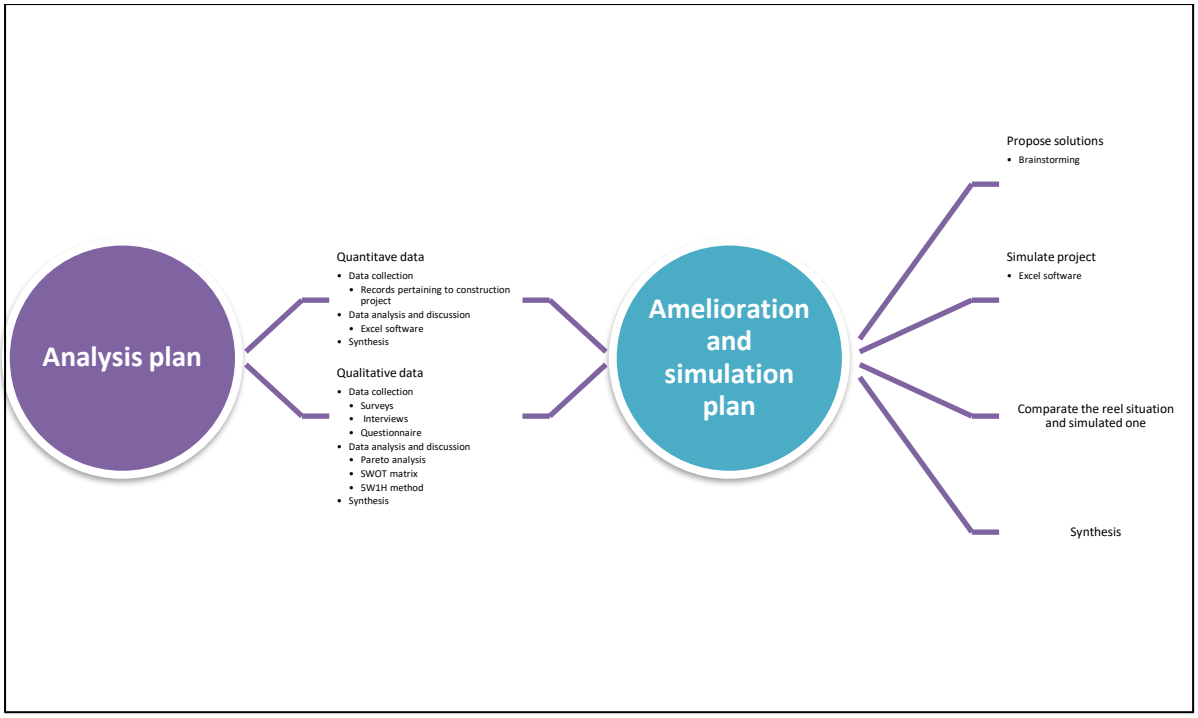


Figure 43 : Path summary

Source: Author

Conclusion

This chapter presented the methodology adapted for applying the Earned Value Management (EVM) system to the selected construction project. Through the integration of both quantitative and qualitative data, we established a framework that aligns with the specific realities of the Algerian construction context. The quantitative data, including baseline planning, cost structures, and project progress, form the core of the EVM analysis, while the qualitative data, gathered through interviews and site observations, add depth to the understanding of on-ground constraints and managerial practices.

The technique emphasizes how crucial it is to adapt project control tools, such as EVM, to local circumstances, such as organizational maturity, resource availability, and legal frameworks. The ability to detect performance abnormalities early and suggest remedial steps proactively is strengthened by the simultaneous focus on human factors and numerical tracking.

This modified approach establishes the groundwork for assessing the efficacy of EVM in the upcoming chapters, where its application to the high school building project's real-time performance will be critically examined. It does this by linking theoretical concepts with practical implementation.

Part III: Managerial Approach

Chapter 1:

EVM

Application

Introduction

The effective process known as Earned Value Management (EVM) combines scope, cost, and schedule to offer a thorough assessment of project performance. EVM is a vital tool for tracking developments, spotting deviations, and facilitating data-driven decision-making in the context of building projects. The actual implementation of EVM is the main topic of this chapter. The case study is the construction of a conventional high school in ELGANTRA, ANNABA province, which was carried out by the business "DIB SALAH."

In order to evaluate the project's financial and temporal health, the chapter starts with a quantitative analysis that computes key performance indicators (KPIs) including Schedule Variance (SV), Cost Variance (CV), Schedule Performance Indicator (SPI) and Cost Performance Indicator (CPI). These metrics give useful information for remedial actions by indicating if the project is on time, over budget, or behind schedule.

A qualitative analysis is carried out using stakeholder, engineer, and project management questionnaires and interviews after the quantitative review which aims to extract gold the root problems causing the delay of the project and increasing its costs. This stage examines the benefits and drawbacks of putting EVM into practice, providing a better grasp of its practicality and constraints.

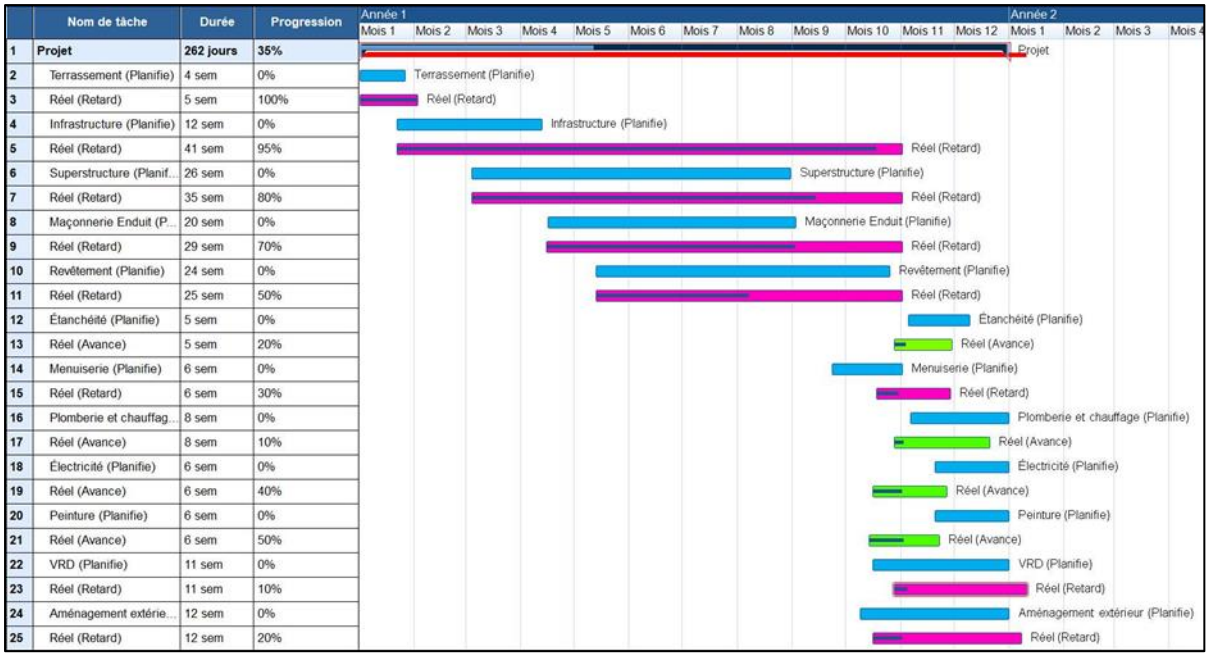
This chapter attempts to show how EVM may improve project performance, reduce risks, and guarantee successful project delivery by integrating quantitative and qualitative data. The results will not only support the idea that EVM enhances schedule and cost control, but they will also offer helpful suggestions for maximizing its application in Algeria's building industry.

1. Quantitative Data

3.1. Data Collection

Data Source: The next figures presented serve to illustrate the project’s organizational structure, technical progress, and performance metrics. They offer a visual representation of the data collected, supporting analysis and decision-making throughout the construction project.

- **1/Planning**



	Nom de tâche	Durée	Progression
1	**Projet**	**262 jours**	**35%**
2	Terrassement (Planifie)	4 sem	0%
3	Réel (Retard)	5 sem	100%
4	Infrastructure (Planifie)	12 sem	0%
5	Réel (Retard)	41 sem	95%
6	Superstructure (Planif...	26 sem	0%
7	Réel (Retard)	35 sem	80%
8	Maçonnerie Enduit (P...	20 sem	0%
9	Réel (Retard)	29 sem	70%
10	Revêtement (Planifie)	24 sem	0%
11	Réel (Retard)	25 sem	50%
12	Étanchéité (Planifie)	5 sem	0%
13	Réel (Avance)	5 sem	20%
14	Menuiserie (Planifie)	6 sem	0%
15	Réel (Retard)	6 sem	30%
16	Plomberie et chauffag...	8 sem	0%
17	Réel (Avance)	8 sem	10%
18	Électricité (Planifie)	6 sem	0%
19	Réel (Avance)	6 sem	40%
20	Peinture (Planifie)	6 sem	0%
21	Réel (Avance)	6 sem	50%
22	VRD (Planifie)	11 sem	0%
23	Réel (Retard)	11 sem	10%
24	Aménagement extérie...	12 sem	0%
25	Réel (Retard)	12 sem	20%

Figure 44 : Planning Schedule

Source: "DIB SALAH" company

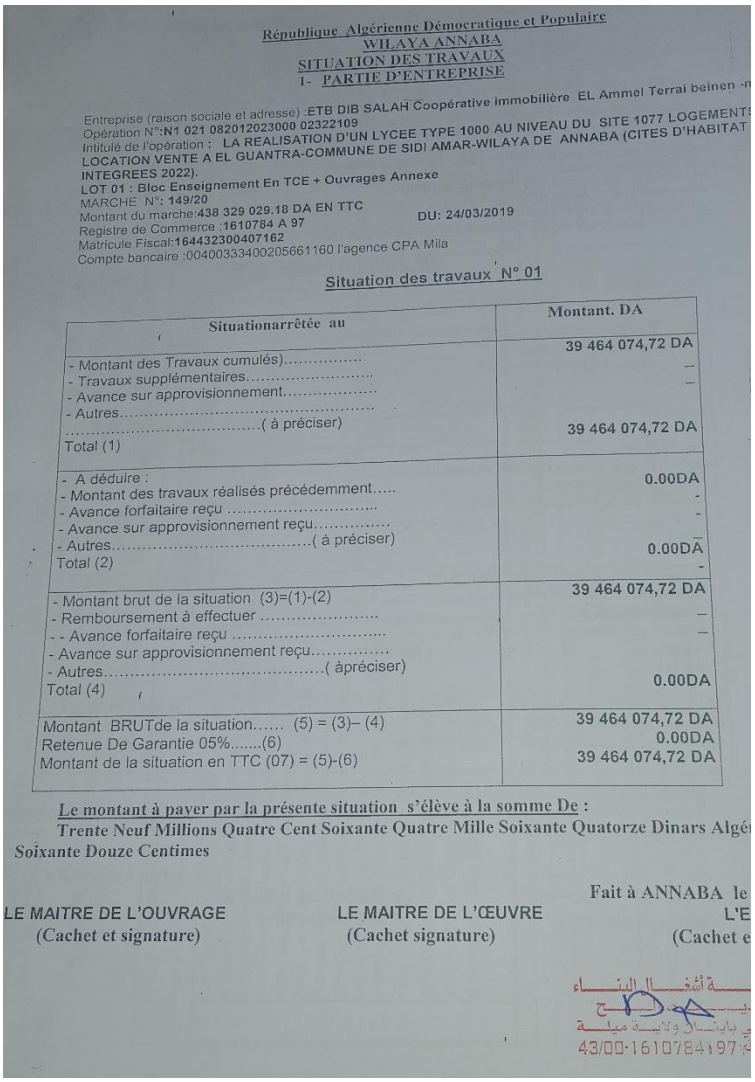
2/ Quantitative and estimated public market quote

Task	Cost	
Earthworks	DZD	3,241,600
Infrastructure	DZD	47,299,500
Superstructure	DZD	64,081,000
Masonry and Coating	DZD	35,390,000
Covering	DZD	26,596,500
Seal	DZD	12,834,000
Carpentry	DZD	44,394,000
Plumbing and heating	DZD	21,603,900
Electricity	DZD	10,908,500
Painting	DZD	10,280,000
VSN	DZD	15,346,400
Outdoor Landscaping	DZD	56,266,000
TOTAL	DZD	348,241,400

Figure 45 : Quantitative and estimated public market quote

Source: "DIB SALAH" company

3/ Situations (1 every 3 months)



République Algérienne Démocratique et Populaire
WILAYA ANNABA
SITUATION DES TRAVAUX
1- PARTIE D'ENTREPRISE

Entreprise (raison sociale et adresse) :ETB DIB SALAH Coopérative immobilière EL Ammel Terrai beinen -n
Opération N°:N1 021 082012023000 02322109
Intitulé de l'opération : LA REALISATION D'UN LYCEE TYPE 1000 AU NIVEAU DU SITE 1077 LOGEMENTS
LOCATION VENTE A EL GUANTRA-COMMUNE DE SIDI AMAR-WILAYA DE ANNABA (CITES D'HABITAT
INTEGREES 2022).
LOT 01 : Bloc Enseignement En TCE + Ouvrages Annexe
MARCHE N°: 149/20
Montant du marche:438 329 029.18 DA EN TTC
Registre de Commerce :1610784 A 97 DU: 24/03/2019
Matricule Fiscal:164432300407162
Compte bancaire :00400333400205661160 l'agence CPA Mila

Situation des travaux N° 01

Situationarrêtée au	Montant. DA
- Montant des Travaux cumulés)……	39 464 074,72 DA
- Travaux supplémentaires……	–
- Avance sur approvisionnement……	–
- Autres……	
……(à préciser)	
Total (1)	39 464 074,72 DA
- A déduire :	0.00DA
- Montant des travaux réalisés précédemment…..	-
- Avance forfaitaire reçu ……	-
- Avance sur approvisionnement reçu……	–
- Autres……(à préciser)	
Total (2)	0.00DA
	-
- Montant brut de la situation (3)=(1)-(2)	39 464 074,72 DA
- Remboursement à effectuer ……	–
- - Avance forfaitaire reçu ……	–
- Avance sur approvisionnement reçu……	
- Autres……(àpréciser)	
Total (4)	0.00DA
Montant BRUTde la situation…… (5) = (3)– (4)	39 464 074,72 DA
Retenue De Garantie 05%……(6)	0.00DA
Montant de la situation en TTC (07) = (5)-(6)	39 464 074,72 DA

Le montant à payer par la présente situation s'élève à la somme De :
Trente Neuf Millions Quatre Cent Soixante Quatre Mille Soixante Quatorze Dinars Algé
Soixante Douze Centimes

Fait à ANNABA le
LE MAITRE DE L'OUVRAGE (Cachet et signature)
LE MAITRE DE L'ŒUVRE (Cachet signature)
L'E (Cachet e

43/00-1610784 97

Figure 46 : Situation Number 01

Source: "DIB SALAH" company

Task	Cost	
Earthworks	DZD	3,241,600.00
Infrastructure	DZD	41,866,817.50
Superstructure	DZD	50,724,442.00
Masonry and Coating	DZD	14,136,080.00
Covering	DZD	5,561,400.00
Electricity	DZD	2,501,000.00
Outdoor Landscaping	DZD	10,245,000.00
TOTAL	DZD	155,414,787.19

Figure 47 : Situation Number 02

Source: "DIB SALAH" company

3.2. Data analysis and discussion

3.2.5. Calculate the Key Performance Indicators (KPIs)KPIs

- **Given data**

Depending on the quantitative and estimated bill market bill, which is a detailed report of the planned costs for each task, as well as the planning showing the distribution of these tasks per unit week, the following table was reached:

Table 8 : Planned values of project tasks

Source: Author

Task Name	PV		Duration(week)	PV by week	
Earthworks	DZD	3,241,600	04	DZD	810,400
Infrastructure	DZD	47,299,500	12	DZD	3,941,625
Superstructure	DZD	64,081,000	30	DZD	2,136,033
Masonry and Coating	DZD	35,390,000	25	DZD	1,415,600
Covering	DZD	26,596,500	26	DZD	1,022,942
Seal	DZD	12,834,000	06	DZD	2,139,000
Carpentry	DZD	44,394,000	10	DZD	4,439,400
Plumbing and heating	DZD	21,603,900	08	DZD	2,700,488
Electricity	DZD	10,908,500	06	DZD	1,818,083
Painting	DZD	10,280,000	06	DZD	1,713,333
VSN	DZD	15,346,400	11	DZD	1,395,127
Outdoor Landscaping	DZD	56,266,000	12	DZD	4,688,833

- **Based on the provided data, the Key Performance Indicators (KPIs) can be calculated for the project. Here's the breakdown:**

The calculation of values at month 6 because all the data and 2 situations are available.

Table 9 : KPIs calculation of EVM

Source: Author

KPI	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
PV	DZD 7,183,225	DZD 22,949,725	DZD 45,124,325	DZD 66,908,933	DZD 81,115,467	DZD 99,413,769	DZD 117,712,072	DZD 149,328,574	DZD 185,384,477	DZD 239,944,661	DZD 294,793,056	DZD 348,241,400
EV	DZD -	DZD -	DZD 39,464,075	DZD 39,464,075	DZD 39,464,075	DZD 155,414,787						
AC	DZD 7,892,815	DZD 19,732,037	DZD 31,571,260	DZD 54,761,402	DZD 77,951,545	DZD 101,141,687	DZD 76,605,307	DZD 97,180,868	DZD 120,645,526	DZD 156,152,502	DZD 191,847,041	DZD 226,630,448
CV = EV- AC	DZD (7,892,815)	DZD (19,732,037)	DZD 7,892,815	DZD (15,297,328)	DZD (38,487,470)	DZD 54,273,100						
SV = EV- PV	DZD (7,183,225)	DZD (22,949,725)	DZD (5,660,250)	DZD (27,444,859)	DZD (41,651,392)	DZD 56,001,018						
CPI = EV/AC	0	0	1.25	0.720654934	0.506264178	1.537						
SPI = EV/PV	0	0	0.874563214	0.589817723	0.486517262	1.563						

EAC = BAC/CPI	**DZD**	**226,630,448**
ETC = EAC − AC	**DZD**	**125,488,760**
VAC = BAC – EAC	**DZD**	**121,610,952**
TCPI = (BAC − EV) / (BAC − AC)		**0.78**

3.2.5. Analysis of the project's performance indicators

1. SV (Schedule Variance) :

- SV < 0 throughout the project
  - A negative SV generally indicates a delay in task execution compared to the initial schedule.
- SV > 0 in the 6th month
  - This month marks a timely advance. (EV > PV).

2. CV (Cost Variance) :

- CV < 0 in 1st, 2nd, 4th et 5th months
  - This means the project was over budget in these months.
- CV > 0 in 3rd et 6th months
  - This means the project was over budget in these months.

3. SPI (Schedule Performance Index) :

- SPI < 1 during the 5 months
  - Indicates a lower temporal performance.
- SPI > 1 in 6th month
  - Ahead of schedule (faster progress than planned) that mean EV > PV → More work has been completed than planned for the given time period.

4. CPI (Cost Performance Index):

- CPI < 1 in 1st,2nd,4th et 5th months
  - The project is over budget (financial inefficiency).
  - Every 1 dinar spent yields less value than planned.
  - Negative interpretation: Cost overruns, poor estimation or resource management.
- CPI > 1 in 3rd et 6th months
  - The project is under budget (financially efficient execution).
  - Every 1 dinar spent yields more value than planned.
  - Positive interpretation: good cost management, budget savings.

4. Curve Graph

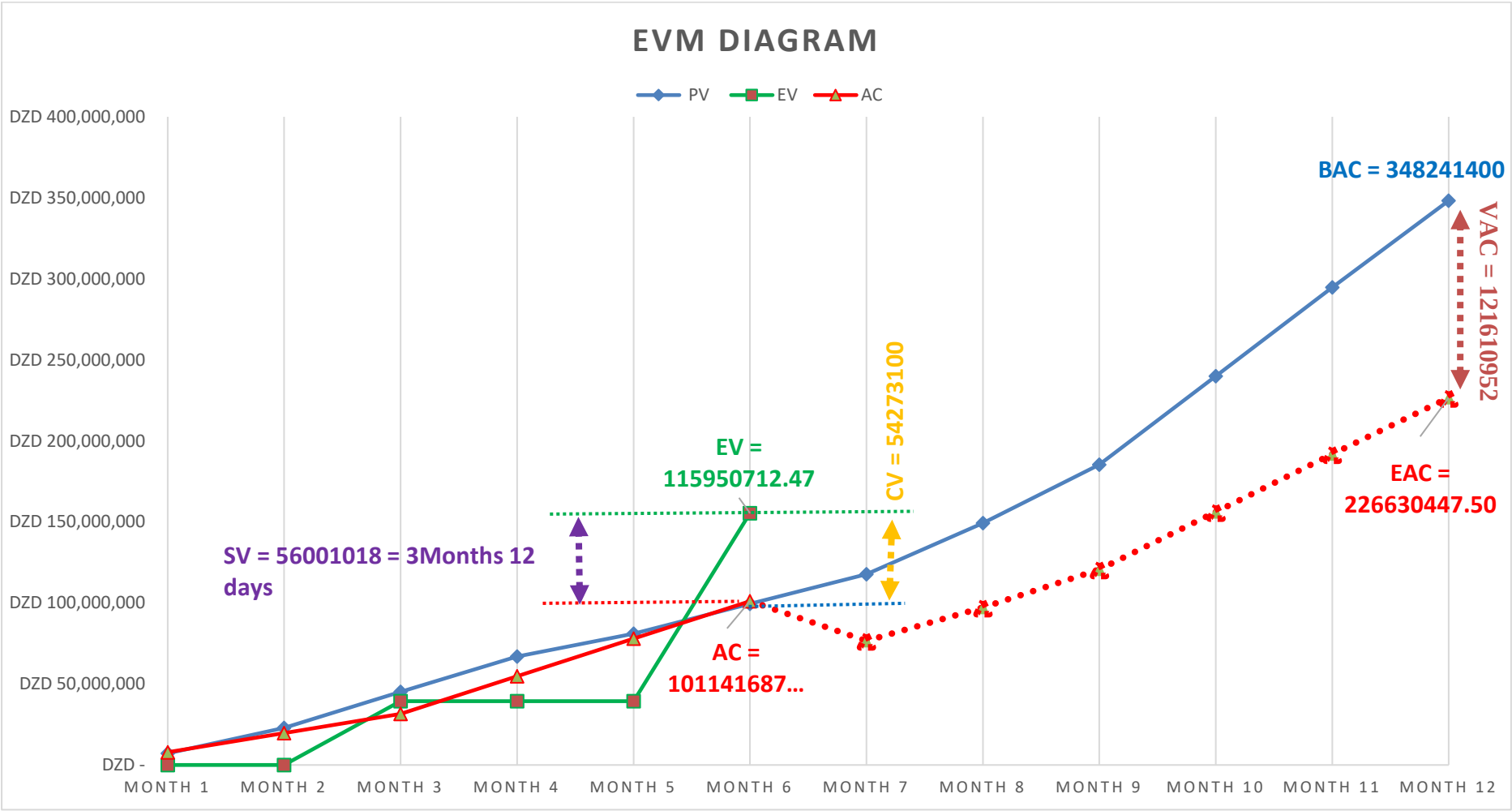


Figure 48 : EVM Diagram

Source: Author

3.2.4. Analysis of the EAC, ETC, VAC, and TCPI indicators

1. **EAC (Estimate at Completion)**

EAC = BAC / CPI

EAC = 348,241,400 / 1.537 ≈ 226,630,448 DA

- Project Expected to Finish Under Budget
- The original budget was 348.24M DA, but the new forecast suggests it will cost only ~226.63M DA.
- Savings of ~121.61M DA (35% less than planned).

2. **ETC (Estimate to Complete)**

ETC = EAC − AC

ETC = 226,630,448 − 101,141,687 ≈ 125,488,761 DA

- ~125.5M DZD is the amount necessary to require to complete the remaining work.
- It is based on the current cost trend and could increase if performance continue to weaken.

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

VAC = BAC − EAC

VAC = 348,241,400 − 226,630,448 = 121,610,952 DA

- The project is forecasted to finish 121.6 million DZD under budget (~35% savings).
- This aligns with your high CPI (1.67), confirming strong cost efficiency.

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

TCPI = (BAC − EV) / (BAC − AC)

TCPI = (348,241,400 − 155,414,787) / (348,241,400 − 101,141,687) ≈ 0.78

- The remaining work only needs to be done at 78% efficiency to stay within budget.
- Since the current CPI = 1.67, the project is far ahead of this requirement.

3.2.5. Synthesis

The project is **cost-efficient** but **behind schedule**. the focus must be on **speeding up execution** while maintaining financial discipline to ensure **timely**, **under-budget completion**.

2. Qualitative Data

3.1. Data Collection

- **Data Source:** Surveys and interviews with stakeholders, engineers, and project managers formulate in a questionnaire contain 6 sections (Cost, Schedule, Quality, Performance and EVM) with 34 questions in three languages English, Arabic and French.

Figure 49 : Questionnaire

Source : Author

- **After that all, the next problems are founded:**

- Delay of 2 months in visa of plans
- Delay of 4 months in payment
- High cost of earthworks.
- High cost of infrastructure.
- Inaccurate soil study
- Lack of monthly situations
- Absence of stores
- Poorly thought-out planning
- Lax in the use of material resources despite their availability
- Lack of safety for workers
- Random placement of building materials on site
- Loss of building materials

3.2. Data analysis and discussion

In the following work, the study will focus on the main problems, as follows:

3.2.5. Pareto analysis

Table 10 : Pareto

Source: Author

Section	Problems	Number of problems	Cumuli	% Cumuli
Technical problems	Inaccurate soil study	5	5	42%
	Random placement of building materials on site			
	Lax in the use of material resources despite their availability			
	Absence of stores			
	Lack of safety for workers			
Budget problems	High cost of earthworks	3	8	67%
	High cost of infrastructure			
	Loss of building materials			
Time problems	Delay of 2 months in visa of plans	2	10	83%
	Delay of 4 months in payment			
Management problems	Lack of monthly situations	2	12	100%
	Poorly thought-out planning			

1. Data Overview

The data is structured within a table listing four main types with various problems categorized under them:

- Technical problems (5 issues)
- Budget problems (3 issues)
- Time problems (2 issues)
- Management problems (2 issues)

The metrics are provided below for each of the following categories:

- Frequency count equals number of occurrences like "5" for issues.
- Occurrences running total: Cumulative Frequency (e.g., "5" if Technical, "8" if Budget, etc.).
- Each category's proportion in the total problems is the cumulative percentage (e.g., 42% for Technical, 67% for Budget, etc.).

2. Pareto Principle (80/20 Rule)

The Pareto Principle suggests roughly 80% of effects come from 20% of causes. In this context:

- Technical issues and budget issues do comprise 67% of total problems or 8 of 12 categories.
- All of the 4 Categories: Management problems on their own do reach 100% because of the fact that these categories indicate that they do cover all of the identified issues.

Addressing of Technical and Budget problems could resolve the majority which is 67% of issues. Time and Management in addition would cover all problems.

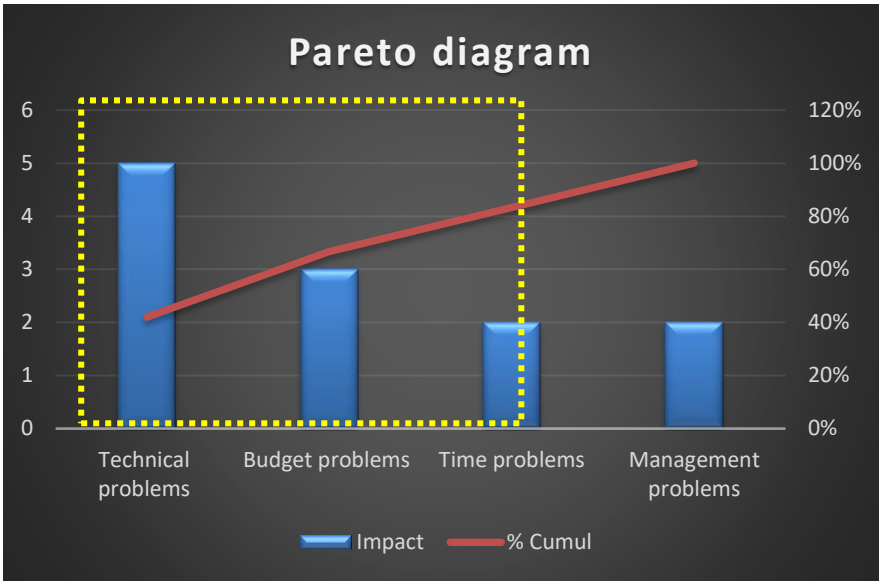


Figure 50 : Pareto Diagram

Source: Author

3. Pareto Diagram Interpretation

A Pareto diagram is described by image two. It includes the following:

- Technical, Budget, and Time Management are some categories ordered by their frequency.
- Cumulative Impact:
  - Technical: ~42%
  - Budget: About 67% (equals 42% plus 25%)
  - Time was about 83%. That includes 16% besides 67%.
  - Management: 83% plus 17% (100%)

In the diagram, a line graph for cumulative percentage and bars for each category (height = frequency) are l shown. Budget problems are causing the "80% threshold" to be crossed, indicating that these two categories are the most critical.

3.2.5. SWOT Matrix

1. **Technical problems**

Table 11 : SWOT analysis for technical problems

Source: Author

Factor	Analysis
Strengths (S)	• **Identified and Documented**: The technical problems are clearly recognized, which provides a basis for targeted corrective action. • **Quantifiable Impact**: With 5 occurrences and 5 impacts (42%), the technical problems are being monitored, making it easier to manage them. • **Experience-Based Awareness**: Repeated issues like inaccurate soil study and random placement of materials suggest a learning curve and opportunity for improved practices.
Weaknesses (W)	• **Inaccurate Soil Studies**: Leads to design and construction flaws, increasing project risk. • **Poor Material Management**: Random placement and lax usage lead to inefficiency and potential waste. • **Lack of Safety Measures**: Endangers workers, leading to possible legal and moral consequences. • **Inadequate Infrastructure (absence of stores)**: Reflects poor planning and logistics. • **Low Impact Resolution Rate**: Despite moderate occurrence, resolution and mitigation efforts appear weak.

Opportunities (O)	• **Implementation of Site Management Systems**: Use of digital tools (like BIM or material tracking software) can streamline resource use and placement. • **Training Programs**: Upskilling the workforce on safety and efficient material handling can reduce technical issues. • **Process Standardization**: Developing standard operating procedures for site studies and logistics can enhance efficiency. • **Investing in Safety Protocols**: Can boost morale, reduce injuries, and improve productivity.
Threats (T)	• **Project Delays and Cost Overruns**: Unresolved technical issues can snowball into time and budget problems. • **Regulatory Sanctions**: Safety violations and substandard practices can lead to penalties. • **Reputation Damage**: Frequent technical issues may affect client trust and future contracts. • **Resource Wastage**: Inefficiencies lead to higher operational costs and environmental impact.

➲ ***Synthesis***

The SWOT analysis of technical problems highlights internal weaknesses such as inaccurate soil studies and lack of safety, which directly affect construction quality and project timelines. However, strengths like the clear identification of these problems open the door to targeted improvements. Addressing these issues through training and site management systems presents key opportunities to enhance performance.

3. Budget problems

Table 12 : SWOT analysis for Budget problems

Source : Author

Factor	Analysis
Strengths (S)	• **Clear Identification of Cost Drivers**: Specific sources of cost issues such as earthworks and infrastructure are known, enabling targeted budgeting. • **Moderate Frequency, High Impact**: Occurs 3 times but with 8 impacts (67%), showing that even a small number of issues can have major financial effects—this clarity helps in prioritizing solutions. • **Awareness of Material Loss**: Recognition of material loss allows for implementing controls to reduce waste and theft.
Weaknesses (W)	• **High Cost of Earthworks and Infrastructure**: Indicates either underestimation in planning or cost inefficiencies. • **Poor Resource Protection**: Loss of building materials reflects weak inventory management and site security. • **Limited Budget Flexibility**: High-cost areas restrict the ability to absorb unexpected expenses. • **Low-Cost Control Mechanisms**: Suggests weak financial oversight and inadequate procurement practices.
Opportunities (O)	• **Cost Optimization Strategies:** Value engineering and alternative material sourcing can help reduce costs.

	• **Improved Procurement Practices:** Centralized purchasing or bulk buying can lower unit costs. • **Technology Adoption:** Using cost control software can enhance budgeting accuracy and track spending in real time. • **Supplier Negotiations:** Renegotiating contracts with vendors could lead to better rates and terms.
Threats (T)	• **Budget Overruns**: Can delay project completion or reduce scope. • **Financial Instability**: High infrastructure costs may lead to liquidity issues or funding shortfalls. • **Loss of Stakeholder Confidence**: Consistently exceeding budgets can erode trust with investors and clients. • **Increased Risk of Corruption or Fraud**: Poor financial tracking and high material loss may open doors for misuse of funds.

➲ ***Synthesis***

The SWOT analysis of budget problems highlights critical weaknesses such as high infrastructure costs and material losses that threaten project stability. However, opportunities exist through cost-saving strategies, better procurement, and digital tracking. Addressing these vulnerabilities can significantly enhance financial control and ensure successful project delivery.

3.2.5. 5W1H Method (Often Mistyped as 5H)

- Technical Problems

Table 13 : 5W1H analysis of technical problems

Source: Author

Question	Answer
Who	Site engineers, construction workers, logistics staff, safety officers.
What	Issues such as inaccurate soil study, poor material placement, lax use of resources, absence of stores, and lack of safety for workers.
When	During early site preparation, throughout material handling and construction phases.
Where	On the construction site—especially areas for material storage, foundations, and high-risk zones.
Why	Caused by poor planning, lack of technical expertise, inadequate safety protocols, and weak logistical coordination.
How	Due to insufficient site assessments, no standardized procedures, limited supervision, and failure to enforce safety standards or manage materials efficiently.

➲ ***Synthesis***

The 5W1H method is a practical tool used to analyze technical problems by asking Who, What, When, Where, why, and how. It helps identify root causes by clearly defining the responsibilities, timings, and reasons behind technical failures on construction sites. This structured approach supports better planning, communication, and targeted problem-solving.

- Budget Problems

Table 14 : 5W1H analysis of Budget problems

Source: Author

Question	Answer
Who	Project managers, procurement officers, financial controllers, and contractors.
What	High cost of earthworks and infrastructure, and loss of building materials.
When	During budgeting, procurement, and construction phases—especially early in the project.
Where	Across procurement processes, construction site, and financial departments.
Why	Caused by poor cost estimation, lack of cost control measures, inadequate inventory protection, and possibly inefficient procurement.
How	Through overestimated expenses, material losses due to theft/waste, and lack of financial oversight or control tools.

➲ ***Synthesis***

The 5W1H method helps identify the root causes of budget problems in construction projects by asking Who, What, When, Where, why, and how. It clarifies which actors and phases are responsible for cost overruns and inefficiencies. This structured questioning supports better planning, cost control, and targeted corrective actions.

3. Amelioration and simulation

Amelioration and simulation play a vital role in enhancing project performance by identifying and testing potential improvements. Through simulated adjustments in cost and schedule parameters, project managers can forecast outcomes and evaluate alternative strategies. This approach helps optimize resource allocation and strengthen decision-making for future project phases.

Based on the reference article under the title of *"Application of Earned Value Management in Construction Projects: A Case Study Approach with Simulation and Improvement Strategies"* by *"Ahmed Mahmoud El-Sayed" ,* the following solutions can be deduced *:[82]*

3.1. The proposed solutions (brainstorming)

3.2.5. Resource Reallocation and Optimization

- ✓ Increase labor efficiency: Assign skilled workers to critical path activities and implement multi-shift schedules (e.g., two 8-hour shifts).
- ✓ Optimize equipment usage: Prevent idle machinery and reduce equipment rental durations by better scheduling.
- ✓ Cross-train workers to handle multiple tasks, minimizing downtime between activity transitions.

3.2.5. Parallel Activity Execution

- ✓ Restructure work sequencing to allow overlapping of certain non-dependent activities.
- ✓ Example: Start interior works (e.g., electrical, plumbing) before full structural completion if areas are accessible.
- ✓ Use modular or prefabricated components to reduce on-site construction time (e.g., prefabricated classrooms or roof trusses).

3.2.5. Strengthen Site Management

- ✓ Appoint dedicated task leads per major work package with daily KPIs.
- ✓ Implement daily site coordination meetings to ensure tight progress tracking and issue resolution.

- ✓ Utilize Earned Value dashboards on site for real-time performance tracking.

3.2.5. Procurement and Logistics Acceleration

- ✓ Secure long-lead materials (e.g., tiles, windows, equipment) early to prevent delivery delays.
- ✓ Partner with local suppliers to ensure faster restocking and reduce transportation costs.
- ✓ Batch deliveries smartly to reduce storage issues and double-handling costs.
- ✓ Quality-First Execution
- ✓ Ensure first-time-right work to avoid rework (a major hidden cost).
- ✓ Deploy QA/QC teams in parallel with execution teams to detect and correct defects early.

3.2.5. Cost Control Measures

- ✓ Renegotiate or reassess contracts with subcontractors for a fixed milestone-based payment plan instead of variable hourly rates.
- ✓ Limit overtime and weekend bonuses unless justified by high-impact critical tasks.
- ✓ Monitor and reduce material wastage through better supervision and site storage practices.

3.2.5. Continuous Monitoring and Adjustments

- ✓ Use weekly Earned Value updates to adjust forecasts and reallocate resources dynamically.
- ✓ Introduce contingency response protocols to rapidly deal with schedule slippages.

3.2. Simulated scenario

After carrying out the previously proposed corrective actions, it is possible to obtain by approximation a curve similar to the following:

3.2.5. Updated Assumptions:

- **AC (Actual Cost)** increases more steeply than before, indicating higher expenses.
- **Project is completed at Month 11**, not Month 12.
- **EV (Earned Value)** must reach the BAC (DZD 348,241,400) by Month 11.
- We'll assume linear progress from Month 6 to Month 11.

3.2.5. Recalculated Simulation

Constants :

- **BAC** = DZD 348,241,400
- **EV at Month 6** = DZD 155,414,787
- **AC at Month 6** = DZD 101,141,687
- **New Duration** = 5 months (Month 7 to Month 11)

New EV and AC Formulas:

- **EV (Evenly distributed to Month 11):**

EVMonthly = BAC − EVM6 / 5 = 348,241,400 − 155,414,787 / 5 = 38,565,322.6
EVMn = EVM6 +] (n – 6) × 38,565,323]

(n = 7 to 11)

- **AC (Increased spending: assume 10% more than previous CPI ≈ 1.0 plan)**

New EAC = 226,630,448 × 1.1 = 249,293,493
ACmonthly = NewEAC – ACM6 / 5
ACmonthly = 249,293,493 − 101,141,687 / 5 = 29,630,361.2
ACMn = ACM6 +] (n – 6) × 29,630,361.2]

(n = 7 to 11)

New Data Table

Table 15 : Simulation of EV and AC

Source: Author

Month	PV (DZD)	EV (DZD)	AC (DZD)
Month 1	DZD 7,183,225	DZD -	DZD 7,892,815
Month 2	DZD 22,949,725	DZD -	DZD 19,732,037
Month 3	DZD 45,124,325	DZD 39,464,075	DZD 31,571,260
Month 4	DZD 66,908,933	DZD 39,464,075	DZD 54,761,402
Month 5	DZD 81,115,467	DZD 39,464,075	DZD 77,951,545
Month 6	DZD 99,413,769	DZD 155,414,787	DZD 101,141,687
Month 7	DZD 117,712,072	DZD 193,980,110	DZD 130,772,048
Month 8	DZD 149,328,574	DZD 232,545,433	DZD 160,402,409
Month 9	DZD 185,384,477	DZD 271,110,756	DZD 190,032,770
Month 10	DZD 239,944,661	DZD 309,676,079	DZD 219,663,131
Month 11	DZD 294,793,056	DZD 348,241,400	DZD 249,293,493
Month 12	DZD 348,241,400	DZD -	DZD -

New Graph of Curves (PV, AC and EV)

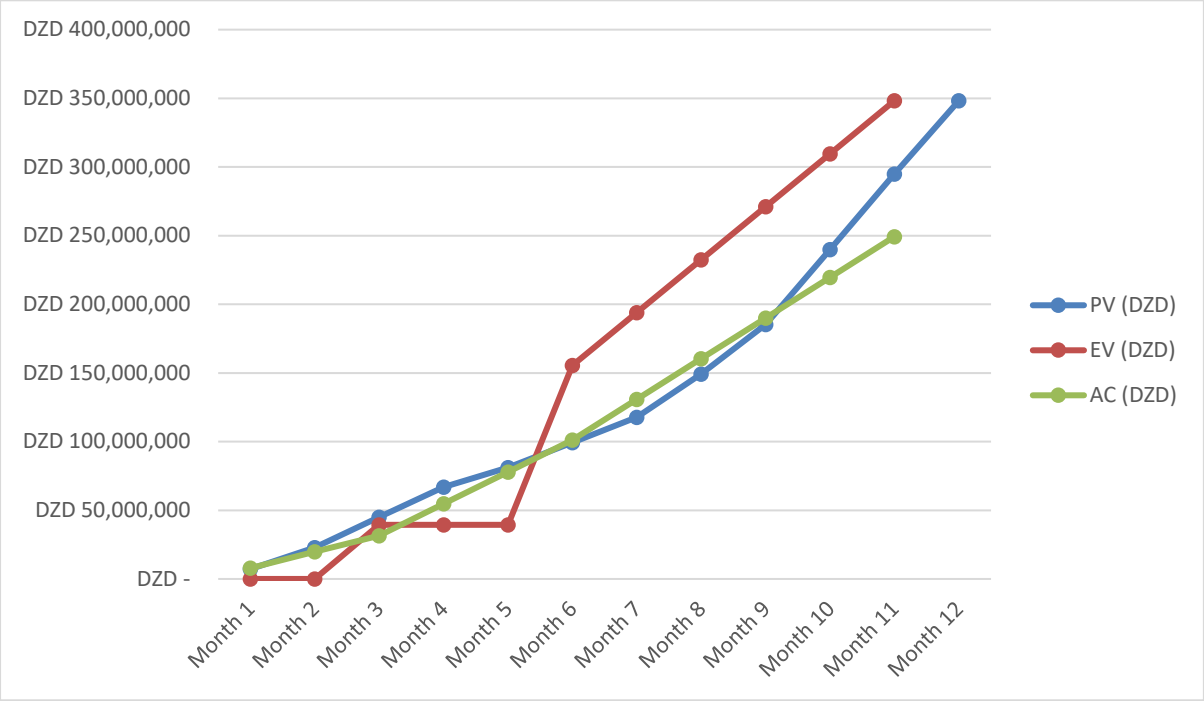


Figure 51 : EVM Diagram Simulated

Source: Author

Outcomes:

- **Project finishes at Month 11**, one month earlier.
- **Total AC** rises to **DZD 249,293,493,** about 10% higher than the previous EAC.
- **CV at completion**:

$$CV=EV-AC=348,241,400-249,293,493=+98,947,907$$

→ Still significantly under budget (~28% savings).

- **SV at completion**:

$$SV=EV-PV=348,241,400-294,793,056=+53,448,344$$

3.3. Comparison between project reel situation and simulated one

3.3.1. Comparison Table

Table 16 : Comparison between reel situation and simulation

Source : Author

Metric	Initial Analysis (Months 1-6)	Simulated Scenario (Months 7-11)	Conclusion
Schedule (SV)	Delays early, recovery in Month 6	Early finish (+1 month)	Corrective actions (e.g., parallel work, resource reallocation) improved pace.
Cost (CV)	Mixed (over/under budget)	Consistently under budget	Higher spending in simulation still yielded savings due to strong initial CPI.
EAC	DZD 226.6M	DZD 249.3M (+10%)	Simulation confirmed feasibility of under-budget completion.
SPI/CPI	SPI: 0.48–1.56; CPI: 0.5–1.53	SPI: >1; CPI: ~1.4	Efficiency gains sustained in simulation.

3.3.2. Synthesis

- **EVM Analysis:** Highlighted early inefficiencies (delays, cost spikes) but demonstrated recovery potential.
- **Simulation:** Validated those proactive measures (e.g., resource optimization, accelerated procurement) could:
    - **Save time** (finish early).
    - **Save costs** (28% under BAC).
- **Recommendation:** Use EVM continuously to monitor deviations and adjust strategies dynamically.

➲ **Final Insight:** The simulation aligns with EVM principles, proving that data-driven adjustments can mitigate risks and enhance outcomes in construction projects.

Conclusion

This chapter examined the real-world implementation of Earned Value Management (EVM) in the building of a conventional high school in ELGANTRA, ANNABA province, which was carried out by the business "DIB SALAH." The study showed how EVM is an effective tool for tracking project performance, spotting deviations, and supporting data-driven decision-making through a combination of quantitative and qualitative analysis.

The quantitative analysis revealed critical insights into the project's financial and temporal health, with key performance indicators (KPIs) such as Cost Variance (CV), Schedule

Variance (SV), Cost Performance Index (CPI), and Schedule Performance Index (SPI) providing a clear snapshot of progress. While the project exhibited cost efficiency (CPI > 1 in later months), it faced schedule delays (SPI < 1 in early months), underscoring the need for proactive corrective actions.

Qualitative data, gathered through stakeholder interviews and surveys, highlighted administrative and technical challenges, such as payment delays and high infrastructure costs. Tools like Pareto analysis, SWOT matrices, and the 5W1H method were employed to dissect these issues, prioritize solutions, and align project goals with regulatory and operational constraints.

The chapter concluded with a simulated scenario that confirmed how well suggested remedial actions, like resource reallocation and parallel task execution, improved project results. The project team might improve performance, accountability, and transparency by incorporating EVM into routine management procedures.

In conclusion, this chapter highlights how EVM has the ability to revolutionize the Algerian construction industry. When used methodically, EVM not only reduces risks but also guarantees that projects are completed on schedule and on budget, opening the door for long-term, steady industry growth. The results reaffirm the importance of EVM as a pillar of contemporary project management and lay the groundwork for additional investigation of managerial tactics in the ensuing chapters.

General Conclusion

The present study set out to evaluate the effectiveness of the Earned Value Management (EVM) method in monitoring and improving the performance of educational construction projects, with a particular focus on the case of a standard high school in Elgantra, Annaba. Through a comprehensive approach combining theoretical exploration, contextual analysis, and practical application, the research demonstrated that EVM is a powerful tool for integrating scope, cost, and schedule performance in a single, coherent framework.

The theoretical part provided a solid foundation for understanding the principles, benefits, and challenges of EVM, particularly in the context of the construction industry. The methodological part contextualized the project and the company "DIB SALAH," highlighting operational practices and project constraints. The managerial part illustrated the application of EVM tools and indicators, showing how real-time data can reveal deviations, inform decisions, and promote corrective action.

Results showed that despite certain challenges, such as data collection complexity and organizational resistance, the application of EVM contributed to better control of time and costs, improved resource allocation, and enhanced project forecasting. The analysis also offered recommendations for improving project performance and institutionalizing EVM practices within Algerian construction companies.

In conclusion, EVM proves to be not only a performance tracking tool but also a strategic management method that supports transparency, efficiency, and accountability. Its implementation can play a significant role in elevating project management standards across Algeria's construction sector, especially in critical areas like educational infrastructure.

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The annexes

Annexes No. 01

Questionnaire

Questionnaire: Cost, Schedule, Quality and EVM in 1000 students High School Construction Project

Section 1: General Information

1. What is your role in the project?

- Project Manager
- Team Member
- Contractor
- Stakeholder (e.g., school administration, government representative)
- Other (please specify): _____

2. How long have you been involved in the project?

- Less than 6 months
- 6 months to 1 year
- More than 1 year

Section 2: Cost Management

3. How effective has the project been in managing costs?

- Very effective
- Somewhat effective
- Neutral
- Somewhat ineffective
- Very ineffective

4. Has the project stayed within the planned budget?

- Yes, completely
- Mostly
- Partially
- No, significant overruns occurred

5. What tools or methods were used to track and control costs?

- Earned Value Management (EVM)
- Budget tracking software
- Manual spreadsheets
- Other (please specify): _____

6. Were cost overruns identified early enough to take corrective actions?

- Yes, always
- Sometimes
- Rarely
- No, overruns were identified too late

7. What were the main causes of cost overruns (if any)?

- Delays in material delivery
- Poor planning
- Changes in project scope
- Contractor inefficiencies
- Other (please specify): _____

Section 3: Schedule Management

8. How effective has the project been in adhering to the planned schedule?

- Very effective
- Somewhat effective
- Neutral
- Somewhat ineffective
- Very ineffective

9. Was the project completed on time?

- Yes, ahead of schedule
- Yes, on schedule
- No, slightly delayed

- No, significantly delayed

10. What tools or methods were used to track and control the schedule?

- Gantt charts
- Critical Path Method (CPM)
- Earned Value Management (EVM)
- Other (please specify): _____

11. Were schedule delays identified early enough to take corrective actions?

- Yes, always
- Sometimes
- Rarely
- No, delays were identified too late

12. What were the main causes of schedule delays (if any)?

- Weather conditions
- Delays in material delivery
- Labor shortages
- Poor planning
- Other (please specify): _____

Section 4: Quality Management

13. How would you rate the overall quality of the construction work?

- Excellent
- Good
- Average
- Poor
- Very poor

14. Were quality standards clearly defined and communicated to all parties?

- Yes, completely
- Mostly
- Partially
- No, not at all

15. What methods were used to ensure quality control?

- Regular inspections
- Third-party quality audits
- Contractor self-reporting
- Other (please specify): _____

16. Were there any major quality issues during the project?

- Yes (please describe): _____
- No

17. How were quality issues addressed when they arose?

- Immediate corrective actions
- Delayed corrective actions
- No corrective actions taken
- Other (please specify): _____

Section 5: Overall Project Performance

18. How satisfied are you with the overall performance of the project?

- Very satisfied
- Somewhat satisfied
- Neutral
- Somewhat dissatisfied
- Very dissatisfied

19. What were the key successes of the project?

- Completed on time
- Stayed within budget
- High-quality construction

- Effective communication
- Other (please specify): _____

20. What were the key challenges of the project?

- Cost overruns
- Schedule delays
- Quality issues
- Poor communication
- Other (please specify): _____

21. What recommendations do you have for improving future projects?

- Better planning
- Improved communication
- More training on tools like EVM
- Other (please specify): _____

Section 6: Earned Value Management (EVM)

Understanding EVM

22. Are you familiar with the Earned Value Management (EVM) method?

- Yes, I have a deep understanding of EVM.
- Yes, I have a basic understanding of EVM.
- No, I have heard of EVM but don't understand it.
- No, I have never heard of EVM.

23. How did you learn about EVM?

- Formal training or certification.
- On-the-job experience.
- Colleagues or team members.
- Self-study (books, online resources).
- Other (please specify): _____

24. Do you feel confident in applying EVM concepts (e.g., PV, EV, AC, CV, SV, CPI, SPI) in your work?

- Yes, very confident.
- Somewhat confident.
- Neutral.
- Not very confident.
- Not confident at all.

Advantages of EVM

25. What do you see as the main advantages of using EVM in this project? (Select all that apply)

- Provides early warning of cost overruns.
- Helps track project progress effectively.
- Improves decision-making with data-driven insights.
- Enhances communication with stakeholders.
- Aligns project performance with goals.
- Other (please specify): _____

26. Has EVM helped improve the project's cost control?

- Yes, significantly.
- Yes, somewhat.
- No, not really.
- No, it made things worse.

27. Has EVM helped improve the project's schedule adherence?

- Yes, significantly.
- Yes, somewhat.
- No, not really.
- No, it made things worse.

28. Has EVM improved transparency and communication among project stakeholders?

- Yes, significantly.
- Yes, somewhat.
- No, not really.
- No, it made things worse.

Challenges of EVM

29. What challenges have you faced in using EVM in this project? (Select all that apply)

- Complexity of EVM concepts and calculations.
- Difficulty in collecting accurate data.
- Lack of training or understanding among team members.
- Resistance to change from team members or stakeholders.
- Time-consuming to implement and maintain.
- Other (please specify): _____

30. Do you feel that EVM added unnecessary complexity to the project?

- Yes, significantly.
- Yes, somewhat.
- No, it was manageable.
- No, it simplified project management.

31. Were there any misunderstandings or misapplications of EVM in this project?

- Yes (please describe): _____
- No

Recommendations for EVM in the Company

32. What improvements would you suggest for implementing EVM in future projects? (Select all that apply)

- Provide more training on EVM concepts and tools.
- Simplify EVM reporting and dashboards.
- Integrate EVM with other project management tools.

- Assign dedicated EVM specialists to support the team.
- Improve data collection processes.
- Other (please specify): _____

33. Should EVM be used in all future projects in the company?

- Yes, for all projects.
- Yes, but only for large or complex projects.
- No, it is not necessary.
- Not sure.

34. What additional support or resources would help you use EVM more effectively?

- More training sessions.
- Better software tools.
- Clearer guidelines and templates.
- Dedicated EVM support staff.
- Other (please specify): _____

استبيان: التكلفة، الجدول الزمني، الجودة وإدارة القيمة المكتسبة في مشروع بناء مدرسة ثانويه ل 1000 تلميذ

القسم 1: المعلومات العامة

- ما هو دورك في المشروع؟
  - مدير المشروع
  - عضو الفريق
  - مقاول
  - صاحب مصلحة (مثل إدارة المدرسة، ممثل حكومي)
  - أخرى (يرجى التحديد) :

2.منذ متى وأنت مشارك في المشروع؟

- أقل من 6 أشهر
- من 6 أشهر إلى سنة
- أكثر من سنة

القسم 2: إدارة التكلفة

3.ما مدى فعالية المشروع في إدارة التكاليف

- فعالة جدًا
- فعالة إلى حد ما
- محايد
- غير فعالة إلى حد ما
- غير فعالة على الإطلاق

4.هل التزم المشروع بالميزانية المخطط لها؟

- نعم، بالكامل
- إلى حد كبير
- جزئيًا
- لا، حدثت تجاوزات كبيرة في التكلفة

5.ما هي الأدوات أو الأساليب المستخدمة لتتبع والتحكم في التكاليف؟

- إدارة القيمة المكتسبة(EVM)
- برامج تتبع الميزانية
- جداول بيانات يدوية
- أخرى (يرجى التحديد):

6.هل تم تحديد تجاوزات التكلفة مبكرًا بما يكفي لاتخاذ إجراءات تصحيحية؟

- نعم، دائمًا
- أحيانًا
- نادرًا
- لا، تم تحديد التجاوزات متأخرًا جدًا

7.ما هي الأسباب الرئيسية لتجاوزات التكلفة (إن وجدت) ؟

- تأخر تسليم المواد
- سوء التخطيط

- تغييرات في نطاق المشروع
- عدم كفاءة المقاولين
- أخرى (يرجى التحديد) :

القسم 3: إدارة الجدول الزمني

8. ما مدى فعالية المشروع في الالتزام بالجدول الزمني المخطط؟

- فعالة جدًا
- فعالة إلى حد ما
- محايد
- غير فعالة إلى حد ما
- غير فعالة على الإطلاق

9. هل تم الانتهاء من المشروع في الوقت المحدد؟

- نعم، قبل الموعد المخطط
- نعم، في الموعد المخطط
- لا، تأخر قليلاً
- لا، تأخر بشكل كبير

10. ما هي الأدوات أو الأساليب المستخدمة لتتبع والتحكم في الجدول الزمني؟

- مخططات جانت

- طريقة المسار الحرج(CPM)
- إدارة القيمة المكتسبة(EVM)
- أخرى (يرجى التحديد)_ :

11. هل تم تحديد التأخيرات في الجدول الزمني مبكرًا بما يكفي لاتخاذ إجراءات تصحيحية؟

- نعم، دائمًا
- أحيانًا
- نادرًا
- لا، تم تحديد التأخيرات متأخرًا جدًا

12. ما هي الأسباب الرئيسية للتأخيرات في الجدول الزمني (إن وجدت)؟

- الظروف الجوية

- تأخر تسليم المواد
- نقص العمالة
- سوء التخطيط
- أخرى (يرجى التحديد) :

القسم 4: إدارة الجودة

13. كيف تقيم الجودة العامة لأعمال البناء؟

- ممتازة
- جيدة
- متوسطة
- ضعيفة
- ضعيفة جدًا

14. هل تم تحديد معايير الجودة بشكل واضح وإبلاغها لجميع الأطراف؟

- نعم، بالكامل
- إلى حد كبير
- جزئيًا
- لا، لم يتم إبلاغها على الإطلاق

15. ما هي الأساليب المستخدمة لضمان مراقبة الجودة؟

- عمليات التفتيش المنتظمة
- عمليات تدقيق الجودة من طرف ثالث
- تقارير ذاتية من المقاولين
- أخرى (يرجى التحديد) :

16. هل كانت هناك أي مشاكل جودة كبيرة خلال المشروع؟

- نعم (يرجى الوصف) :
- لا

17. كيف تم التعامل مع مشاكل الجودة عند ظهورها؟

- إجراءات تصحيحية فورية
- إجراءات تصحيحية متأخرة
- لم يتم اتخاذ أي إجراءات تصحيحية

- أخرى (يرجى التحديد) :

القسم 5: الأداء العام للمشروع

18.ما مدى رضاك عن الأداء العام للمشروع؟

- راضٍ جدًا
- راضٍ إلى حد ما
- محايد
- غير راضٍ إلى حد ما
- غير راضٍ على الإطلاق

19.ما هي النجاحات الرئيسية للمشروع؟

- الانتهاء في الوقت المحدد
- الالتزام بالميزانية
- جودة البناء العالية
- التواصل الفعال
- أخرى (يرجى التحديد) :

20.ما هي التحديات الرئيسية للمشروع؟

- تجاوزات التكلفة
- تأخيرات الجدول الزمني
- مشاكل الجودة
- سوء التواصل
- أخرى (يرجى التحديد) :

21.ما هي التوصيات التي لديك لتحسين المشاريع المستقبلية؟

- تحسين التخطيط
- تحسين التواصل
- المزيد من التدريب على أدوات مثلEVM
- أخرى (يرجى التحديد) :

القسم 6: إدارة القيمة المكتسبة(EVM)

فهمEVM

22.هل أنت على دراية بطريقة إدارة القيمة المكتسبة(EVM) ؟

- نعم، لدي فهم عميق لـ.EVM
- نعم، لدي فهم أساسي لـ.EVM
- لا، سمعت عن EVM ولكنني لا أفهمها.
- لا، لم أسمع عن EVM من قبل.

23.كيف تعلمت عنEVM ؟

- تدريب رسمي أو شهادة.
- خبرة عملية.
- زملاء أو أعضاء الفريق.
- دراسة ذاتية (كتب، موارد عبر الإنترنت).
- أخرى (يرجى التحديد) :

24.هل تشعر بالثقة في تطبيق مفاهيم) EVM مثلPV ، EV، AC، CV، SV، CPI، SPI)في عملك؟

- نعم، واثق جدًا.
- واثق إلى حد ما.
- محايد.
- غير واثق جدًا.
- غير واثق على الإطلاق.

مزاياEVM

25.ما هي المزايا الرئيسية لاستخدام EVM في هذا المشروع؟ (اختر جميع ما ينطبق)

- يوفر إنذارًا مبكرًا لتجاوزات التكلفة.
- يساعد في تتبع تقدم المشروع بشكل فعال.
- يحسن صنع القرار باستخدام رؤى تعتمد على البيانات.
- يعزز التواصل مع أصحاب المصلحة.
- ينسجم أداء المشروع مع الأهداف.
- أخرى (يرجى التحديد) :

26.هل ساعد EVM في تحسين التحكم في تكاليف المشروع؟

- نعم، بشكل كبير.
- نعم، إلى حد ما.

- لا، ليس حقًا.
- لا، لقد جعل الأمور أسوأ.

27.هل ساعد EVM في تحسين الالتزام بالجدول الزمني للمشروع؟

- نعم، بشكل كبير.
- نعم، إلى حد ما.
- لا، ليس حقًا.
- لا، لقد جعل الأمور أسوأ.

28.هل حسّن EVM الشفافية والتواصل بين أصحاب المصلحة في المشروع؟

- نعم، بشكل كبير.
- نعم، إلى حد ما.
- لا، ليس حقًا.
- لا، لقد جعل الأمور أسوأ.

تحدياتEVM

29.ما هي التحديات التي واجهتها في استخدام EVM في هذا المشروع؟ (اختر جميع ما ينطبق)

- تعقيد مفاهيم وحسابات.EVM
- صعوبة جمع البيانات الدقيقة.
- نقص التدريب أو الفهم بين أعضاء الفريق.
- مقاومة التغيير من أعضاء الفريق أو أصحاب المصلحة.
- استهلاك الوقت في التنفيذ والصيانة.
- أخرى (يرجى التحديد) :

30.هل شعرت أن EVM أضاف تعقيدًا غير ضروري للمشروع؟

- نعم، بشكل كبير.
- نعم، إلى حد ما.
- لا، كان يمكن التحكم فيه.
- لا، لقد بسّط إدارة المشروع.

31.هل كانت هناك أي سوء فهم أو تطبيق خاطئ لـ EVM في هذا المشروع؟

- نعم (يرجى الوصف) :
- لا

توصيات لـ EVM في الشركة

32.ما هي التحسينات التي تقترحها لتطبيق EVM في المشاريع المستقبلية؟ (اختر جميع ما ينطبق)

- توفير المزيد من التدريب على مفاهيم وأدوات.EVM
- تبسيط تقارير ولوحات.EVM
- دمج EVM مع أدوات إدارة المشاريع الأخرى.
- تعيين متخصصين مخصصين لـ EVM لدعم الفريق.
- تحسين عمليات جمع البيانات.
- أخرى (يرجى التحديد)_ :

33.هل يجب استخدام EVM في جميع المشاريع المستقبلية في الشركة؟

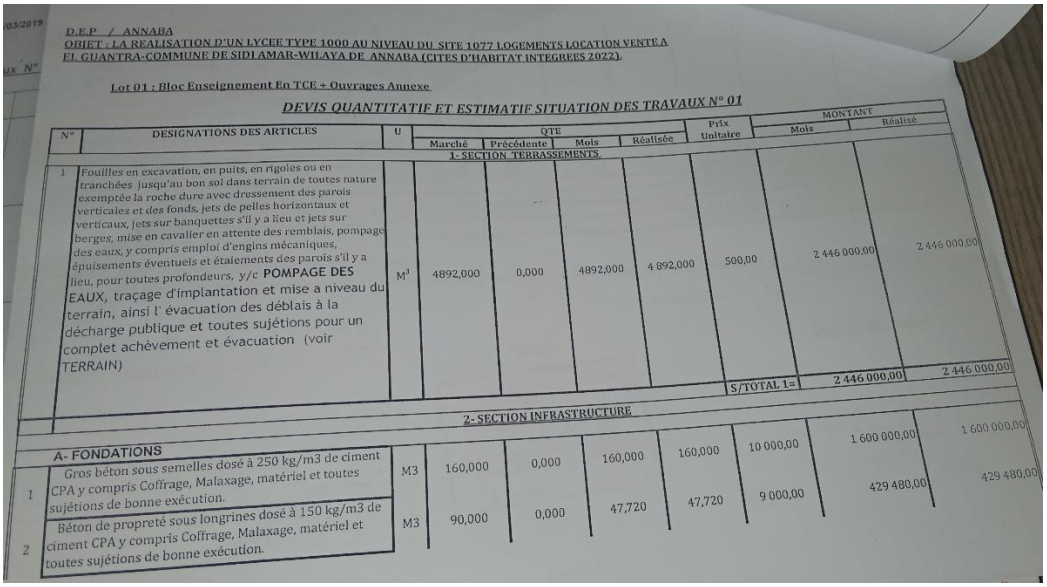
- نعم، لجميع المشاريع.
- نعم، ولكن فقط للمشاريع الكبيرة أو المعقدة.
- لا، ليس ضروريًا.
- غير متأكد.

34.ما هي الموارد أو الدعم الإضافي الذي سيساعدك على استخدام EVM بشكل أكثر فعالية؟

- المزيد من جلسات التدريب.
- أدوات برمجية أفضل.
- إرشادات وقوالب أكثر وضوحًا.
- موظفين دعم مخصصين لـ.EVM
- أخرى

Annexes No. 02

Detailed Situation No. 01



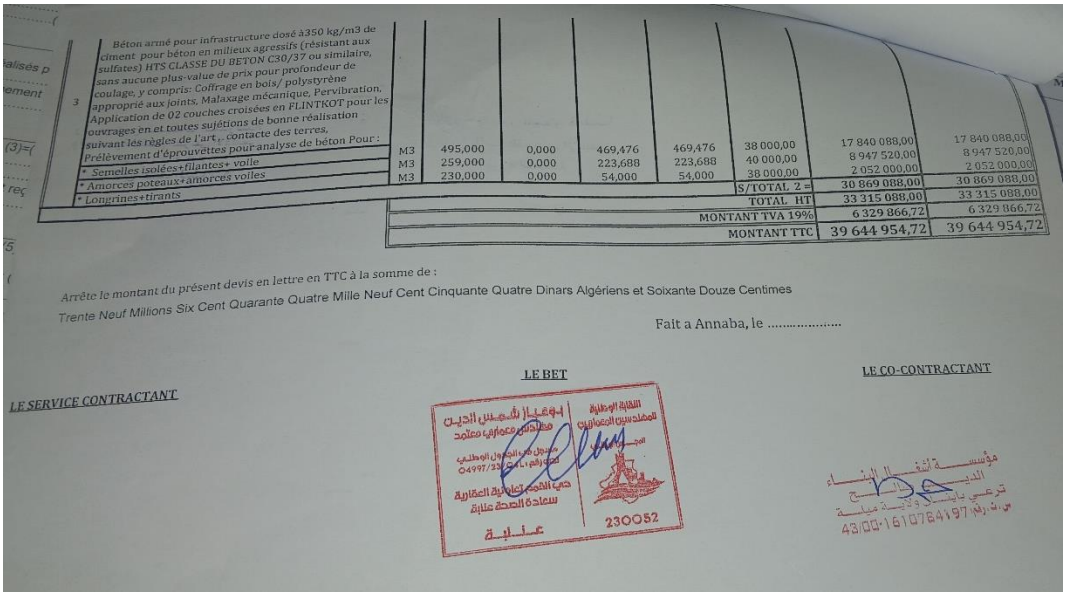
D.E.P / ANNABA

OBJET : LA REALISATION D'UN LYCEE TYPE 1000 AU NIVEAU DU SITE 1077 LOGEMENTS LOCATION VENTE A EL GUANTRA-COMMUNE DE SIDI AMAR-WILAYA DE ANNABA (CITES D'HABITAT INTEGREES 2022).

Lot 01 : Bloc Enseignement En TCE + Ouvrages Annexe

DEVIS QUANTITATIF ET ESTIMATIF SITUATION DES TRAVAUX N° 01

N°	DESIGNATIONS DES ARTICLES	U	QTE				Prix Unitaire	MONTANT	
			Marché	Précédente	Mois	Réalisée		Mois	Réalisé
	1- SECTION TERRASSEMENTS								
1	Fouilles en excavation, en puits, en rigoles ou en tranchées jusqu'au bon sol dans terrain de toutes nature exemptée la roche dure avec dressement des parois verticales et des fonds, jets de pelles horizontaux et verticaux, jets sur banquettes s'il y a lieu et jets sur berges, mise en cavalier en attente des remblais, pompage des eaux, y compris emploi d'engins mécaniques, épuisements éventuels et étaiements des parois s'il y a lieu, pour toutes profondeurs, y/c POMPAGE DES EAUX, traçage d'implantation et mise a niveau du terrain, ainsi l' évacuation des déblais à la décharge publique et toutes sujétions pour un complet achèvement et évacuation (voir TERRAIN)	M³	4892,000	0,000	4892,000	4 892,000	500,00	2 446 000,00	2 446 000,00
							S/TOTAL 1=	2 446 000,00	2 446 000,00
	2- SECTION INFRASTRUCTURE								
	A- FONDATIONS								
1	Gros béton sous semelles dosé à 250 kg/m3 de ciment CPA y compris Coffrage, Malaxage, matériel et toutes sujétions de bonne exécution.	M3	160,000	0,000	160,000	160,000	10 000,00	1 600 000,00	1 600 000,00
2	Béton de propreté sous longrines dosé à 150 kg/m3 de ciment CPA y compris Coffrage, Malaxage, matériel et toutes sujétions de bonne exécution.	M3	90,000	0,000	47,720	47,720	9 000,00	429 480,00	429 480,00



3	Béton armé pour infrastructure dosé à 350 kg/m3 de ciment pour béton en milieux agressifs (résistant aux sulfates) HTS CLASSE DU BETON C30/37 ou similaire, sans aucune plus-value de prix pour profondeur de coulage, y compris: Coffrage en bois/ polystyrène approprié aux joints, Malaxage mécanique, Pervibration, Application de 02 couches croisées en FLINTKOT pour les ouvrages en et toutes sujétions de bonne réalisation suivant les règles de l'art,. contacte des terres,								
	Prélèvement d'éprouvettes pour analyse de béton Pour :	M3	495,000	0,000	469,476	469,476	38 000,00	17 840 088,00	17 840 088,00
	* Semelles isolées+filantes+ voile	M3	259,000	0,000	223,688	223,688	40 000,00	8 947 520,00	8 947 520,00
	* Amorces poteaux+amorces voiles	M3	230,000	0,000	54,000	54,000	38 000,00	2 052 000,00	2 052 000,00
	* Longrines+tirants						S/TOTAL 2 =	30 869 088,00	30 869 088,00
							TOTAL HT	33 315 088,00	33 315 088,00
							MONTANT TVA 19%	6 329 866,72	6 329 866,72
							MONTANT TTC	39 644 954,72	39 644 954,72

Arrête le montant du présent devis en lettre en TTC à la somme de :

Trente Neuf Millions Six Cent Quarante Quatre Mille Neuf Cent Cinquante Quatre Dinars Algériens et Soixante Douze Centimes

Fait a Annaba, le .....

LE SERVICE CONTRACTANT

LE BET

LE CO-CONTRACTANT

Annexes No. 03

Detailed Situation No. 02

No.	ITEM DESIGNATIONS	U	QTEPrix					AMOUNT	
			Market	Previous	Month	Achieved	Unitair	Month	Realised
1. EARTHWORKS SECTION									
1	Excavations in excavations, shafts, ditches or trenches to the good ground in ground of all kinds exempted from hard rock, with vertical walls and bottoms, horizontal and vertical shovel throws, jets on benches if necessary and jets on banks, horseback riding while waiting for embankments, pumping of water, including the use of mechanical equipment, possible exhaustion and shoring of the walls if necessary, for all depths, including water pumping, layout and levelling of the ground, as well as the removal of excavated material to the public landfill and all constraints for complete completion and disposal (see LAND)	M3	4892.000	4892.000	0.000	4,892.000	500.00	0.00	2,446,000.00
2	Backfilling of the excavations, carried out in successive layers of 0.20 m including watering,	M3	3978.000	0.000	3978.000	3,978.000	200.00	795,600.00	795,600.00