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The Impact of Engagement Delivery Models on Project Profitability: A Study in Automotive Consultancy

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Abstract

This study examines the impact of the two primary Engagement Delivery Models (EDMs), Time and Material (T&M) and Fixed Price (FP), on profitability and efficiency in the automotive consultancy sector. A literature review was conducted to investigate EDM applications across different industries, highlighting a lack of research specifically addressing the automotive sector. While engagement models have been extensively analysed in IT and software development, their adaptation within Original Equipment Manufacturers (OEMs) and consulting firms remains largely unexplored. The analysis suggests that profitability drivers vary between the two models, with project size playing a key role in T&M contracts, while cost control represents the primary challenge in FP engagements. Additionally, the influence of offshore resources allocation, governance structure, and contractual constraints on supplier margins and overall project success is examined. To validate these hypotheses, an empirical analysis was performed using a Capgemini Engineering dataset, assessing the impact of worked days, average cost, turnover, and governance complexity on financial performance. The findings provide practical insights for both researchers and industry professionals, presenting a data-driven approach to EDM selection in automotive consultancy.

Summary

1 Introduction

1.1 Context and relevance of outsourcing in the automotive industry

Outsourcing has revolutionized the automotive industry, profoundly reshaping its operational and strategic structure. In the early 20th century, automotive companies operated under a vertically integrated model, where every phase of production was managed internally. This approach ensured direct control over quality and costs, proving particularly effective in an era characterized by simple technologies and limited competition.

As vehicle demand increased, the integrated model reached its peak. Largest companies built massive industrial ecosystems. However, as technological complexity grew and globalization expanded, this model began to reveal its limitations. The increasing pressure to innovate quickly and respond to the needs of an increasingly diverse market led automotive manufacturers to deeply reconsider their operational strategies.

The automotive industry began to approach a radical transformation. The need to reduce costs, increase flexibility, and access advanced technological expertise drove Original Equipment Manufacturers (OEMs) to outsource non-strategic activities.

During the 1980s and 1990s, the industry met the need of a new approach, which relied on close collaboration with suppliers, allowed manufacturers to minimize waste and inventory, improving operational flexibility. The success led many companies to adopt similar models, contributing to the fragmentation of the industry and the creation of global supply chains.

The expansion of global supply chains enabled manufacturers to collaborate with external suppliers for cost-competitive component production. Some companies emerged as strategic partners, providing advanced technological solutions and becoming key players in a layered and interconnected production network.

With the introduction of advanced systems such as infotainment, electric powertrains, and ADAS sensors, OEMs have found it more convenient to collaborate with specialized external suppliers rather than develop these capabilities internally. External companies started providing advanced solutions that accelerate development times and enhance vehicle performance. This approach allows OEMs to focus on key activities such as vehicle design and brand management.

From an economic perspective, outsourcing helps convert fixed costs into variable costs, improving financial resilience. Entrusting Tier 1 and 2 suppliers with the production of standardized components reduces infrastructure investments and allows OEMs to allocate resources toward innovation.

Globalization has further strengthened outsourcing, enabling OEMs to exploiting economies of scale and benefit from lower costs in emerging markets. However, this strategy is not without risks, as geopolitical tensions and dependency on global suppliers pose significant challenges.

Despite its advantages, outsourcing presents significant risks. Dependence on suppliers can expose OEMs to delays, quality issues, or operational disruptions.

Another major risk is the loss of strategic expertise. Relying on external suppliers for the development of autonomous or electric vehicle software could limit an OEM's ability to differentiate itself in the market.

Additionally, sustainability has become an increasing challenge. Globalization has led to higher CO_2 emissions due to the transportation of components, while a lack of transparency in supply chains makes it difficult to ensure ethical practices.

With the rise of electric and autonomous vehicles, outsourcing is taking on new forms. The production of batteries, inverters, and energy management systems is an area of increasing externalization. However, some OEMs, are bringing critical processes back in-house through reshoring, ensuring greater control over strategic technologies.

Emerging technologies like 3D printing are revolutionizing prototyping and small-scale production, offering greater flexibility and cost reduction. At the same time, digitalization is transforming supply chain management, enhancing transparency and operational efficiency through tools.

Outsourcing has enabled the automotive industry to navigate the challenges of globalization and technological complexity, but it requires careful risk management. OEMs must balance the advantages of outsourcing with the need to retain control over critical expertise and sustainability. In a rapidly evolving market, the ability to adapt, innovate, and collaborate with suppliers will be essential for future success. [20]

As outsourcing continues to shape the automotive sector, the effectiveness of these collaborations largely depends on the contractual frameworks that govern them. Choosing the right Engagement Delivery Model is crucial for optimizing project execution, balancing costs, and managing risks, making it a key strategic decision for both OEMs and suppliers.

1.2 What is an Engagement Delivery Model?

An Engagement Delivery Model (EDM) defines the agreement structure and operational structure under which a project is executed between a service provider and a client. It establishes roles, responsibilities, pricing mechanisms, and performance expectations, shaping the way resources, risks, and deliverables are managed throughout the project lifecycle.

EDMs are particularly relevant in consulting, IT, and engineering services, where organizations outsource specific tasks or projects to external vendors. The choice of an EDM directly impacts cost efficiency, project flexibility, and risk allocation, making it a crucial strategic decision for both parties involved.

The selection of an EDM depends on multiple factors, including project complexity, duration, scope clarity, and risk tolerance. A well-defined EDM enhances efficiency, collaboration, and overall project success by aligning expectations and ensuring that both parties operate within a structured and transparent framework.

1.3 Description of Time and Material and Fixed Price

Time and Material (T&M) and Fixed Price (FP) are two of the most commonly used Engagement Delivery Models (EDMs) in project-based consulting and service contracts.

In a Time and Material contract, the client agrees to pay the supplier based on the actual time spent on the project and the resources used. This means that billing is typically done according to hourly or daily rates, multiplied by the number of hours or days worked by the assigned personnel. In addition to labour costs, other expenses such as materials, software licenses, travel costs, or any additional requirements may also be included in the final invoice.

From an operational perspective, T&M contracts typically involve ongoing communication between the client and the supplier. The supplier must provide detailed records of the hours worked and resources used, ensuring transparency in billing. Meanwhile, the client retains control over priorities, making decisions about how to allocate resources, adjust team composition, or even scale up or down the workforce as needed. This approach is commonly seen in software development, research and development (R&D), and other innovation-driven projects where defining precise requirements in advance is difficult.

On the other hand, a Fixed Price contract operates under a completely different logic. In this model, the total project cost is determined at the beginning, and the supplier commits to deliver a well-defined scope of work within an agreed budget and timeframe. The client and supplier negotiate and finalize the contract before execution begins, specifying in detail the expected deliverables, project schedule, and the exact amount to be paid upon completion of the work.

Since the price is agreed upon in advance, the supplier assumes the responsibility of managing the resources, time, and costs necessary to complete the project within the agreed conditions. The client does not pay for the number of hours worked but rather for the outcome. This makes FP particularly suitable for projects with well-defined requirements, predictable workloads, and clear deliverables, where the risk of significant changes is minimal.

The execution of an FP contract typically follows a structured approach, where milestones or phases are defined in advance, allowing the client to monitor progress without being deeply involved in the daily execution. Payments may be structured as lump sums upon project completion or divided into milestone-based payments, depending on the complexity and length of the project.

In both models, the way work is carried out and monitored differs significantly. T&M focuses on process flexibility and resource engagement, while FP emphasizes strict budget and timeline control. The choice between them depends on the nature of the project, the level of certainty in requirements, and the strategic priorities of both the client and the supplier.

1.4 Thesis Structure

This thesis is structured into six chapters, each addressing a critical aspect of the research, from theoretical foundations to empirical validation and managerial implications.

- **Chapter 1 – Introduction**: This chapter presents the context and motivation for the study, highlighting the importance of selecting the right Engagement Delivery Model in automotive consultancy. It outlines the research problem, scope, and expected contributions to both academia and industry.
- **Chapter 2 – Literature Review**: A comprehensive review of existing research is conducted to examine the factors influencing EDM selection in different industries. Special focus is placed on the IT and software development sector, where T&M and FP contracts have been extensively analysed, providing a theoretical foundation for the study. Then this chapter explores the specificities of the automotive industry, detailing how project lifecycle, risk factors, and governance complexity influence the selection of an EDM. The Product Development Plan (PDP) is analysed to understand how engagement models align with different phases of a project.

- **Chapter 3 – Research Methodology:** The empirical approach is detailed, describing the Capgemini Engineering case study, the data collection process, and the multiple regression model used to assess the relationship between project variables and financial performance. The selection criteria for the dataset and the limitations of the methodology are also discussed.
- **Chapter 4 – Data Analysis and Results**: This chapter presents the results of the regression analysis, identifying key factors affecting profitability, efficiency, and risk under different EDMs. The findings are interpreted in relation to the hypotheses developed in the literature review.
- **Chapter 5 – Discussion, Implications, and Conclusions**: The final chapter discusses the practical implications of the findings, providing recommendations for consultancy firms, automotive OEMs, and project managers. The study's limitations and potential future research directions are also outlined.

1.5 Thesis objective

The primary objective of this thesis is to identify best practices in project management for selecting the most suitable Engagement Delivery Model (EDM) based on project characteristics, risk factors, and operational constraints. It answers to the research question; "*Which project variables have the greatest impact on project profitability depending on the chosen Engagement Delivery Model?*".

The study aims to provide a data-driven framework that can support consultancy firms and automotive clients in making more informed decisions regarding contract selection, balancing flexibility, cost efficiency, and risk mitigation.

To achieve this, the research is structured in three main phases:

- **Literature Review and Theoretical Framework**: A literature review is conducted to analyse existing studies on EDM selection and project dynamics across different industries. Particular attention is given to the IT and software development sector, where these contract models have been extensively examined. The review highlights key variables influencing contract effectiveness, such as project size, resource turnover, cost structure, and governance complexity.
- **Adaptation to the Automotive Industry**: The insights from the literature review are then adapted to the automotive sector, where outsourcing plays a crucial role in engineering, design, testing, and infotainment development. This adaptation is carried out by analysing the Product Development Plan and its phases, considering their interdependencies, key

milestones, and associated risks. The study aims to determine how T&M and FP contracts align with different phases of automotive project execution.

- **Empirical Validation through Case Study**: To validate the theoretical findings, a case study on Capgemini Engineering (Italian perimeter) is conducted. A database of 63 projects is developed, containing detailed information on contract type, project size, team composition, and cost variables. The data is analysed through multiple regression analysis, identifying patterns and correlations that confirm or refine the theoretical hypotheses.

2 Literature Review

2.1 Review objective

The main objective of this chapter is to provide a detailed analysis of the existing literature regarding the application contexts of various engagement models used in project management. These models, including approaches such as Time & Material, Fixed Price and hybrid configurations, serve as fundamental tools in project management and have been extensively discussed in academic literature for their impact not only on costs and quality, but also on timelines and risk distribution.

To fully understand the dynamics and implications of these models, scientific articles and case studies have been analysed and compared, focusing on success factors and key challenges associated with project management in various industries, such as technology, automotive and consultancy services.

This analysis has enabled the identification of the most used models in their respective contexts and highlighted the variables that most significantly influence project performance, such as the clarity of requirements, system complexity, contractual flexibility, and the level of integration between client and supplier.

Another key element addressed in this chapter pertains to risk factors and how engagement models influence the distribution of responsibilities between parties. Particular attention has been paid to the impact these models have on resource management, progress monitoring, and adaptation to unforeseen changes during the project lifecycle. The analysed literature also offers valuable insights into mitigating risks associated with information asymmetry and the emergence of contractual conflicts.

The approach adopted for this review involved selecting studies focusing on three main aspects:

- **Success factors in projects**, such as client-supplier collaboration and the effectiveness of governance tools.
- **Risk management**, with the identification of key vulnerabilities associated with different contractual models and strategies to mitigate potential negative impacts.
- **Impact variables**, with the study of conditions determining efficiency, economic sustainability, and the quality of deliverables.

2.2 Review of academic articles and variables studied

A total of 16 papers were selected and analysed, each addressing themes related to various industrial sectors. Particular attention was given to the Information Technology (IT) sector, with a specific focus on software development projects. These projects provide a rich context for examining numerous variables, as the dynamics of project management in the IT sector offer extensive opportunities to study and evaluate the effectiveness of different contractual models, such as Time & Material, Fixed Price and hybrid contracts. The IT domain is especially suited for this type of analysis due to the frequent presence of variable requirements, high technical complexity, and the need for iterative adaptations.

A critical element to highlight is the scarcity of academic literature on engagement delivery models applied to the automotive sector. Existing studies principally focus on other aspects of product lifecycle management, leaving the role and effectiveness of contractual models in managing complex projects, like new vehicle development, largely unexplored. This gap in the literature poses both a challenge and an opportunity: using the lessons learned and best practices from the IT sector offers the potential to bridge this gap and provide a theoretical and practical foundation.

In particular, the comparison between the two sectors reveals interesting insights into similarities and differences in project management approaches. For example, while agile methodologies are commonly adopted in the IT sector to respond rapidly to changes, the automotive sector's regulatory constraints and the technical complexity of design and production phases may necessitate a different approach, one that can still integrate flexible and iterative models.

This translation is not without challenges, requiring a critical analysis to determine which elements of the contractual models studied in the IT sector can be effectively adapted to the automotive context.

Of the 16 analysed articles, 12 relied exclusively on quantitative analysis, employing advanced tools such as statistical regressions, numerical models, and simulations to explain and predict the behaviour of key variables. Three articles adopted an exclusively qualitative approach, using semi-structured interviews, focus groups, and questionnaires to explore the context and perceptions of stakeholders involved in the projects. Finally, one article combined both quantitative and qualitative approaches, integrating statistical analyses with insights derived from the direct experiences of practitioners, offering a more comprehensive perspective.

KPIs	Sources															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Quantitative Analysis	*	*	*	*	*	*			*	*	*	*	*	*	*	
Qualitative Analysis					*		*	*								*
EDM	I			I		I	I		I	I	I	O	O	I	I	I
Success rate		O					O	O						O		O
Profitability	O	O								O	O		O			
Risk	O								O				I			
Deliverable quality	O	O		O	O	O					O				O	
Deliverable complexity	I			I	I				I		I		I			
Duration	O		O		O		O		O			I	I			
Personnel turnover	O												I			
Supplier effort		I										I				
Incentives		I	I			I				O						
Client benefits		O			I											O
Bargaining power			I	O				I								
Project cost		I		O	O				O			O			O	
Requirements uncertainty	I					I										
Renegotiations frequency		I				I		I		I						
Transparency			I				I		I		I					
Team seniority				I							I					
Monitoring level									I	I						
Partner integration							I					I			I	
Agile practises																I

Table 1: indicators studied in analysed articles

The analysed papers present a total of twenty key variables and KPIs. However, many variables function as both input and output factors, depending on the specific focus of the article. For example, some studies conduct comparative analyses of similar projects managed under Time & Material or Fixed Price models, aiming to evaluate the effectiveness of each approach in terms of cost, quality, and timelines. Other articles, on the other hand, start from project characteristics, such as complexity and clarity of requirements, to determine which engagement delivery model is best suited to maximize results and minimize risks.

The most frequently used variables include key indicators such as the quality of the delivered output, project profitability, deliverable complexity, project success rate, adherence to deadlines, and total project cost. These elements serve as universal metrics that enable a comparable evaluation of the performance of different projects and contractual models.

However, the range of variables considered is quite broad, including specific aspects related to risk management and personnel dynamics. For instance, some studies focus on risk assessment variables, evaluating the probability of delays or cost overruns, while others examine the project team, analysing factors such as technical skills, turnover rates, and familiarity with the project type and the client company.

These aspects are important to understand not only project performance but also the stability and effectiveness of the organization in responding to challenges.

Other studied variables include transparency and communication between the client and the provider, which are crucial elements for reducing information asymmetry and ensuring strategic alignment between the parties. Some articles highlight the presence of incentives, both positive (bonuses) and negative (penalties), to encourage the achievement of contractual objectives and improve the final product's quality.

Others analyse project adaptability, emphasizing the importance of iterative methodologies and agile practices, such as Scrum and Kanban, to manage complex projects with evolving requirements.

This wide range of variables and analytical approaches highlights the complexity and varied nature of project management across different industries. Each article contributes to clarify specific aspects, providing a complete perspective on the dynamics that influence the success or failure of projects managed with different engagement delivery models. This level of detail is essential for deriving best practices and cover gaps in the existing literature.

2.3 Key challenges in EDM selection

2.3.1 Distribution of risks and goal misalignment

The distribution of risks between the client and the supplier varies significantly depending on the Engagement Delivery Model chosen for a project. The allocation of financial, operational, and performance risks impacts project governance, cost management, and quality assurance.

Two of the most used EDMs, Time & Material and Fixed Price, offer distinct risk-sharing mechanisms, influencing contractual obligations and managerial decisions.

In Fixed Price contracts, the supplier assumes the majority of financial and operational risks associated with project execution. Since the cost and scope are predefined in the contract, the supplier is responsible for delivering the defined results within the stipulated budget and timeframe.

This disposal provides cost predictability for the client, as the total expenditure is known in advance, making FP models particularly suitable for projects with well-defined requirements and limited expected changes.

However, this cost certainty shifts a significant financial burden to the supplier. If unexpected challenges arise, such as technical difficulties, resource shortages, or inflation in labour costs, the supplier must absorb these additional expenses. To mitigate this risk, suppliers often apply risk premiums to their pricing, increasing the overall cost of FP contracts compared to T&M agreements.

Moreover, suppliers may seek to optimize internal expenses by limiting resource allocation, which could result in understaffing or reliance on lower-cost personnel, potentially impacting project quality and delivery speed.

Operationally, FP contracts require meticulous resource and cost management from the supplier. Since the agreed price does not change regardless of the actual effort required, suppliers must carefully allocate their workforce and optimize processes to avoid financial losses. This often results in strict adherence to project timelines and cost-cutting measures, which may lead to a reduction in flexibility when addressing unforeseen issues. Additionally, since the supplier is fully accountable for execution, they may adopt rigid project management approaches that prioritize efficiency over adaptability [7].

From the client's perspective, while FP contracts ensure budget stability, they introduce a risk of misalignment between expectations and execution if requirements were not well specified during contract negotiation. Any modifications to the agreed scope typically require formal renegotiations, leading to potential delays and added costs.

In contrast, Time & Material contracts shift a greater portion of financial risk to the client, as costs are directly tied to the time spent and resources utilized throughout the project. Unlike FP contracts, T&M models allow cost fluctuations based on real-time project needs, which can be beneficial in cases where requirements are unclear or likely to evolve. However, this cost variability introduces a significant financial risk for the client, particularly if the project experiences inefficiencies, scope variations, or extended timelines.

Since the supplier is compensated based on labour input rather than deliverables, there is a potential risk of prolonged project durations and inflated costs if proper controls are not in place. Clients must invest in continuous financial supervision, closely monitoring time records, expenses, and resource allocation to prevent uncontrolled budget escalation.

Without such monitoring, there is a risk of billing inefficiencies, where the supplier may overestimate required effort or extend project durations to maximize revenue.

For these reasons, T&M contracts require a more active approach from the client in managing project progress and decision-making.

Since the supplier’s role is primarily to provide expertise and workforce rather than guaranteeing an end-to-end solution, the client must actively engage in planning, resource allocation, and quality assurance. This increased operational responsibility can be a risk, especially for organizations with limited project management capabilities.

While financial and operational risks are critical in defining the viability of an engagement model, another subsequent challenge in project execution is the misalignment of goals between the client and the supplier. Even with well-structured contracts, differences in strategic priorities, performance expectations, and risk tolerance can lead to conflicts that undermine project success.

In Fixed Price contracts, the supplier’s primary goal is to complete the project within the agreed budget and timeframe, while the client may focus more on quality improvements or evolving requirements. These conflicting priorities can lead to tensions, especially when additional revisions are necessary but not covered by the contract. The supplier, aiming to protect profit margins, may limit flexibility, under-resource the project, or strictly adhere to the original scope, even if adjustments could improve the final outcome. At the same time, the client may attempt to obtain extra work without formally modifying the contract, leading to disputes over deliverables and fair compensation.

In contrast, Time & Material contracts compensate the supplier based on effort rather than fixed deliverables, shifting the financial risk to the client. While this model provides greater adaptability, it can also result in cost inefficiencies and delays if progress is not carefully monitored. Clients may struggle to ensure cost control and timely execution, as the supplier has no direct financial incentive to minimize project duration or optimize resource allocation. The supplier's financial incentive is directly tied to billable hours, which can create a risk of inefficiencies or extended project timelines. Clients, in turn, may push for cost reductions that compromise the supplier’s ability to allocate adequate resources or retain skilled personnel, leading to deteriorating project outcomes.

Conflicts of interest are inherent in both FP and T&M contracts, as each party seeks to maximize its own benefits, sometimes at the expense of the other. Without clear alignment on project objectives and contractual expectations, these dynamics can lead to inefficiencies, unmet expectations, and disputes, ultimately impacting project success.

To mitigate these risks, transparent governance mechanisms, such as performance-based incentives, independent audits, and predefined dispute resolution procedures, should be integrated into contract structures.

By ensuring that both parties have aligned financial and operational motivations, conflicts of interest can be managed effectively, reaching a more collaborative and productive engagement.

To better manage these factors, various specific contractual strategies can be adopted, each designed to improve alignment between the client and provider and to ensure optimal outcomes.

Incentive Contracts: Promoting Quality and Efficiency

Incentive contracts serve as a strategic tool for project governance, aligning client and provider interests while mitigating risks associated with information asymmetry and opportunistic behaviour. These agreements link remuneration to the achievement of specific objectives, measured through milestones or Key Performance Indicators.

A well-structured incentive contract defines compensation based on project milestones, quality standards, and compliance with deadlines. For instance, in Fixed Price contracts, providers may receive bonuses for exceeding quality expectations or penalties for delays and non-compliance, thus ensuring accountability and encouraging operational efficiency [19].

These contracts are particularly effective in modular or iterative projects, where clearly defined milestones enable continuous performance evaluation and progressive alignment of objectives. In software development, for example, the completion of a testing phase or the release of a functional version can serve as incentive checkpoints, ensuring sustained quality across the project lifecycle.

Beyond financial compensation, contract-linked incentives facilitates transparency and collaboration, strengthening client-provider trust and reducing inefficiencies. Adherence to certified quality standards can further activate performance-based bonuses, creating a direct correlation between work quality and provider earnings. This mechanism motivates suppliers to invest in skills and resources, ultimately improving overall project outcomes [6].

Moreover, the introduction of penalties for delays or non-compliance adds an extra layer of accountability, particularly in complex projects where ambiguity or scope changes might otherwise lead to inefficiencies. The enforcement of such clauses deters opportunistic behaviour and ensures adherence to contractual agreements, reinforcing a results-driven approach [4].

Periodic review clauses

Regular reviews are a critical component for ensuring flexibility in agile contracts. Through formally scheduled meetings at predefined intervals, the parties involved can assess project progress, identify discrepancies relative to the initial objectives, and adjust requirements or priorities to accommodate emerging needs. This approach ensures that the project remains aligned with the client's expectations while maintaining transparency and contractual accountability.

These structured interactions not only reinforce trust but also enhance the ability of both parties to navigate the dynamic complexities of the project environment effectively [18].

Risk sharing

A particularly effective contractual model in leading to a collaborative relationship is the shared-risk contract, where both the client and the supplier share not only the risks but also the benefits of the project. This arrangement leads to a closer collaboration and strategic alignment, mitigating tensions arising from conflicting objectives.

For instance, contractual clauses can allocate responsibility for requirement changes to the client, while the supplier manages operational costs and optimizes available resources. This approach not only ensures impartial distribution of responsibilities but also allows exploiting the specific expertise of each party [5].

Effective risk management in agile contracts demands a deep understanding of project characteristics and the relational dynamics between client and supplier. Flexible contractual strategies, such as performance-based contracts, periodic review clauses, and risk-sharing agreements, are critical for addressing the challenges posed by complexity and uncertainty. These strategies help maintain a balance between flexibility, control, and contractual accountability.

By adopting such approaches, organizations can maximize project value while minimizing risks related to inefficiencies or conflicts. The key lies in ensuring transparency, collaboration and strategically distributing responsibilities, aligning project outcomes with both client and supplier expectations.

The selection of the most suitable contractual model, whether Time & Material or Fixed Price, depends on various factors, including project complexity, the clarity of requirements, risk levels, and staff turnover. As previously introduced, T&M contracts offer flexibility to address evolving requirements and complex deliverables, while FP contracts provide cost predictability and incentivize efficiency but may lack adaptability in uncertain environments.

2.3.2 Requirements clarity and flexibility

Requirements clarity and scope flexibility are critical features in project management, allowing for modifications throughout the project lifecycle to align deliverables with needs as they are modified. This adaptability enhances the quality of the final outcome but introduces complexities in resource allocation, requiring a structured balance between flexibility and control.

In Time & Material contracts, scope flexibility is inherent, enabling clients to adjust requirements dynamically without incurring substantial renegotiation costs. This responsiveness allows suppliers to accommodate client needs variations efficiently.

However, such flexibility demands rigorous direction to prevent cost escalation, as suppliers are compensated based on time and materials rather than predefined deliverables. Without robust monitoring, inefficiencies may emerge, leading to extended project durations and inflated budgets.

Conversely, Fixed Price contracts prioritize cost predictability over adaptability. Any scope changes require formal renegotiations, potentially increasing costs and delaying delivery.

While FP models provide financial stability, their rigidity can decrease responsiveness to unexpected challenges, limiting the supplier's ability to integrate ongoing feedback or address emerging market demands efficiently.

Agile Approaches to Scope Management

To balance flexibility with control, many organizations integrate agile methodologies into their project frameworks. Agile models operate through short iterations, continuous feedback, and adaptive planning, mitigating the risks associated with both FP and T&M contracts.

Milestone-based contracts, for example, tie payments to verifiable deliverables, ensuring incremental progress while incentivizing suppliers to maintain efficiency without compromising quality.

A key component of agile governance is the use of collaborative tools, which promote structured adaptability. These frameworks facilitate continuous dialogue between client and supplier, reducing informational asymmetry and enabling real-time adjustments.

Shared dashboards, periodic meetings, and iterative reviews provide transparency, ensuring that evolving requirements are integrated without disrupting project objectives. All these are useful especially under a Time and Material engagement delivery model, where a higher level of supervision is suggested.

Additionally, adaptive contracts combine elements of both FP and T&M models to accommodate varying levels of uncertainty. In the early phases of high-variability projects, a T&M structure allows for requirement refinement. As clarity is achieved, transitioning to an FP model ensures budget stability and predictable outcomes. This hybrid approach aligns strategic agility with financial control, optimizing both flexibility and cost efficiency.

The Importance of Requirement Clarity

Clarity of requirements is a fundamental variable influencing the effectiveness of Engagement Delivery Models. In FP contracts, success heavily depends on detailed specifications established during the initial phase.

Vague requirements can lead to contractual conflicts, delays, and unforeseen costs, ultimately damaging project viability. Misaligned expectations often result in clients requesting modifications beyond the original scope, while suppliers, seeking to preserve profit margins, resist additional work without contractual alterations.

As said, in T&M contracts, a lack of well-defined objectives can lead to inefficiencies. Suppliers may extend project timelines to maximize billable hours, while clients struggle to control evolving requirements effectively. Without precise milestones and monitoring tools, this misalignment can diminish project efficiency and compromise supplier reputation.

Misunderstandings regarding deliverables or performance expectations can escalate conflicts, increasing the likelihood of project failure.

To mitigate these risks, organizations must adopt governance practices that emphasize contractual transparency, measurable quality criteria, and continuous client-supplier communication.

Contractual Adjustments and Renegotiation

Given the dynamic nature of project environments, contractual renegotiation is often necessary to address varied conditions without moving away from overall objectives.

In FP contracts, renegotiation typically arises to accommodate unanticipated requirements, ensuring feasibility despite changing circumstances. In T&M contracts, renegotiation is more focused on refining control mechanisms, maintaining cost efficiency, and aligning project scope with business priorities.

A practical approach to manage uncertainty is the implementation of risk buffers, which allocate additional time and resources to absorb unforeseen challenges. These buffers reduce pressure on both parties, enhancing project stability and quality. However, when requirements remain undefined or significant changes emerge, structured renegotiation processes become necessary.

To streamline renegotiations, periodic review clauses can be incorporated into contracts. These predefined checkpoints allow for structured reassessments of progress, minimizing administrative burdens and ensuring that scope adjustments are managed efficiently.

Thanks to a proactive contract management, renegotiation enhances flexibility while preserving financial and operational stability.

2.3.3 Communication dynamics

Effective communication between client and supplier is fundamental to ensuring project success and maximizing contractual efficiency. Transparent and frequent dialogue reduces informational asymmetry, strengthens trust, and fosters effective collaboration.

These dynamics are particularly crucial in complex projects with high uncertainty, where strong governance mechanisms mitigate conflicts and enhance process efficiency [18].

Client Involvement in Engagement Delivery Models

The degree of client involvement varies significantly depending on the Engagement Delivery Model chosen. In Time & Material contracts, where the supplier is compensated based on effort rather than predefined deliverables, the client plays an active role in project supervision.

This model allows for flexible scope adjustments but requires continuous control to prevent inefficiencies and budget overruns.

In contrast, Fixed Price contracts are structured to minimize direct client involvement in daily operations. Since costs, scope, and timelines are predefined, the supplier assumes responsibility for execution, while the client primarily focuses on periodic milestone verifications and final deliverable assessments. This model provides cost predictability, making it particularly beneficial in budget-sensitive environments.

However, FP contracts require meticulous upfront planning to ensure clarity of requirements, as any modifications typically involve formal renegotiations that can increase costs and extend timelines [4].

Balancing Communication and Control in EDMs

One of the most effective strategies for managing client-supplier interactions is the integration of collaborative project teams, where both parties engage in strategic decision-making and risk mitigation. This approach is particularly valuable in highly complex projects, where close coordination helps manage interdependencies and align priorities.

In cases where the client lacks technical expertise, structured governance mechanisms, such as joint risk management committees and independent audits, ensure that potential conflicts are addressed proactively, minimizing disruptions.

2.3.4 Client-Supplier relationship

Supplier selection and the negotiation power of the parties are essential elements in establishing the foundations of a contractual relationship. These factors significantly influence the quality of deliverables, the allocation of risks, and the overall success of the project. A meticulous selection process, coupled with a balanced management of negotiation power, can enhance collaboration, mitigate conflicts, and ensure greater operational efficiency.

Supplier selection is an essential phase that directly impacts a project's ability to meet quality objectives and deadlines. Several key criteria play a central role in this process:

Technical Competence and Reputation: Selecting suppliers with sector-specific expertise significantly increases the likelihood of timely and high-quality deliveries. This is especially critical in serial projects, where standardization and process repeatability are essential to maintaining consistency and efficiency.

Previous Collaboration: Established relationships between the client and supplier enhance communication and minimize the risk of conflicts. This is particularly beneficial in parallel projects, where effective coordination across teams demands a high degree of integration and cooperation.

In Fixed Price contracts, assessing a supplier’s ability to rigorously plan and adhere to strict deadlines while maintaining high-quality standards is essential. The predictability of costs and timelines in FP projects connects the supplier's operational precision and planning capabilities.

In Time & Material contracts, the emphasis shifts to selecting suppliers who exhibit operational flexibility and a readiness to collaborate iteratively. These traits are critical in adapting to evolving requirements throughout the project lifecycle, ensuring responsiveness to change while maintaining alignment with the project’s goals.

By carefully evaluating these criteria during the supplier selection process, organizations ensure the principles for robust collaboration, minimize risks, and optimize the likelihood of project success.

The role of bargaining power

Negotiation power plays a crucial role in shaping the contractual framework and determining the allocation of risks and benefits between the client and the supplier.

When the client holds significant bargaining power, contracts typically shift the majority of operational and financial risks onto the supplier. This dynamic is commonly observed in Fixed Price contracts, where the supplier is bound to adhere to strict deadlines and budgets, thereby assuming greater responsibility for risk management. Such an arrangement incentivizes the supplier to focus on efficiency and cost control but may also limit their flexibility in accommodating changes or unforeseen challenges.

Conversely, when the supplier wields greater negotiating power, contracts often adopt more flexible terms, as seen in Time & Material models. Under this structure, the client assumes a substantial portion of the risks related to the project’s overall costs.

However, this configuration allows for higher quality and adaptability, particularly in projects characterized by evolving or uncertain requirements. The flexibility inherent in T&M contracts enables a more iterative and responsive approach, inducing alignment with the project’s dynamic needs while leveraging the supplier’s expertise.

Assuring an equitable balance in negotiation power is therefore necessary to ensuring a contract that aligns with the project’s goals and optimally distributes risks and benefits. A balanced negotiation dynamic between the client and the supplier creates constructive collaboration and a shared commitment to the quality of deliverables. Establishing trust-based relationships, adopting collaborative governance tools, and employing a strategic approach to supplier selection are fundamental pillars for ensuring project success.

Such a balance not only ensures an equitable distribution of risks but also cultivates a collaborative working environment. This, in turn, enhances operational efficiency and minimizes conflicts, allowing both parties to align their efforts towards achieving the project's objectives with greater coherence and effectiveness.

2.3.5 Trade off in quality and profitability

Effective project management necessitates a delicate balance between costs and quality, an aspect that varies significantly depending on the contractual model adopted and the specific characteristics of the project. Every decision, from selecting the contractual model to distributing responsibilities, directly impacts overall performance, perceived risks, and benefits for both client and supplier.

Three key variables shape project performance:

Quality of Deliverables: In Time & Material contracts, quality benefits from flexibility but relies heavily on client supervision. Fixed Price contracts require the integration of incentivizing clauses to mitigate the risk of quality compromises.

Economic Sustainability: FP contracts offer predictable costs but are less suited for complex projects. Conversely, T&M contracts provide greater adaptability but necessitate constant monitoring to manage the budget effectively.

Operational Efficiency: In T&M contracts, efficiency is driven by close collaboration between client and supplier, whereas in FP contracts, it is incentivized by the need to adhere to strict cost and time constraints.

The choice of contract type, whether Time & Material or Fixed Price, comes with distinct advantages and limitations in balancing flexibility and control. These models influence not only the costs of monitoring and adaptation but also the quality of deliverables.

An additional critical factor is personnel turnover, which can disrupt project continuity and quality, with varying effects depending on the contractual model in place. Managing turnover effectively becomes crucial to maintaining operational flow and meeting quality standards [16].

Organizational learning dynamics, such as learning curves, alongside mechanisms to prevent overspending, play a crucial role in ensuring economic sustainability and operational efficiency. By exploiting them in combination with incentivized contracts and robust governance strategies, organizations can optimize resource utilization and tackle uncertainties with greater resilience.

This chapter is split into how these variables influence the trade-off between costs and quality, providing a detailed analysis of contractual models and the most effective management strategies for optimizing project performance. By comparing various approaches, it highlights strengths and weaknesses, offering guidance for selecting the most suitable model to meet the unique demands of each project.

Inefficiencies in consulting teams: learning and operational optimisation

The success of a project relies heavily on the consulting team's ability to minimize inefficiencies and incorporate organizational learning mechanisms such as viability learning and cost learning. These approaches play a critical role in improving quality and optimizing costs, particularly in complex or iterative contexts where project variables demand continuous adaptation. This is especially important in projects with significant technological or organizational complexity, as these mechanisms enhance contractual performance.

Viability learning refers to the project team's capacity to progressively refine its operational efficiency. This involves reducing delivery times while simultaneously increasing quality.

On the other hand, cost learning is focused on the progressive optimization of costs. Through repeated tasks, the provider learns to lower the unit cost, ultimately benefiting the client by reducing the overall project expenditure.

Another key factor in selecting the most appropriate Engagement Delivery Model is the linearity of the project. In iterative projects, the Time & Material model is particularly effective because it allows for rapid adjustments to changing requirements.

This adaptability is complemented by viability learning, which incentivises continuous improvement in quality over time. For modular projects, cost learning becomes especially impactful. By treating each module as a learning opportunity, teams can progressively reduce costs and improve quality. In such cases, a hybrid model, employing T&M during exploratory phases and Fixed Price contracts in later, more stable stages, offers an optimal balance of flexibility and cost control.

Serial projects, where tasks are highly repetitive, are better suited to the Fixed Price model. This approach provides predictable costs and timelines while allowing providers to optimize processes through repetition.

However, it does require careful monitoring to ensure consistent quality. In parallel projects, characterized by interdependencies among teams and activities, the T&M model provides the flexibility needed to address variable requirements and complex challenges. This structure encourages collaboration between teams and supports proactive risk management, making it well suited for dynamic environments.

By aligning the project's characteristics with the appropriate engagement model, teams can enhance both performance and efficiency, ensuring successful outcomes in even the most challenging contexts.

Overspending Prevention: Cost Control Mechanisms

Overspending is one of the main threats to the performance of complex projects, particularly in Time & Material. The inherent flexibility of these contract types can lead to uncontrolled cost growth if not carefully managed. To mitigate this risk, it is essential to adopt tools and strategies that enhance transparency, optimize resources utilization, and ensure budget compliance without compromising quality.

One effective tool is the Earned Value Analysis (EVA), which allows for a comparison between actual expenditures and project progress. By providing a clear view of deviations from the planned budget, EVA is especially useful in T&M contracts where continuous monitoring is critical to preventing waste and inefficiencies. This method enables both the client and the provider to make data-driven decisions to keep the project on track.

Another crucial measure is the introduction of contractual spending limits. In T&M contracts, establishing these limits helps maintain control over overall costs. These spending caps can be reinforced by linking financial milestones to verified project progress. This approach incentivizes the provider to meet intermediate objectives while staying within the agreed budget [15].

Additionally, independent audits and real-time dashboards are powerful tools for improving control and transparency. Independent audits ensure impartial supervision, quickly identifying inefficient or unnecessary activities that may inflate costs. Real-time dashboards, on the other hand, provide continuous updates on costs, timelines, and performance metrics. This immediate access to project data ensures trust and collaboration between the client and provider while enabling corrective actions when needed [1].

By implementing these strategies, organizations can effectively address the challenges of overspending in flexible contract arrangements, safeguarding project performance and ensuring value for both parties involved.

Implications of Turnover in Contractual Models and Impacts on Costs and Quality

Employee turnover poses a significant challenge that can critically impact project costs and quality, with effects varying based on the contractual model in use. In Time & Material contracts, the client benefits from greater flexibility in managing team changes, as the contract structure allows for adjustments to resources as needed. However, this flexibility comes with added costs related to supervising and training new personnel, which can strain project budgets and timelines.

In contrast, Fixed Price contracts place greater pressure on the provider to address the consequences of turnover. The provider is obligated to ensure operational continuity and maintain quality standards regardless of internal staffing changes [6].

Understanding these dynamics is essential for both clients and providers when choosing a contract model. Careful planning and proactive management strategies can mitigate the negative impacts of turnover, ensuring that projects remain on track despite team changes.

Supervision and Training Costs

One of the most noticeable impacts of turnover is related to the costs of supervision and training. In Time & Material contracts, usually, the client directly takes on the responsibility of integrating new resources, leading to increased operational costs and a temporary decline in productivity. This additional burden can strain the project's budget and timeline, particularly in cases where turnover rates are high or unforeseen.

In Fixed Price contracts, however, the responsibility for addressing turnover falls entirely on the provider. To meet contractual deadlines and obligations, providers often resort to accelerated onboarding processes. While these processes help maintain schedule adherence, they risk compromising the accuracy of knowledge transfer. This, in turn, can affect the overall quality of the deliverables, as new team members may lack the complete understanding of project requirements or previously established workflows.

Both scenarios highlight the importance of carefully managing turnover through robust onboarding strategies and effective knowledge management systems. These measures can help mitigate the negative impacts on productivity, cost, and quality, regardless of the contractual model in place.

Quality Risks of Deliverables

The departure of key personnel inevitably results in a loss of critical expertise, which can reduce the team's ability to meet the expected quality standards. In Fixed Price contracts, replacing experienced personnel with less qualified resources can lead to a significant decline in quality.

Although Time & Material contracts offer greater flexibility to manage such changes, operational inefficiencies can also arise if new team members are not adequately trained.

Strategies to Mitigate the Effects of Turnover

To reduce the negative impacts of turnover, it is essential to adopt a strategic approach that includes the following practices:

Staff Retention: Implement economic and non-economic incentives to motivate and retain key personnel, producing a stimulating and collaborative work environment.

Structured Documentation and Knowledge Transfer: Develop knowledge repositories to ensure operational continuity even in the event of turnover. Standardizing processes and documentation facilitate knowledge transfer and reduces the risk of losing critical information.

Cross-Functional Teams: Build teams with diversified skills to ensure that multiple members can cover critical roles. This approach enhances organizational resilience and reduces dependence on individual contributors.

Employee turnover is an inevitable phenomenon in complex projects, but its impacts can be effectively mitigated. Adopting retention practices, knowledge transfer tools, and cross-functional team creation minimizes additional costs and maintains high-quality standards. Such strategies not only improve the project's sustainability and overall performance but also promotes greater operational resilience, ensuring long-term success [3].

Allocation of experienced resources

Experienced resources are typically the most expensive assets for a consultancy firm. Their high cost not only impacts the provider's budget but also represents a financial challenge for the client, who may not always be willing to accept higher billing rates. For this reason, consultancy firms strategically allocate these senior professionals to specific projects where their expertise can maximize value and efficiency. The decision to deploy highly experienced resources depends on several factors, including the complexity, uncertainty, time constraints, and strategic importance of the project.

Below are the key scenarios in which experienced resources are prioritized, along with their expected role and the corresponding Engagement Delivery Model best suited for each case:

- High level of complexity: In highly complex projects, experienced resources are allocated as technical leaders, guiding the team and solving critical problems that require advanced expertise. Their role is essential for ensuring high-quality deliverables and maintaining technical coherence throughout the project lifecycle. These projects can be managed using either Fixed Price or Time & Material models. In FP contracts, once the project reaches a stable phase where the rest of the team can work autonomously, senior professionals may be partially or completely withdrawn to optimize efficiency and cost-effectiveness while maintaining quality standards.

- High level of uncertainty: In most cases, such projects are managed using a Time & Material contract, as this model provides the flexibility needed to handle uncertainty. Senior resources act as leaders, ensuring that the team can respond rapidly and effectively to modifications in client requirements, thereby minimizing risks and improving adaptability.
- Strict temporal limits: Projects with tight deadlines, where timely delivery is a critical success factor, often require experienced resources to accelerate execution and problem-solving. This scenario is related to Fixed Price contracts, as the supplier assumes the risk of delays. The presence of senior professionals is crucial during the design and planning phases, ensuring that the project follows an efficient roadmap. Once the critical phases are completed and only minor adjustments remain, senior resources can be gradually phased out, allowing the remaining team members to handle final refinements without risking the deadline obedience.
- Strategic projects for client acquisition: In some cases, projects are not primarily focused on maximizing profitability but rather on establishing a long-term relationship with the client. These strategic engagements are designed to demonstrate high-quality service and expertise, encouraging client trust and loyalty for future business opportunities. Even if these projects do not yield immediate financial benefits, consultancy firms prioritize the allocation of experienced resources to ensure optim deliverables, reinforcing their reputation and increasing the likelihood of securing larger and more profitable contracts in the future.

2.3.6 Offshore

Offshore outsourcing is a widely used strategy to reduce operational costs and access specialized skills globally. Companies adopt this approach to improve flexibility, accelerate development, and optimize resource allocation. However, selecting the right Engagement Delivery Model is essential for ensuring the success of offshore outsourcing. There are several reasons for which offshore workforce is adopted, especially in consultancy projects:

The main reasons why companies adopt offshore workforce, especially in consultancy projects, include:

- Cost reduction: Hiring professionals in low-cost countries helps lower operational expenses. This is usually the main factor in outsourcing decisions.
- Access to specialized skills: Offshore teams offer expertise that may not be available locally.
- Scalability: Companies can quickly expand or reduce project teams based on business needs, avoiding long and expensive recruitment processes.

Despite its advantages, offshore outsourcing presents some risks:

- Loss of control: A lower level of supervision can lead to quality issues.
- Communication barriers: Differences in language and culture may cause misunderstandings and slow decision making.
- Dependency on suppliers: Excessive outsourcing can complicate knowledge management and reduce internal expertise.

Another issue is related to the labour market in emerging countries. In low-cost countries, the labour market operates at a much faster pace compared to Europe. As these economies continue to grow, professionals often pursue better opportunities, frequently switching companies to secure higher salaries. This rapid turnover presents a significant challenge for suppliers managing offshore teams.

When employees leave, suppliers must quickly replace them to maintain project stability. However, if replacements are not found in time, there is a risk of resource shortages, which can impact the project in several ways. A lack of experienced personnel may lead to delays, lower quality standards, or difficulty in meeting project deadlines.

To mitigate this risk, supplier companies need to implement effective retention strategies, such as offering competitive salaries, professional development opportunities, and a structured career progression. Additionally, having a backup resource plan and ensuring knowledge transfer among team members can help maintain continuity and reduce disruptions in project execution.

The characteristics of Time & Material and Fixed Price contracts remain the same in any context. However, offshore resources introduce additional challenges that affect the choice between these models.

The decision depends on three key factors:

1. Control and supervision: How much involvement the company has in managing the offshore team.
2. Communication complexity: How well remote collaboration can be handled.
3. Risks to quality and deadlines: Ensuring project stability and timely delivery.

Time and Material:

- Cost reduction advantage for the client
- Risk for suppliers: In offshore markets, employees tend to switch jobs frequently for better salaries. This can lead to resource shortages, affecting quality and deadlines.

Fixed Price:

- Possibility to make high efficiency, but high level of supervision is necessary

2.4 EDM in automotive industry

The Product Development Process (PDP) is a structured, multi-stage approach that guides a project from the initial product concept to the commercial launch of a new vehicle. It serves as a reference framework that can be adapted based on the specific characteristics of each project, ensuring consistency and efficiency throughout development.

The Product Development Process follows a structured timeline, divided into seven main phases, each associated with one or more critical milestones that mark the progress of the project. This systematic approach ensures a linear and well-organized progression, minimizing risks and optimizing resource allocation.

For analytical purposes, the PDP can be divided into two main stages:

• Pre-program concept of the new product definition and approval.

• Development and Industrialization for Commercial Launch. Therefore, transition between these two stages of the PDP coincides with approval of the Initiative by the CEO (Chief Executive Officer) and all the Departments involved.

2.4.1 Product Development Process (PDP) and its structure

Concept Phase: The Concept Phase is the initial stage of product development, aimed at identifying the vehicle concept that best aligns with market demands while considering the company’s long-term strategic goals. This phase serves as a foundation for the entire development cycle, ensuring that the chosen concept is both financially viable and technically feasible.

One of the main deliverables of this phase is the top-down business case, which provides a preliminary profitability analysis. This evaluation is based on the product's market positioning, expected sales volumes, and competitive landscape. Additionally, a budget framework is established, setting a target cost limit for the vehicle, which will later guide the engineering and procurement activities.

At the same time, a product briefing is developed to outline the vehicle architecture and key top-level features. These specifications will serve as a reference for the following development stages. Many Original Equipment Manufacturers (OEMs) adopt modular architecture strategies, enabling greater synergies between different vehicle platforms and components. This approach improves industrial efficiency, cost optimization, and product scalability across multiple models.

Another crucial aspect of the Concept Phase is the program planning, which involves defining the development timeline, key milestones, and resource allocation. The project team is also assembled, ensuring that all necessary expertise is in place to support the next phases of development.

The successful definition of all these elements marks the achievement of the first key milestone: the Concept Approval. At this stage, management formally approves the concept, allowing the project to advance to the next development phase. Additionally, the budget required to cover early-stage expenses is also authorized, ensuring that essential research, feasibility studies, and initial prototype activities can proceed without financial constraints.

Strategic Definition: The Strategic Definition phase is a fundamental step in the product development process, where the key requirements and objectives of the new vehicle are established in alignment with the company’s strategic positioning and long-term goals. This stage plays a crucial role in translating customer expectations into measurable technical specifications, ensuring that the final product meets both market demands and engineering feasibility criteria.

The process begins with a detailed analysis of customer needs, aimed at identifying the key aspects that define the driving experience, comfort, performance, and overall perception of the vehicle. These insights are then transformed into technical and performance requirements, which are further broken down into system and component-level objectives. A crucial tool used in this phase is the Customer Car Profile (CCP), which represents the highest level of differentiation in terms of how a consumer perceives and evaluates a vehicle’s performance. The CCP covers various attributes, including interior spaciousness, cabin noise levels, acceleration, braking efficiency, seat comfort, and driving dynamics.

To define these targets, a benchmarking process is carried out, comparing the vehicle's expected performance against competitors' models. This evaluation is conducted through two complementary approaches. First, a panel of potential customers provides qualitative feedback, offering insights into subjective aspects such as driving feel, design preferences, and perceived quality. Simultaneously, in-house experts conduct technical evaluations, simulating the customer experience while ensuring that the product aligns with the company's engineering standards. Through this process, subjective performance targets are assigned to each CCP attribute, using a standardized scale such as the SAE scale, ranging from one to ten. However, to be effectively implemented in the engineering process, these qualitative targets must be converted into objective, measurable values.

As the strategic definition progresses, another critical output is the final product briefing, which consolidates all key decisions regarding vehicle dimensions, architecture, and technical constraints. At this stage, the definition of Hard Points plays an essential role in guiding the design process. These technical and dimensional constraints, established by the Product Development team, provide fundamental guidelines to the Style Centre, enabling designers to create a vehicle aesthetic that is both visually appealing and technically feasible. Early design sketches and renderings are developed, offering an initial vision of the model's styling language. Alongside these sketches, the first Visual Bill of Materials (BOM) is created, providing a graphic representation of the macro-components that will constitute the new vehicle. This early BOM also highlights strategic choices related to component carry-over and standardization plans, optimizing production efficiency and cost control.

From a financial perspective, a business case assessment is also conducted during this phase to determine whether the technical targets set for the vehicle are economically viable. This process begins with a detailed product description, which is then analysed by the Cost Engineering Team to ensure that the proposed specifications align with budget constraints and profitability goals.

The Strategic Definition phase culminates with the Product Content Sign-Off, which marks the formal validation of all major technical and commercial aspects of the new vehicle. At this milestone, the final agreement on performance targets, functional requirements, and styling direction is reached, enabling the project to progress into the Target Definition phase. This approval serves as a key checkpoint, ensuring that all foundational elements have been properly defined, and that the vehicle concept is ready for the next stage of development.

Target definition: The Target Definition phase is a critical step in refining the product's technical, financial, and commercial requirements, ensuring they align with the company's strategic vision and market expectations. At this stage, the high-level objectives established in the Product Content Sign-Off are further detailed into precise, measurable targets, guiding the work of engineering, purchasing, and testing teams. These specifications define not only the vehicle's performance and technical constraints but also its styling direction, ensuring consistency between aesthetic appeal and functional feasibility.

A key aspect of this phase is the development of appearance and surface finish standards, which translate customer expectations into engineering targets. Elements such as paint quality, material textures, and interior finishes play a fundamental role in shaping the vehicle's perceived quality. Since these characteristics impact both brand identity and customer satisfaction, their refinement continues throughout the entire development process until Start of Production (SOP).

Alongside aesthetic considerations, a comprehensive benchmarking process is conducted to assess the market positioning of the new model. Through comparative analysis, competitor vehicles are evaluated, and customer preferences are collected to guide styling, powertrain selection, and feature content decisions. By combining consumer insights and expert assessments, the company ensures that the new vehicle remains competitive and aligned with market expectations.

The phase also involves a progressive refinement of the vehicle's styling, where early sketches and design concepts are transformed into engineering-compatible digital models using Computer-Aided Styling (CAS). This process allows designers and engineers to work collaboratively, ensuring that aesthetic ambitions remain compatible with technical and manufacturing constraints. These digital models are continuously optimized, making refinements faster and reducing late-stage design conflicts.

In parallel, the Product Plan/Grid is finalized, outlining the vehicle's feature distribution across different market versions and ensuring that all configurations are financially and commercially viable. This document plays a crucial role in shaping the business case, determining whether the planned product specifications align with budget constraints and profitability targets.

The phase concludes with two critical milestones. Theme Confirmation validates the styling direction and ensures it is both technically feasible and aligned with customer expectations. Program Approval then represents the official endorsement from the executive board, confirming that all aspects of the project, technical, financial, and commercial, have been defined with sufficient detail to proceed to the next development stage. At this point, both the interior and exterior styling are finalized, and the business case undergoes a final profitability assessment, using financial indicators such as Net Present Value (NPV) to determine the project's economic sustainability.

With Target Definition completed, the vehicle's core attributes have been clearly defined and validated, allowing for the transition to the next development phase, where engineering details, supplier selection, and prototype development take place.

Technical development: During this phase, the mathematical definition of the vehicle is finalized using CAD modelling and virtual analysis tools, ensuring that all technical and technological requirements for components are set while integrating final styling refinements. At this point, the styling of the model is officially frozen, solidifying the design before moving into the next development stages.

In parallel, the Product Structure is completed, providing a clear framework for component integration. The Technological Process reaches a stable definition, with feasibility studies and preliminary production methods being finalized.

This phase also marks the transition toward prototype construction. Additionally, supplier sourcing is completed, and tooling activities commence, ensuring that manufacturing resources are in place for the next steps. Furthermore, the Key Characteristics of critical parts are defined, establishing essential quality parameters for production.

The ultimate objective of this phase is to achieve Tooling Validation, ensuring that all design, production, and quality criteria are met before moving into industrialization.

Tooling development: During this phase, the supplier and production plant tooling is set up, followed by program reviews to assess progress.

Once the tooling setup is complete, the process undergoes final approval. The Tooling Kick-Off (TKO) marks the official authorization to start the design, procurement, and manufacturing of production tools, molds, and dies required for the mass production phase of a product. This milestone ensures that all design specifications are finalized and approved before production tooling begins.

If required by the project, experimental testing is conducted on prototypes, including physical safety, fatigue, and functionality assessments. These tests may lead to necessary modifications in both the design and production process. Additionally, numerical and experimental correlation loops are performed to validate the results.

At this stage, the selection of colours, materials, and trim is finalized and officially frozen. Finally, the Production Bill of Materials (BoM) for VP is defined, ensuring readiness for the next development steps.

Verification of processes: This phase marks the production of the first vehicle bodies and complete units at the plant, using Off Tool parts rather than Off Process components. The primary objective is to assess and validate the production process, ensuring compliance with the Control Plan.

Additionally, statistical tests are conducted to evaluate the significance of supplied components and verify that both specific and overall vehicle performance meet the required standards.

A crucial aspect of this phase involves quality and reliability analyses, aimed at identifying residual risks and implementing corrective actions to improve reliability during the first production cycle. These evaluations help to evaluate processes and ensure that the vehicle meets performance expectations.

At the same time, several key technical and regulatory activities take place. The Technical Validation certification process is completed, and the tooling tuning phase is initiated to optimize manufacturing precision.

Additionally, the Qualification process is launched to determine whether specific components will be produced in-house or sourced externally.

Another critical aspect of this stage is the homologation process. Preliminary regulatory checks are performed. This phase serves as a very important step in the industrialization process, allowing manufacturers to refine production techniques, validate performance metrics, and address any remaining technical or regulatory challenges before mass production begins.

Pre Series: During this phase, complete vehicles are produced using Off Tool Off Process parts, now featuring their final aesthetic characteristics.

This stage is crucial for conducting quality and reliability analyses aimed at identifying any residual risks and implementing corrective actions where necessary to improve reliability in the second production cycle.

At the same time, aesthetic and functional evaluations are carried out to assess potential defects, while performance objectives are certified. Simultaneously, official homologation tests start, and certified operation tags are released, ensuring regulatory compliance.

In addition to technical validation, this phase involves the preparation of essential documentation for vehicle maintenance and servicing. The Maintenance and Usage book and Repair Manual are compiled, providing comprehensive guidance for end-users and service providers. Additionally, technical assistance training is structured, defining both the content and methodologies required to ensure effective after-sales support.

This phase plays a fundamental role in finalizing the vehicle's functional and aesthetic characteristics, securing regulatory approvals, and preparing essential documentation for future maintenance and repairs, all while enhancing overall reliability and product quality.

Production readiness: The Production Readiness Phase marks the final stage before mass manufacturing, ensuring that the manufacturing process, equipment, and production workflows meet all defined quality, reliability, and performance standards. This phase is essential for validating that the final production setup operates at full efficiency and consistency, maintaining the specifications established in the design phase.

A structured qualification process is carried out to assess both the product and the production system. The goal is to fine-tune manufacturing lines to function at their intended final cadence while maintaining dimensional accuracy, functional integrity, and aesthetic quality. The Quality Department oversees this validation, certifying that the product and process objectives have been successfully met, thus authorizing the transition to full-scale production.

To reinforce process stability, additional Critical Process Audits (CPAs) and Performance Index assessments are conducted, alongside a second Reliability Growth loop to monitor long-term durability. Furthermore, some OEMs implement the Internal Customer Test, where pre-production vehicles are assigned to internal teams for real-world usage simulations, allowing for a final round of feedback and refinements from a user perspective.

A critical milestone in this phase is the Production Release Approval (PRA), which serves as the official quality certification. Issued by the Quality Department, PRA confirms that both the product and production system have achieved the required performance and consistency levels, granting the formal approval for the production ramp-up.

Between PRA and Job 1, final adjustments are made to logistics, production workflows, and supply chain coordination to ensure a seamless transition to mass production.

The phase culminates in Job 1, the milestone that signifies the manufacturing of the first vehicle of the official production batch, marking the full transition from pre-series validation to large-scale production.

Serial life: The Serial Life Phase begins after Job 1, marking the transition to stable mass production. At this stage, the manufacturing process reaches its intended production rate, with all workflows, quality controls, and logistics fully operational.

During the early Serial Life, any residual inefficiencies are addressed through process capability analyses, defect rate monitoring, and continuous improvement methods. Statistical Process Control is applied to detect and correct deviations, while supplier performance monitoring ensures a stable and reliable supply chain.

From a logistics perspective, production is aligned with market demand through just-in-time strategies, optimizing inventory and minimizing excess stock while preventing shortages.

The Serial Life Phase continues until the product nears end-of-life, at which point production volumes are gradually reduced, and phase-out strategies are implemented. This phase ensures that manufacturing remains efficient, cost-effective, and maintains high quality standards throughout the product's lifecycle.

2.4.2 Interactions between different phases

The Product Development Process (PDP) involves strong interconnections between its different phases, ensuring process consistency and the overall quality of the final product. These interactions play a fundamental role in risk mitigation, efficiency improvement, and cross-functional collaboration, facilitating alignment across different teams and disciplines. The following sections provide a detailed overview of the key interactions that shape the PDP.

Feedback Loops Between Consecutive Phases

Each phase of the PDP generates results and data that serve as inputs for the next phase. However, when discrepancies or issues arise, feedback loops allow adjustments to be made to previous phases to maintain alignment and quality.

For instance, during Tooling Validation, unexpected design issues related to components developed in Technical Development may emerge. In such cases, engineering teams revisit the CAD models to implement necessary corrections before proceeding with production, ensuring a transition between development and manufacturing.

Integration Between Design and Production

The technical and production phases are closely interconnected, ensuring that product design remains compatible with industrial manufacturing processes.

During Technical Development and Process Validation, engineering and production teams collaborate to verify that design solutions are industrially feasible. This process includes feasibility analysis, cycle time reduction, and production line ergonomics optimization, ensuring that the manufacturing process is both efficient and sustainable.

Knowledge Transfer Across Phases

Each phase not only completes its own set of tasks but also transfers critical knowledge to subsequent stages.

This knowledge transfer ensures continuity and a holistic view of the project. For example, Strategic Definition provides essential inputs to Technical Development by translating strategic objectives, such as technical requirements and aesthetic specifications, into measurable engineering targets. These early phase decisions serve as reference points for the entire development cycle, ensuring that all downstream activities remain aligned with initial expectations.

Multidisciplinary Collaboration

Each phase requires the involvement of multidisciplinary teams working in parallel to integrate different aspects of the product.

During Tooling Validation and Pre-Series, production teams collaborate with testing teams to ensure that manufacturing equipment can produce components that meet the performance and quality requirements defined in the pre-series phase. This cross-functional coordination is essential to maintain product integrity and manufacturing efficiency.

Iterative Problem-Solving

When unforeseen issues arise in later phases, teams often return to earlier stages to make necessary modifications and resolve criticalities. This iterative approach is crucial for achieving a high-quality final product.

For instance, during Pre-Series, pre-production testing may reveal anomalies that require adjustments to manufacturing processes validated in Process Validation. These adjustments may involve additional calibrations, parameter modifications, or equipment revisions to ensure that the final production process meets the expected standards.

Coordination Between Virtual and Physical Testing

The integration of virtual simulations and physical testing enables a progressive validation of design choices throughout the development cycle.

For example, during Technical Development, virtual simulations such as CAD modelling and resistance analysis help engineers predict potential performance issues. These virtual tests are later validated during Process Validation, where physical testing ensures that real-world results align with virtual predictions, reducing the risk of design flaws and optimizing development timelines.

Continuous Monitoring and Alignment

Each phase includes structured monitoring and review checkpoints, ensuring that project progress is continuously measured against previously defined targets. This approach maintains alignment with strategic objectives and prevents major deviations.

For instance, the objectives set in the initial phases are systematically reviewed during Pre-Series and Launch to verify compliance with market expectations, regulatory requirements, and strategic business goals. By continuously monitoring progress, companies can make timely adjustments to ensure product and market alignment.

The interactions within the Product Development Process are not strictly linear but form a dynamic network of feedback and collaboration. This interconnected approach allows OEMs to rapidly identify and resolve issues, improve overall efficiency, and ensure that each phase actively contributes to achieving the final project goals.

Effective management of these interactions is essential for project success and for maintaining competitiveness in the global automotive market.

2.4.3 Risks related to interactions

In the Product Development Process, the interactions between different phases can create various risks that impact project timelines, costs, and overall efficiency. These risks arise from delays, quality issues, changing requirements, integration problems, supply chain disruptions, unforeseen costs, regulatory non-compliance, and poor communication. Effective risk management is essential to mitigate negative consequences and ensure smooth project execution.

One of the most common risks is represented by delays in project timelines. If technical specifications or components are not delivered on time, the subsequent phases may be affected, creating a domino effect throughout the development plan. For instance, in the Technical Development phase, failure to complete detailed CAD models on schedule can postpone Tooling

Development, which in turn delays prototype production. These cascading effects can significantly disrupt project milestones.

Another critical risk involves quality issues, where defects discovered during testing may require revisions and modifications, leading to increased costs and extended timelines. During the Process Verification phase, for example, the assembly of VP prototypes might reveal alignment or tolerance issues, necessitating design revisions. Addressing these issues retroactively not only consumes time but also requires additional resources.

Changes in technical or market requirements present another significant challenge. If new performance standards or regulatory constraints emerge in later stages, substantial adjustments may be necessary, impacting both budgets and timelines. A clear example occurs in the Pre-Series phase, where testing may indicate that an ADAS system does not meet regulatory or performance expectations, requiring modifications to previously developed software. Such late-stage adjustments can be costly and complex.

Integration issues also pose a risk, particularly when components and systems developed independently in different phases fail to function smoothly when assembled. During the transition from Technical Development to Process Verification, an infotainment system might prove incompatible with the vehicle's electrical architecture, necessitating last-minute updates and causing production delays.

Another major risk category relates to the supply chain, where delays or issues with critical component suppliers can slow down the entire process. For instance, during Tooling Development, if suppliers fail to deliver specific materials on time, the production of VP prototypes may be delayed, blocking further development activities and impacting overall project timelines.

Unexpected cost increases are another potential consequence of poorly managed phase interactions. Problems encountered during testing or last-minute modifications can result in reengineering costs or tooling updates.

Regulatory non-compliance represents yet another serious risk. If a vehicle fails to meet market regulations during certification tests, urgent corrections are required, leading to significant time and budget implications.

For example, during homologation tests in the Pre-Series phase, an engine might fail to comply with emission standards, requiring recalibration of software or modifications to the design to meet the required specifications.

Finally, collaboration and communication risks can have substantial consequences. A lack of coordination between different teams can result in duplicated work, design errors, or production inefficiencies. If design teams fail to communicate technical constraints to production teams, manufacturing tools may not be properly configured to meet the required specifications. Such misalignment leads to costly rework and potential production setbacks.

2.4.4 Approach to outsourced processes

As previously introduced, throughout the Product Development Process, certain activities are commonly outsourced to third parties for various strategic reasons. The decision to externalize specific processes is often driven by the specialization of external suppliers, allowing OEMs to focus on their core competencies while exploiting the economies of scale provided by specialized partners. This approach not only enhances efficiency and cost effectiveness but also ensures access to innovative expertise and technologies that may not be available in-house.

Standardized Processes: Component Manufacturing and Modular Assembly

In the automotive industry, certain manufacturing processes, such as the production of fasteners, wiring harnesses, or engine components, follow well defined requirements and established methodologies. Due to their standardized nature, these processes are frequently outsourced to third-party suppliers, allowing OEMs to reduce costs and focus on their core competencies.

- **EDM choice**: Outsourcing these components is particularly effective when using a Fixed Price contract model, as it provides cost predictability and a clear allocation of responsibilities to the supplier. Since standardized components are produced based on stable and well-defined requirements, the FP model ensures financial stability and minimal operational risks for the OEM. Additionally, this approach transfers operational and financial risks to the supplier while maintaining strict adherence to costs and delivery timelines.

Consultants play a crucial role in optimizing the outsourcing process. Their expertise can help in defining contractual specifications and key performance indicators related to quality and delivery standards. Furthermore, consultants assist in supervising supplier performance and implementing monitoring tools, ensuring compliance with predefined standards and expectations.

This outsourcing strategy not only enhances cost efficiency and risk management but also enables OEMs to focus on innovation and strategic business areas, leveraging the specialized expertise of external suppliers.

Interactions in Standardized Process Outsourcing

The successful outsourcing of standardized components requires strong coordination and effective interaction across different stakeholders:

- Internal Coordination: Procurement teams must continuously monitor compliance with contractual terms and assess supplier performance against quality KPIs. This ensures that outsourced components meet predefined quality, cost, and timeline expectations.
- External Relations: The OEM-supplier relationship is structured around regular audits and inspections, which serve to verify adherence to agreed specifications and maintain consistent quality standards. These periodic reviews help identify potential deviations early, ensuring corrective actions are implemented before they impact production.
- Phase-to-Phase Interactions: The timely delivery of components is critical to preventing delays in the final assembly phase. Any interferences in the supply chain can create a domino effect, affecting production schedules, increasing costs, and impacting overall project efficiency. Therefore, ensuring synchronization between component manufacturing and final assembly is essential for maintaining a smooth production workflow.

Technological and Innovative Processes: ADAS and Infotainment Systems

The design and integration of advanced technological systems, such as ADAS (Advanced Driver Assistance Systems) and infotainment, require specialized expertise and high flexibility.

Since technical requirements often evolve throughout the development cycle, external collaboration becomes a key strategy to ensure access to advanced technology without requiring significant internal R&D investments.

- **EDM choice**: to manage these complexities, Time & Material contracts are often used in the early stages of development, when specifications are still unclear and frequent iterations are necessary. This model provides the adaptability needed to refine prototypes and explore technological solutions without rigid cost constraints. Once requirements are defined and stabilized, a hybrid approach may be more suitable, transitioning from a T&M model for exploratory phases to a Fixed Price (FP) contract for the final implementation. This combination allows for initial flexibility while ensuring cost predictability in later stages.

Consultants play a fundamental role in facilitating collaboration among multidisciplinary teams, ensuring that complex technologies are integrated efficiently into the overall vehicle architecture. Additionally, they provide support in defining project milestones and assist in managing contractual adjustments, ensuring that project objectives remain aligned with evolving requirements.

Key Interactions and potential risks in the Development Process

- Internal Coordination: The continuous involvement of R&D teams is essential to provide ongoing feedback and validate technological progress.
- External Collaboration: A close partnership with suppliers ensures effective requirement adjustments and integration feasibility throughout development.
- Phase-to-Phase Interaction: Critical interactions occur between early-stage development and prototype integration phases, where functional validation and system compatibility are assessed.
- Integration Challenges: Technologies developed externally may face compatibility issues when incorporated into the broader vehicle architecture.

By exploiting external expertise and adopting flexible engagement models, OEMs can successfully integrate innovative automotive technologies while maintaining agility and cost control throughout the development process. This structured approach enables a transition between exploration, refinement, and large-scale implementation, ensuring that ADAS and infotainment systems meet both performance expectations and market demands.

Design and Engineering Services

The development of design and engineering services requires close collaboration between the client and the supplier, ensuring that design requirements are effectively translated into technical solutions. This approach provides flexibility and allows companies to access specialized expertise without the need to expand their internal workforce.

- **EDM choice**: To manage these dynamic processes, Time & Material contracts are particularly suitable for creative and iterative activities, such as initial design development and the engineering of new components. This model enables continuous improvements and adjustments, accommodating changes in design specifications and technical feasibility. In cases where a more structured execution phase is required, a hybrid model can be implemented. In this approach, T&M is used during the ideation and proof-of-concept phase, while a Fixed Price model is adopted for detailed engineering execution, ensuring cost predictability and delivery commitments.

Consultants play a crucial role in optimizing these processes. They act as mediators between technical and managerial teams, ensuring that expectations remain aligned throughout the project lifecycle. Additionally, consultants can support the implementation of agile methodologies, which help accelerate design cycles and improve time-to-market efficiency.

By outsourcing this process towards specialised third parties and approaching flexible engagement models, companies can enhance innovation, streamline engineering processes, and ensure that design solutions meet both functional and commercial requirements. This structured approach fosters efficient collaboration, technical excellence, and a more agile response to evolving project needs.

2.4.5 Impact of OEM size on the choice of EDM

The size of an OEM, in sold vehicles volume, plays a crucial role in determining the most suitable Engagement Delivery Model for consultancy projects. Differences in operational capacity, available resources, and strategic priorities lead to distinct approaches in the management of production and development processes.

Large OEMs, such as Stellantis or Volkswagen, possess significant financial, technological, and organizational resources, allowing them to maintain strict control over their most critical processes.

As previously discussed, their high bargaining power enables them to adopt a Fixed Price model for many standardized processes, ensuring cost predictability and operational efficiency.

However, when it comes to highly innovative phases, these companies often opt for Time & Material or hybrid EDMs to leverage the flexibility needed for technological advancements.

This strategic approach offers several advantages. By utilizing FP for high-volume standardized processes, large OEMs can exploit economies of scale, reducing unit costs and improving efficiency. Simultaneously, by keeping innovation driven activities internally or in close collaboration with selected partners, they can minimize dependency on external suppliers and maintain control over core technological advancements.

Conversely, OEMs operating in niche markets, such as those specializing in sports cars, luxury vehicles, or highly customized electric vehicles, often follow a different strategy.

Their production volumes tend to be lower, but their products require a high degree of customization to meet client expectations.

Due to the frequent modifications in design and technical requirements, these companies rely more extensively on T&M contracts, which offer the necessary flexibility to satisfy evolving specifications.

For these OEMs, each vehicle is treated almost as an independent project, requiring close collaboration with suppliers not only for design adaptation but also for co-developing new technologies and solutions. In this context, suppliers act as strategic partners in innovation, contributing to the creation of unique and technically sophisticated products.

The priority in these cases is not mass production efficiency but rather quality and exclusivity. The limited production scale allows these companies to concentrate resources on technical refinement and customization. Although using T&M contracts even for standardized processes may appear counterintuitive, it is a logical choice for quality-driven OEMs. Unlike mass-market vehicles, high-end models cannot be strictly defined by fixed timelines or costs, as client preferences introduce high variability in production. For instance, variations in optional features and custom configurations may require adaptations in wiring systems, making a rigid FP approach impractical.

Ultimately, the selection of EDMs is strongly influenced by an OEM’s market positioning and strategic priorities. While large manufacturers capitalize on FP models to achieve cost efficiency and scalability, niche OEMs prioritize flexibility and supplier collaboration to maintain their competitive edge in customization and innovation.

3 Methodology

3.1 Description of Capgemini and Altran acquisition

Capgemini Engineering, formerly known as Altran Technologies, is a global consulting company specializing in innovation and engineering.

During the 1980s, Altran adopted a decentralized growth strategy, allowing small operational units to manage their own expansion. This structure enabled the company to adapt quickly to market demands and diversify its services.

In 2019, Altran was acquired by Capgemini, a strategic move that combined the strengths of both companies to offer more integrated solutions to clients. In 2021, following the merger with Capgemini's engineering and R&D services, Altran was rebranded as Capgemini Engineering, reflecting its new identity and expanded service offerings.

Figure 1: Capgemini Engineering logo

Capgemini Engineering specializes in engineering and research & development (R&D) services. The company provides innovative solutions covering the entire product lifecycle, from the initial concept phase to production and post-sales support. By combining traditional engineering expertise with new digital technologies, Capgemini Engineering helps businesses innovate and tackle the challenges of the global market.

Its main areas of expertise include product and systems engineering, with a focus on mechanical design, electronics, and semiconductors, as well as the development of complex systems. The company is also highly involved in the digital and software sector, focusing on software engineering, connectivity, networks, data science, and artificial intelligence. Additionally, it provides support in industrial operations optimization, helping companies enhance their manufacturing processes, operations management, and product support.

Capgemini Engineering operates across several key industries, collaborating with leading global companies. It has a strong presence in the aerospace and defence sector, contributing to the development of civil and military aviation solutions, as well as in the automotive industry, where it supports vehicle design and innovation, including electric and autonomous vehicles. The company is also active in the railway sector, offering services to improve infrastructure efficiency and safety, and in telecommunications, working with network operators to enhance connectivity and digital infrastructure.

The company also provides strategic consulting in the energy sector, developing solutions to support the transition to sustainable energy sources. In the life sciences field, it helps pharmaceutical and medical companies innovate their products and processes. The semiconductor and software & internet industries are also key focus areas for Capgemini Engineering, as it partners with high-tech companies to develop new digital products and services.

Capgemini Engineering positions itself as a strategic partner for companies looking to exploit the latest digital and engineering technologies to enhance their competitiveness and innovation.

Today, Capgemini Engineering continues to operate as a key division within the Capgemini Group, providing consulting services in innovation and engineering to clients worldwide.

Specifically, this thesis focuses on the Automotive, Infrastructure & Transportation (AIT) division, headquartered in Turin.

3.2 Analysis Description

From a theoretical perspective, extensive research has been conducted to examine the impact of multiple variables on project performance. Similarly, the relationships between these factors and the selected engagement delivery model have been analysed, mainly in the Information Technology sector.

Building on this foundation, as outlined in the chapter defining the thesis objectives, an empirical approach is adopted to explore potential correlations between project profitability and other key project parameters. The aim is to validate theoretical assumptions through real-world data analysis.

To achieve this, a comprehensive database has been created using project monitoring documentation from Capgemini. The dataset consists of a selection of relevant projects, enabling an empirical investigation that closely aligns with studies reviewed in the literature.

The database includes a total of 63 projects, categorized according to their engagement delivery model. Specifically, 37 of these projects have been managed under a Time and Material contract, while the remaining 26 follow a Fixed Price model.

For the purpose of this analysis, the dependent variable selected is the absolute value of profit, rather than its percentage representation. This approach facilitates a clearer understanding of the actual profit figures and enhances the interpretability of regression coefficients, ultimately leading to more precise and meaningful conclusions.

The other independent variables considered in this analysis are as follows:

- **Worked Days**: This variable represents the cumulative number of workdays contributed by the project team that are accounted for as costs by the supplier company. However, it is important to note that the number of days worked by the project manager is excluded from this calculation. This metric serves as the primary indicator of the effort applied on the project, providing a quantitative measure of the total workload involved.
- **Average Cost**: This parameter is determined by dividing the total cost associated with the project team by the total number of worked days. It plays a crucial role in assessing the seniority level of the resources assigned to the project. Given the complexity of standardizing resource seniority on a scale from 1 to 5, as is commonly done in literature studies, this metric provides a more practical alternative for evaluation.
- **Duration**: This variable represents the total length of time required for project completion and serves as a secondary measure of the project timeline. However, due to variations in project team sizes, the duration alone does not provide substantial insight into overall project complexity or efficiency.
- **Average Team Size**: This metric calculates the average number of full-time equivalent (FTE) resources engaged in the project per month, excluding management roles. It offers a comprehensive perspective on both the total costs incurred and the overall complexity of the project, as a higher number of FTEs generally correlates with more challenging project scope and resource requirements.
- **Team Size Standard Deviation**: This value reflects the level of variation in the size of the project team on a monthly basis. A higher standard deviation indicates greater fluctuations in team composition over time. As will be discussed in subsequent sections, this metric has significant implications for other project variables, particularly in terms of total costs and resource stability.
- **Low-Cost Country FTE**: LCC stands for "Low-Cost Country," referring to offshore resources involved in the project. This metric captures the average number of offshore team

members engaged per month, providing insight into the extent of offshore outsourcing within the project.

- **Low-Cost Country %**: This variable represents the proportion of offshore resources within the total project team. A higher percentage indicates a greater degree of externalization of project activities, which could potentially imply a reduced level of direct supervision over the execution of tasks.
- **EDM (Engagement Delivery Model)**: This is a dummy variable that categorizes the project based on the type of contract used. It takes a value of 1 if the project is managed under a Fixed Price contract, while it is assigned a value of 0 if the project follows a Time and Material engagement delivery model.

The model is developed with this process:

1. The first step in developing the model is the selection of the most relevant variables. While all variables have an impact on profit, some have a stronger influence, while others contribute less significantly. Since it is not feasible to include all variables in the model, a careful selection process is required to ensure accuracy and avoid unnecessary complexity. To achieve this, a correlation analysis is performed to identify potential multicollinearity among the independent variables. If two or more variables are highly correlated, it could lead to redundancy and distort the reliability of the model. Therefore, variables that show strong interdependence may need to be excluded or adjusted. Additionally, the correlation between the dependent variable (profit) and each independent variable is analysed. This step provides preliminary insights into which factors have a stronger or weaker relationship with profitability. Although correlation alone does not imply causation, it serves as a useful indicator for identifying the most relevant predictors before proceeding with more advanced statistical techniques. By conducting this initial analysis, the model is built on a solid foundation, ensuring that the selected variables contribute meaningfully to explaining variations in profitability while minimizing the risk of multicollinearity.
2. The second and most critical step in the methodology involves the construction of the multiple-variable regression model, thanks to Excel functions. Once the most relevant variables have been selected, the goal is to analyse how these factors collectively influence the absolute value of profit across two different project governance structures: the Time and Material model and the Fixed Price model. A key aspect of this analysis is recognizing that some variables may not appear to have a direct impact on profitability when observed in

isolation. However, their influence could become significant when analysed in combination with other factors. The multiple regression structure allows for a broad evaluation of these interactions, helping to expose relationships that may not be immediately apparent in simpler analyses. By applying this approach, the model aims to provide a detailed understanding of how different project governance types affect financial performance. This analysis will help determine whether certain variables play a more dominant role under one engagement model compared to the other, offering valuable awareness into the profitability drivers within consultancy projects.

3. The final step of the analysis focuses on evaluating the validity and limitations of the developed regression model. To ensure the reliability of the findings, several key aspects are examined, including the normality of residuals, multicollinearity, and the statistical significance of both individual variables and the overall model through p-values. This validation process is essential, as even if the model provides valuable insights into the relationships between variables, it may still contain a margin of error or limitations that affect its predictive accuracy. By critically assessing these factors, the analysis ensures that the conclusions drawn are statistically sound and meaningful. Furthermore, recognizing the model's constraints opens the door for future research, allowing experts and practitioners to refine these findings and gain a deeper understanding of best practices in project governance and profitability analysis. Identifying areas for improvement also encourages further studies that could enhance decision-making processes in similar consultancy environments.

4.Results

4.1 Correlation

To ensure the accuracy and reliability of the regression analysis, it is essential to carefully select the variables used in the model. A high level of attention and precision is required during this process to minimize potential issues that could compromise the validity of the results.

One critical aspect to consider is the possibility of interdependencies between certain variables. If two or more variables are strongly correlated, including them together in the analysis could lead to redundancy, distorting the overall interpretation of the results and affecting the robustness of the regression model. To address this trouble, the following table presents the correlation coefficients between each pair of variables. By analysing these correlations, we can identify potential connections and influences that should be mitigated to prevent unnecessary repetition in the calculations.

	Profit	*worked days*	*Team size std dev*	*Avg Cost*	*Avg Team size*	*Low Cost Country FTE*	*LCC %*	*Duration*	*EDM*
Profit	1								
worked days	0,94	1							
Team size std dev	0,19	0,28	1						
Avg Cost	-0,04	-0,18	-0,13	1					
Avg Team size	0,60	0,62	0,40	-0,12	1				
Low Cost Country FTE	0,44	0,53	0,26	-0,58	0,69	1			
LCC %	0,17	0,26	0,11	-0,75	0,17	0,66	1		
Duration	0,60	0,63	0,22	-0,15	0,06	0,12	0,15	1	
EDM	-0,47	-0,56	-0,15	0,15	-0,26	-0,22	-0,10	-0,48	1

Table 2: correlation analysis

This approach ensures that only the most relevant and independent variables are included in the regression analysis, ultimately improving the clarity and effectiveness of the study.

Some pairs of variables exhibit a strong correlation, making it necessary to exclude one of them to prevent redundancy in the regression analysis. Below are the key variable pairs identified and the motivation for their exclusion:

- **Worked Days – Average Team Size**: These two variables are clearly interconnected. As the number of resources assigned to a project increases, it is highly likely that the total number of days worked by the team will also rise. Since both metrics essentially capture the same underlying effect, only one should be retained in the model. In this case, "Worked Days" is kept, as it provides a more direct measure of effort.
- **Worked Days – Duration**: Like the previous pair, both variables serve as indicators of project size. A higher total number of worked days typically implies that the project extends over a longer period, resulting in increased costs over multiple months. To maintain consistency with the variable selection criteria, "Duration" is excluded from the model.
- **Average Cost – Low-Cost Country FTE:** The use of offshore resources has become a fundamental practice in modern consulting projects. As mentioned in the previous chapter, one of the main goals of outsourcing to lower-cost countries is cost reduction. Consequently, a higher proportion of LCC resources, who generally have lower salary costs, tends to lower the overall average cost of the project team. Given this strong correlation, only one of these variables can be retained. **"**Average Cost**"** is chosen, as it offers a broader and more direct representation of project expenses.
- **Average Cost – LCC%:** The relationship between these two variables is essentially the same as the one described above, with an even stronger correlation. A higher percentage of offshore resources naturally leads to a reduction in average costs, reinforcing the need to exclude one of them. In this case, "LCC%" is removed from the model to avoid redundancy.

A separate evaluation is executed on the variable representing the contract choice for each project.

- **EDM**: The dummy variable used to represent the Engagement Delivery Model in the regression does not exhibit a particularly high correlation with any of the other independent variables. This finding is consistent with the guidelines established in the literature review, which our study further supports.

The absence of strong correlations suggests that the choice of EDM is influenced by a combination of factors rather than by a single dominant variable.

By analysing the R-values associated with the use of a Fixed Price model, we can identify best practices in project management and contractual decision-making. However, it is crucial to recognize that the impact of this variable on profitability and overall project dynamics should not be assessed in isolation. Instead, its effects must be examined in combination with other factors to fully understand how different project characteristics interact under distinct governance models.

The Fixed Price model shows a negative correlation with several key project attributes, including profit, worked days, team size standard deviation, average team size, the number and percentage of low-cost FTEs, and project duration. The only positive correlation observed is with average cost. This suggests that Fixed Price contracts are generally implemented in shorter-duration projects, where there is a greater need for stability and predictability. These projects tend to have lower turnover rates and smaller teams, which facilitate better control over resources and execution. Additionally, they tend to rely less on offshore resources, reinforcing a preference for highly skilled and senior professionals who, despite their higher costs, contribute to maintaining high-quality standards and operational efficiency.

Furthermore, the higher cost of resources in Fixed Price projects reflects the need for more experienced personnel who can handle complex tasks efficiently and ensure that strict project timelines are met. Since Fixed Price contracts typically impose greater financial risk on suppliers, companies may opt for leaner teams composed of highly specialized professionals to optimize performance while minimizing unexpected deviations.

The negative correlation with the profit does not imply that the choice of this model imposes an opportunity loss in profitability but reminding the high connection between the dependent variable and the worked days, involved projects consequently have lower returns.

Ultimately, these findings confirm that the selection of an Engagement Delivery Model is not a one-dimensional choice but rather a strategic decision shaped by multiple project-specific constraints and objectives.

By eliminating these highly correlated variables, the regression model remains more precise and avoids potential distortions caused by overlapping influences. This careful selection ensures that each retained variable provides unique and valuable insights into the project's characteristics. Below the table containing the descriptive analysis of the previously illustrated variables included in the model. The mean, standard deviation, minimum, and maximum of each variable are provided.

Parameter	Average	Std Deviation	Min	MAX
Worked days	1095.67	990,93	13	3736
Average Cost	187,94	47,60	89,88	262
Turnover	1,64	1,53	0	6,76
Team size	7,07	5,38	1	20,6
Duration	8,49	6,40	1	36
LCC team size	2,88	3,20	0	14
LCC%	0,36	0,31	0	1

Table 3: descriptive analysis

4.2 Variables selection

Following this detailed analysis of the correlations between each pair of parameters, only three key variables have been retained, in addition to the EDM dummy variable. The selected variables are Worked Days, Average Cost, and FTE Number Standard Deviation. These three variables have been carefully chosen because they effectively represent the three fundamental dimensions of project management.

- **Project Size**: This aspect is captured through the Worked Days variable, which provides a clear measure of the overall effort dedicated to the project. A higher number of worked days typically indicates a larger or more resource intensive project.
- **Resource Seniority and Expertise**: The Average Cost variable serves as a reliable indicator of the seniority, experience, and capabilities of the professionals involved in the project. Since more experienced and highly skilled resources tend to have higher costs, this metric indirectly reflects the composition of the project team in terms of expertise levels.
- **Personnel Turnover and Stability**: The Team Size Standard Deviation variable helps assess fluctuations in team composition over time. A high standard deviation suggests frequent changes in the number of personnel working on the project, which can introduce both economic and qualitative challenges. These challenges may have distinct impacts depending on the engagement delivery model used.

By including these three variables, the model ensures that all key project management dimensions are represented: effort and scale (Worked Days), workforce quality (Average Cost), and team stability (Team Size Standard Deviation). This selection allows for a more comprehensive analysis of the project's characteristics and potential influences on overall performance.

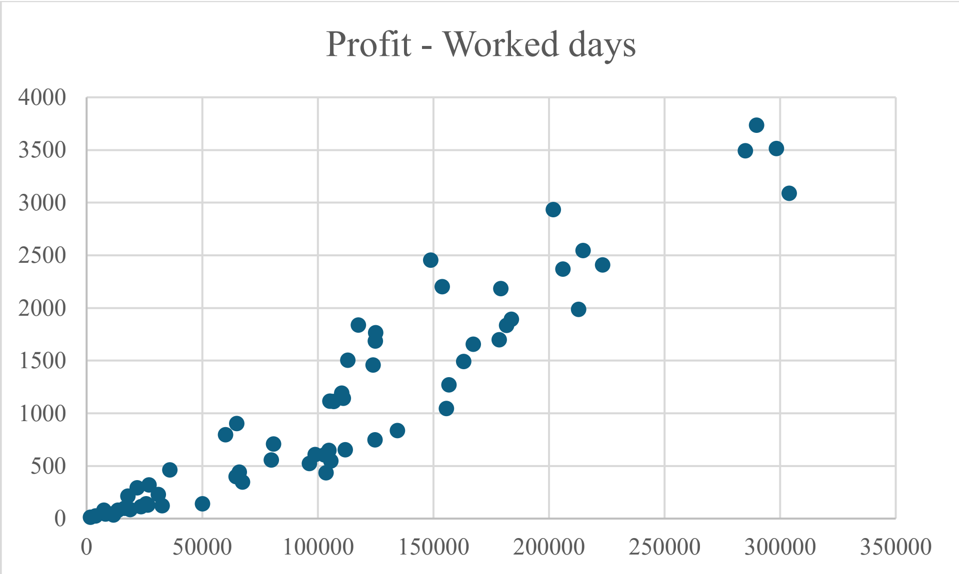

Figure 2: correlation between profit and worked days

With an R-value of 0,94, the number of worked days emerges as one of the primary factors influencing project profit. This result is expected, as this variable serves as an indicator of project size. It is logical that larger projects, which require more workdays, tend to have higher costs. Consequently, to maintain financial viability, these projects must also generate higher profits.

The other two variables analysed show a lower direct correlation with profit compared to worked days. However, despite their weaker statistical relationship with profit itself, they play a crucial role in project management efficiency and overall project effectiveness. Their impact is significant in shaping how resources are allocated, costs are managed, and risks are mitigated throughout the project lifecycle.

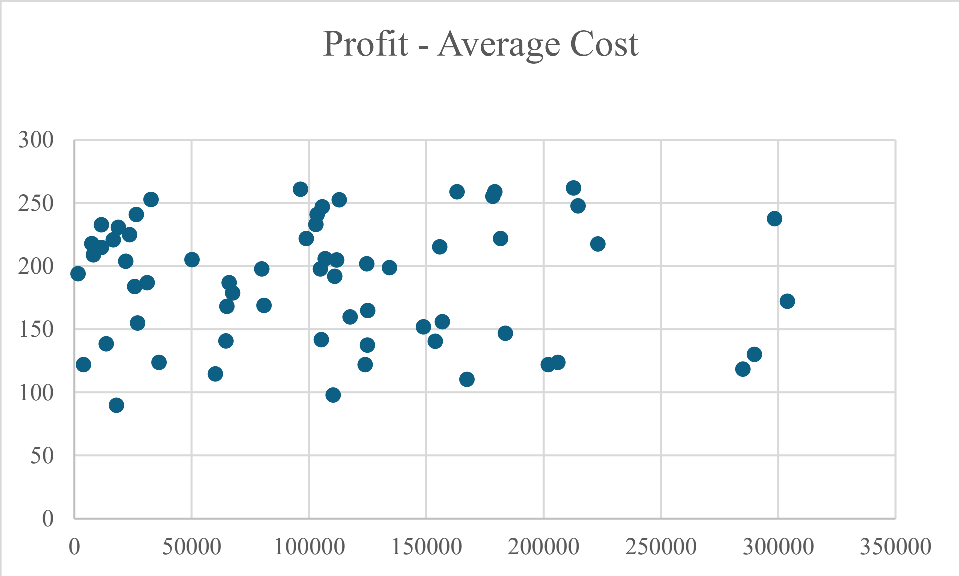

Figure 3: correlation between profit and average FTE daily cost

As previously mentioned, there is no clear or direct relationship between average resource cost and profit. While resource seniority plays a significant role in project execution, its effect on profitability is not immediately apparent or direct. More experienced team members typically require less supervision, demonstrate greater problem-solving abilities, and can often complete tasks more efficiently, leading to shorter execution times for specific activities. These advantages contribute to operational efficiency, reducing the likelihood of errors and the need for rework.

However, these benefits do not necessarily translate into higher profit margins in a predictable or linear manner. The correlation coefficient for this variable is -0.04, suggesting a very weak negative relationship with profit. This low correlation indicates that average resource cost alone is not a strong determinant of project profitability and that its effect should not be analysed in isolation.

Instead, it is essential to consider the interaction between resource costs, project duration, and workforce stability to gain a comprehensive understanding of how seniority influences both project performance and financial outcomes. A project with a highly experienced team may benefit from higher quality deliverables and reduced operational risks, but if the additional costs associated with senior resources are not offset by efficiency gains or premium pricing, the overall impact on profit may remain marginal or even negative.

This complexity emphasizes the need for a general approach when evaluating the cost-benefit dynamics of team composition, ensuring that resource allocation strategies align with both financial objectives and project execution efficiency.

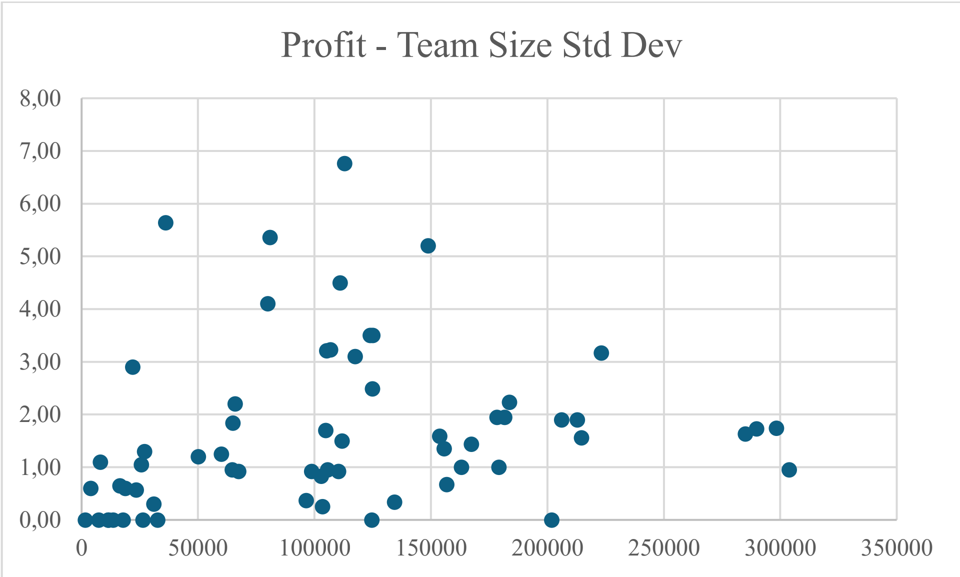

Figure 4: correlation between profit and team size variability

In this case as well, the correlation between personnel turnover, represented by the standard deviation of the number of resources involved per month, and final profit is quite low, approximately 0,19. While this value does not indicate a completely negligible impact on its own, it does lead to secondary effects that require proper management.

For instance, one important consideration is that the higher the average resource cost, the greater the impact of turnover. Frequent changes in personnel can introduce additional costs, such as time spent on training or inefficiencies due to knowledge transfer, which become more significant when dealing with highly skilled and more expensive resources.

Moreover, it is crucial to assess the correlation between the three selected variables, as they should ideally be considered independent when included in the regression analysis.

- **Worked Days – Average Cost**: With an R-value of -0,18, there is no strong correlation between these two parameters. The negative relationship suggests that projects with longer durations tend to have lower-cost resources allocated to them. This could be explained by the fact that longer projects may inherently involve higher risks, especially regarding team size variations, which organizations might attempt to mitigate by employing less experienced but adaptable resources.

Nevertheless, as illustrated in the scatter plot, the distribution of data points confirms that these two variables can be treated as independent, reinforcing their suitability for inclusion in the model without causing significant multicollinearity issues.

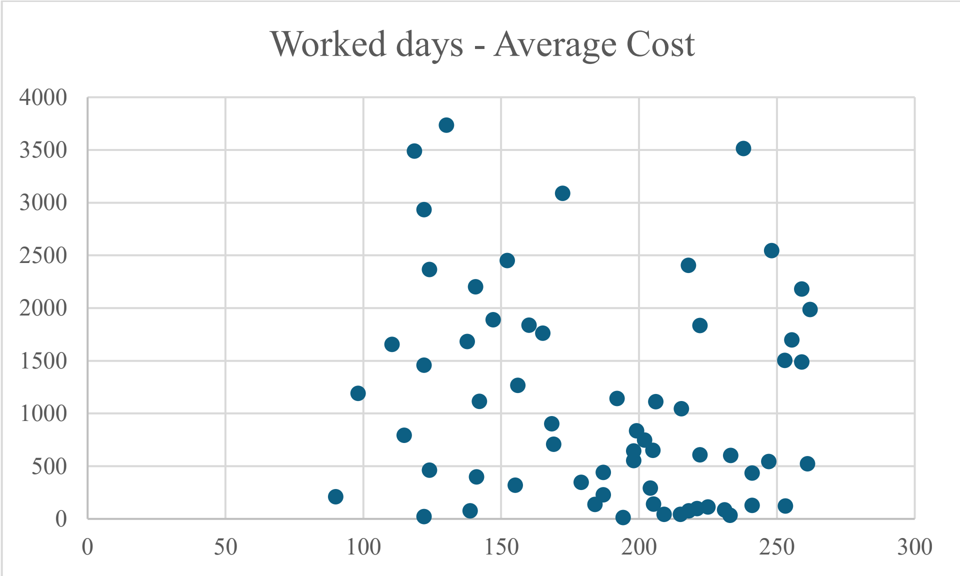

Figure 5: correlation between worked days and average FTE daily cost

- **Average Cost – Team Size Standard Deviation**: In this case, the correlation between these two variables is even weaker, with an R-value of approximately -0,13. This suggests that there is virtually no significant relationship between the average cost of resources (which reflects their seniority) and the variation in team size over time.

This lack of correlation is understandable, as there is no inherent reason to assume that the seniority of the resources involved would directly influence fluctuations in team composition. The primary factor driving changes in team size is typically client-driven decisions, which are influenced by project specific needs, evolving requirements, and external factors rather than the experience level or cost of the assigned personnel.

Given this very low correlation, it can be concluded that these two variables are largely independent, and their combined effect on project outcomes should be analysed.

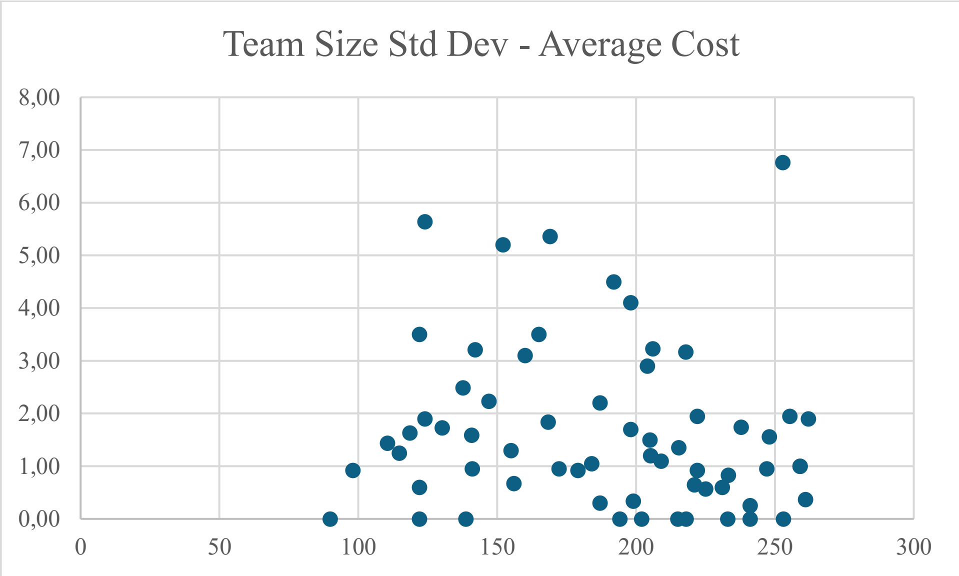

Figure 6: correlation between team size variability and average FTE daily cost

- **Team size Standard Deviation – Worked Days**: Among all the variable pairs analysed, this is the one that appears to have the better correlation, but still very low, with an R-value of 0,28. However, it is important to highlight that there is no direct causal relationship between them.

The variation in team size tends to fluctuate based on new resource allocations or removals from the project, rather than being directly influenced by the duration of the project itself. While it is true that longer projects are more likely to experience fluctuations in team composition, this is primarily due to the extended timeframe allowing for more staffing adjustments. Additionally, as previously discussed, project duration is closely correlated with the total number of worked days.

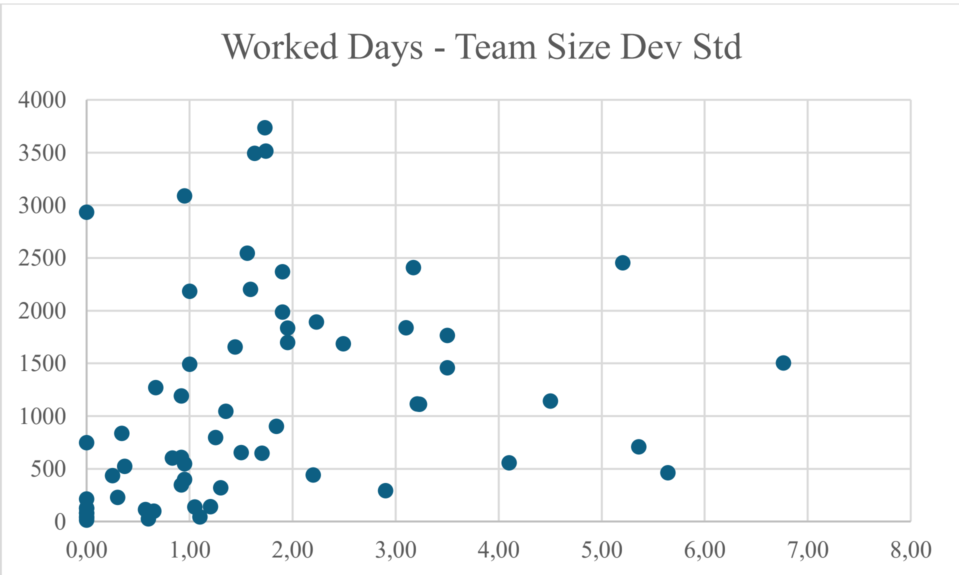

Figure 7: correlation between worked days and team size variability

The results of this analysis provide valuable insights into the expected absolute profit of a consultancy project within the automotive industry. To ensure the validity and effectiveness of the selected independent variables, the Variance Inflation Factor (VIF) is used.

VIF is a statistical metric that helps identify multicollinearity in a multiple regression model. Multicollinearity arises when two or more independent variables are highly correlated, leading to redundancy in the model and making it challenging to isolate the individual contribution of each variable to the dependent one.

The VIF for a given independent variable is calculated using the formula:

$$VIF = \frac{1}{1 - \mathrm{R}^2}$$

where R^2 represents the coefficient of determination obtained by regressing one independent variable against all the others.

Independent Variable	R Square	Variance Inflation Factor
Average FTE daily cost	0,043	1,05
Worked days	0,362	1,57
Team size standard deviation	0,088	1,10
EDM	0,317	1,46

Table 4: Variance Inflation Factors

Since all calculated VIF values are below the standard threshold of 5, indicating no significant multicollinearity, the regression model is considered valid and reliable for further analysis.

4.3 Regression model

By leveraging Excel's regression analysis tools, we have been able to examine the impact of the selected variables on project profitability. Although the results indicate some degree of influence, it is important to acknowledge certain limitations in validity, which may be due to factors such as data variability or potential model constraints.

The standard formula for a multiple variable regression analysis is as follows:

$$Y = \beta 0 + \beta 1x1 + \cdots + \beta nxn + \varepsilon$$

The Null Hypothesis for this model states that none of the selected variables, the number of worked days, the average FTE daily cost, the team size variability, and the choice of EDM, have a significant impact on the absolute profit value.

Because of database small size and inability to get more detailed information about projects, the model validity is assessed relatively to an alpha value of 10%.

The values deriving from the previously described database are the following ones.

	Intercept	Worked days	Average cost	Turnover	FP
Coefficient	-19668,9	81,63	209,64	-3704,73	11414,06
Std error	14666,78	3,81	64,79	2063,36	7415,65
P-value	0,185	3,11*10-29	0,002	0,078	0,129
Lower 95%	-49027	74	79,96	-7835	-3429,97
Upper 95%	9689	89,26	339,32	425,53	26258,09

Table 5: regression coefficients

Furthermore, the following table provides an overview of the extent to which the developed model accounts for the observed results. This table highlights the explanatory power of the regression analysis, allowing us to assess how well the selected variables contribute to predicting project profitability. By examining these values, we can evaluate the accuracy and reliability of the model in capturing key factors that influence financial outcomes.

Regression Statistics	
Multiple R	0,956
R Square	0,915
Adjusted R Square	0,909
Observations	63

Table 6: regression model performance indicators

The primary parameter to consider when evaluating the completeness and reliability of the regression model is the Adjusted R-Square value. In this case, with a value of 0,909, the model achieves a high level of explanation, providing insight into the relationship between the selected variables and project profitability.

Since the model has a Fisher's F-value equal to 156, associated with a significance level in the order of 10^{-30}, we can reject the null hypothesis with high confidence and conclude that our model provides a better fit than the null model.

Anyway, certain project-related factors have not been considered in the current model, caused by the variability of project domains. These omitted variables may contribute to the remaining unexplained variance, and they will be discussed in further detail later in the analysis.

- **Intercept**: The beta coefficient for the intercept is -19669, indicating a negative starting point for the regression model. This suggests that, at the initial stage, the model predicts an economic loss, which is gradually offset as the project progresses. However, the p-value associated with this intercept is higher than the 10% threshold, indicating a high level of variance in the project-specific factors influencing overall performance. This lack of statistical significance reduces the validity of the intercept as a reliable estimate. Despite this, a negative initial value is expected. In fact, every project incurs fixed costs at the beginning, such as those related to sales efforts, contract negotiations, and administrative setup. These expenses can result in an initial financial loss, which is then recovered over time as the project progresses and generates revenue.
- **Worked Days**: As previously introduced in the section outlining the analysis variables, this metric serves as the primary indicator of project size, influencing key aspects such as project duration, effort, and total cost. Given this intrinsic characteristic, a positive coefficient was anticipated, and the results confirm this expectation with a value of approximately 81,63. This figure represents an average profit per resource allocated to a project, though it is influenced by multiple factors beyond just seniority. One such factor is license involvement, which plays a role in determining project profitability. From a statistical standpoint, the coefficient demonstrates strong validity, with a significance level in the range of 10^{-29}. This high level of reliability stems from the strong correlation between profit and project size, reinforcing the robustness of the relationship between these variables. This trend is evident in both Time and Material and Fixed Price contracts. However, it is particularly pronounced in Time and Material projects, where operating margins are directly tied to time-based billing, making worked days a key driver of profitability. In the case of Fixed Price contracts, while profit is not directly dependent on time, larger and more complex projects tend to yield higher profits, as they often require greater effort and resources. It is important to note that the discussion here focuses on absolute profit values. This does not necessarily imply that an increase in worked days would be a positive factor in percentage terms, as profitability relative to costs could vary depending on project efficiency and resource allocation.

- **Average Cost**: While it is not directly linked to profit margins, average cost serves as an important indicator of project complexity. This metric acts as a Key Performance Indicator that reflects the seniority and capabilities of the team members assigned to a project. In many ways, average cost can be considered a baseline for project profitability. Theoretically, higher seniority levels should be financially rewarded in both engagement models:

  1. In Time and Material contracts, higher costs should be offset by higher billing rates charged to the client, ensuring that experienced resources contribute to profitability.
  2. In Fixed Price contracts, greater expertise can lead to higher efficiency, reducing the risk of delays or unforeseen costs, and ultimately benefiting the project's financial performance.

  As expected, the regression coefficient for average cost is strictly positive, with a value around 210, reinforcing the idea that more experienced resources are generally associated with higher project earnings.

  It has a reasonable level of robustness, registering at 0,002 p-value. This suggests that the relationship between average cost and profitability is meaningful and aligns with the expected hypothesis. Given the relatively low correlation between average cost and profit, it cannot be definitively classified as a profit margin driver. However, it is reasonable to assert that consultancy firms strategically allocate more experienced resources to projects with higher levels of risk, where greater expertise is required to mitigate uncertainties and maximize expected profit.

- **Team Size Standard Deviation**: In this context, turnover is measured as the standard deviation of the number of FTE allocated to a project on a monthly basis. This metric reflects fluctuations in team composition over time, which can have a significant negative impact on a project's financial performance. The regression analysis confirms this effect, with the coefficient associated with turnover being highly negative, approximately -3704,73. This strong negative value highlights how increased variability in team size leads to economic inefficiencies, ultimately reducing overall profitability. The p-value, being equal to 0,078, can be confirmed as valid in this model. The reasons behind this negative impact are multiple and closely interrelated. Expanding or frequently changing the project team can lead to several consequences:
  1. Increased Costs Due to Unrecognized Revenue Losses:

    - When new resources are added to the project, they require a handover period to become familiar with ongoing work and processes.
    - During this transition, additional costs arise, but they are not always compensated by corresponding revenue, leading to a financial burden on the project.
2. Decline in Quality and Loss of Client Trust:
    - If the new Full-Time Equivalent is recognized by the client, their limited knowledge of the project can result in reduced efficiency and lower-quality output.
    - Inexperienced team members may require more time to complete tasks or introduce errors, impacting the overall quality of deliverables.
    - A decline in quality can, in turn, lead to a loss of trust between the consultancy firm and the client, potentially damaging future collaboration and affecting the project's long-term success.

Due to these factors, high turnover rates introduce both direct financial losses and indirect risks related to project execution and client satisfaction. For this reason, ensuring team stability and minimizing workforce fluctuations is essential for optimizing project profitability and maintaining a high level of quality throughout the engagement.

When resources are removed from a project, several factors must be considered to assess the potential impact. The implications of such removals depend on the reason behind the decision and the engagement delivery model in use.

1. Removal Due to Resource Redundancy: If the removal occurs because certain resources are no longer necessary, then, in theory, no major issues should arise. In this case, the remaining team members can compensate for the absence of those removed, maintaining the same effort and performance levels. The decision to remove resources can be made either by the supplier or by the client, depending on the contractual framework.

This scenario unfolds differently based on the engagement delivery model:

- Time and Material Contracts: When this model is used, the decision to reduce resources typically comes from the client. The client, after evaluating the project's progress, may realize that a certain number of allocated resources is no longer required. They then communicate their decision to the supplier, requesting a reduction in team size to optimize costs.

- Fixed Price Contracts: In this case, the supplier is the one making the decision to reduce resources. If the supplier determines that the desired outcome can be achieved with greater efficiency, they may decide to reduce the number of resources involved. This allows them to increase profit margins, as the cost savings from fewer personnel lead to higher overall profitability while still delivering the expected results.

Overall, resource removal can be strategically beneficial in certain situations, if it does not compromise project execution or affect quality standards.

2. Unexpected Resource Reduction by the Client: When a client decides to reduce costs related to external consultants due to internal financial constraints or strategic adjustments, the supplier may not have anticipated this decision. In such cases, operational challenges may arise, as the remaining team members must compensate for the workload of the removed resource. This unexpected reduction can negatively impact team performance, increasing pressure on the remaining staff and potentially affecting project efficiency. Moreover, there is a significant risk to profitability, as the supplier may struggle to adjust resource allocation quickly enough to offset financial losses in these situations.
3. Impact of Team Composition and International Regulations: Another crucial factor to consider is the composition of the project team, which often includes resources from both Italy and offshore locations. Managing these resources is subject to strict regulations and contractual agreements between different countries, which can complicate staff adjustments.

For instance: In Capgemini Morocco, governance rules require one month’s notice before removing resources assigned to an Italian-led project. This creates potential financial risks when operating under a Time and Material engagement model, especially if a client unexpectedly demands a reduction in team size, specifically requesting the removal of low-cost country resources. In such cases, Capgemini Italy could face significant financial losses, as they may still be contractually obligated to pay for resources that are no longer billable to the client.

Even if contractual clauses explicitly outline these conditions, bargaining power dynamics between the involved parties may make it difficult for the supplier to fully claim compensation for these additional costs. This can lead to complex negotiations, potentially reducing the supplier's financial position and reducing the overall profitability of the project.

- **EDM**: A dummy variable is used to indicate the engagement delivery model selected for a given project. Ideally, a separate sample analysis should have been conducted for each engagement model to fully evaluate FP as an independent variable. However, due to the limited number of available projects, this approach was not feasible.

  The primary purpose of the FP dummy variable is to quantify the profit premium or loss associated with the Fixed Price model, keeping all other parameters constant. In other words, it aims to measure how the choice of a Fixed Price contract impacts profitability compared to a Time and Material model.

  However, there are several factors within the dataset that contribute to the low statistical validity of this variable:

  1. Different Project Objectives:
     - Fixed Price and Time and Material projects often have varying objectives, particularly in terms of effort required and the level of detail expected in deliverables.
  2. Variability in Project Team Composition:
     - The team structure differs significantly across projects, with high variance in governance control by Capgemini Italian perimeter, which affects how resources are managed.
  3. Diversity in Project Types and Contexts:
     - The sample includes projects from various domains, such as engineering, design, testing, and infotainment system development, each with unique characteristics and requirements.
  4. Additional Costs and Complexity Factors:
     - Some projects involve extra costs, such as software licenses and material purchases, which introduce variability in complexity and risk levels.

- The way clients evaluate and account for these additional expenses is not always consistent, leading to further unpredictability.

With all these influencing factors, the coefficient associated with FP is positive, with a coefficient of 11414, while the p-value is higher than the 10% threshold, equal to 0,129, so it still has a certain level of reliability in the information it gives.

The positive coefficient may be linked to the company's ability to implement efficiency in their projects, provided that the initial requirements were clearly defined before the project's start date. In some cases, projects with higher profitability levels also involve additional cost sources that are difficult to track. These hidden costs could have negatively impacted the model's outcome, leading to potential distortions in the results. This effect is largely due to the diversity of project types within the sample. For instance, projects focused on testing and developing infotainment systems often require significant expenditures on materials, making cost estimation and tracking more complex.

5.Conclusions

The findings highlight that the choice of EDM influences project performance and should be carefully aligned with project characteristics, client expectations, and external constraints.

- Time & Material contracts provide greater flexibility and adaptability in managing evolving project requirements but require strong governance and financial oversight to prevent cost overruns. This model is particularly effective in innovation-driven projects or when requirements are uncertain.
- Fixed Price contracts, on the other hand, ensure predictability in costs and timelines but require highly detailed initial planning to avoid costly renegotiations. This model is better suited for projects with well-defined objectives and lower complexity.
- The presence of offshore resources introduces additional challenges in project supervision, talent retention, and communication. The study suggests that T&M is generally preferred in offshore settings, as it allows companies to mitigate risks associated with turnover and evolving requirements. However, FP can still be viable if strong monitoring mechanisms and clear contractual agreements are in place.

The empirical analysis conducted using Capgemini Engineering's dataset confirms that project size, governance complexity, and resource allocation strategies all influence the profitability of both engagement models. For Original Equipment Manufacturers and consulting firms operating in the automotive sector, these findings offer practical insights into contract selection:

1. Project Size Matters: Larger projects with evolving requirements benefit from T&M contracts, while smaller, standardized projects can be managed effectively with FP agreements.
2. Fixed Price models can have great impact on simpler and more standardised projects, with more experienced workers, lower duration and effort necessary and more stability in project team composition.
3. Offshore Considerations: When outsourcing to offshore teams, companies must balance cost savings with potential risks related to resource stability and cultural differences.

It is interesting to compare the results of this analysis with the findings presented in the sample of 16 reviewed papers. However, it should be noted that not all studies examined the same variables in the same way, and several of them had different research objectives. Therefore, the comparison is limited but still useful for identifying patterns and validating some hypotheses.

- **Project Size**: Nine papers discuss how project size, measured in terms of effort, duration, or overall cost, can influence the choice of the most suitable Engagement Delivery Model. All of them support the hypothesis that Fixed Price contracts are more appropriate for smaller projects, which tend to have shorter timelines and lower profitability.
- **Team Size and Stability**: In three studies, there is a focus on the importance of team composition and turnover. These articles generally agree that Fixed Price models require greater stability within the project team. However, one study also highlights that smaller teams may be more effective when using a Time and Material model, due to their adaptability and easier coordination.
- **Team Experience**: Two papers analyse the role of experienced resources in project success. Both studies suggest that assigning more senior team members is particularly effective in Fixed Price contracts, where autonomy, problem-solving skills, and efficiency are crucial for meeting targets within strict constraints.

While this study provides a comprehensive analysis of EDMs in the automotive consultancy sector, certain limitations remain. The findings are based on a specific dataset from Capgemini Engineering, which may not fully represent the dynamics of other firms or industries.

Future research could expand on this work by:

- Examining a broader range of projects across different automotive companies to validate the conclusions.
- Exploring hybrid EDM models, which combine elements of both T&M and FP to optimize flexibility and cost efficiency.
- Investigating the long-term impact of offshore outsourcing on knowledge retention and innovation within OEMs.

Selecting the right Engagement Delivery Model is a critical decision that directly affects a project's profitability, efficiency, and overall success. By leveraging data-driven insights and best practices in contract management, consultancy firms and automotive companies can optimize project execution, mitigate risks, and enhance collaboration with external partners.

As the automotive industry continues to evolve, balancing flexibility, cost efficiency, and risk management will be essential for companies aiming to remain competitive in an increasingly complex and globalized market.

5.1 Study limitations

This empirical analysis provides valuable insights into how the selected variables influence project profitability. However, the proposed model has certain limitations in terms of validity, as it does not fully address the gaps in the existing literature on similar studies. These limitations primarily arise from the dataset composition and statistical constraints, which affect the accuracy and robustness of the results.

One of the main challenges is the sample size. According to best practices in statistics, a reliable regression model should have at least 15 observations per independent variable to ensure statistical significance. In an ideal scenario, the analysis would have been conducted separately for the two Engagement Delivery Models, Time and Material and Fixed Price. This would have required two independent datasets, each containing at least 45 projects, to accurately examine how worked days, team members' average daily cost, and team size variability impact profitability.

However, due to the limitations of the available dataset, comprising 26 Fixed Price projects and 37 Time and Material projects, it was necessary to introduce a dummy variable to differentiate between the two contract types. This solution, while useful, does not fully capture the complex interactions between project characteristics and financial performance. Furthermore, the diversity in project types suggests that a larger and more representative dataset would be beneficial. For example, while design projects typically require only a computer and software licenses, testing or infotainment system development often involve significant material and component purchases. These additional costs, which are not accounted for in the current model, may introduce further profitability variations that are not properly analysed.

Another validity concern arises from the residuals' distribution, which was assessed using the QQ-plot. This plot helps determine whether the residuals follow a normal distribution, which is a key assumption for linear regression models. In this case, since not all p-values fell below the selected significance threshold, the normality assumption cannot be fully confirmed. Instead, the residuals appear to be concentrated along the positive axis, indicating potential biases in the model.

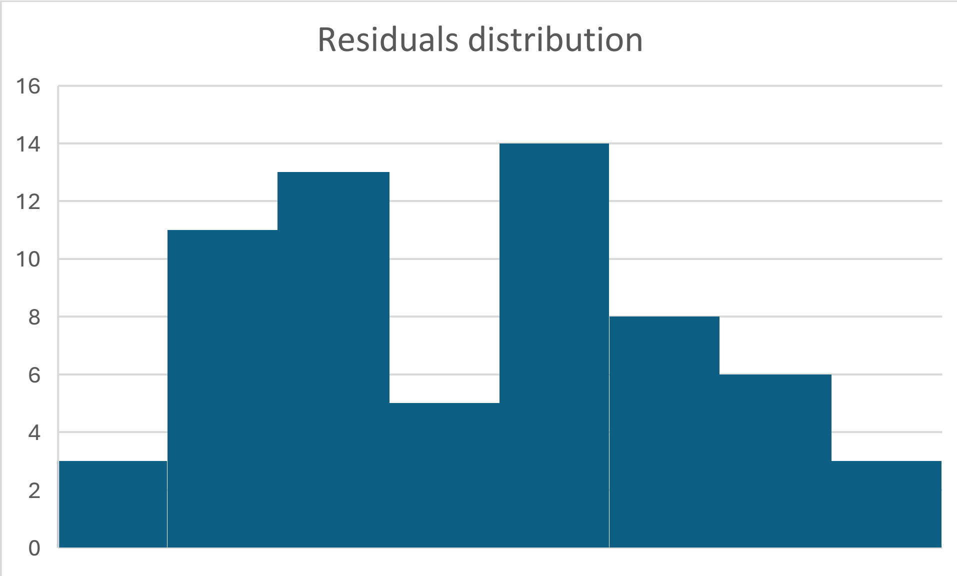

Figure 8: Residuals distribution

Additionally, homoskedasticity, the assumption that the variance of errors remains constant across different values of the independent variables, was also tested. If this assumption is violated, the model is said to be heteroskedastic, meaning that the accuracy of predictions declines as the independent variable values increase. In this case, the dispersion of residual values appears to be relatively consistent, regardless of the actual profit values, suggesting that heteroskedasticity may not be an issue. However, further refinement of the dataset and model specification could enhance the robustness of the findings.

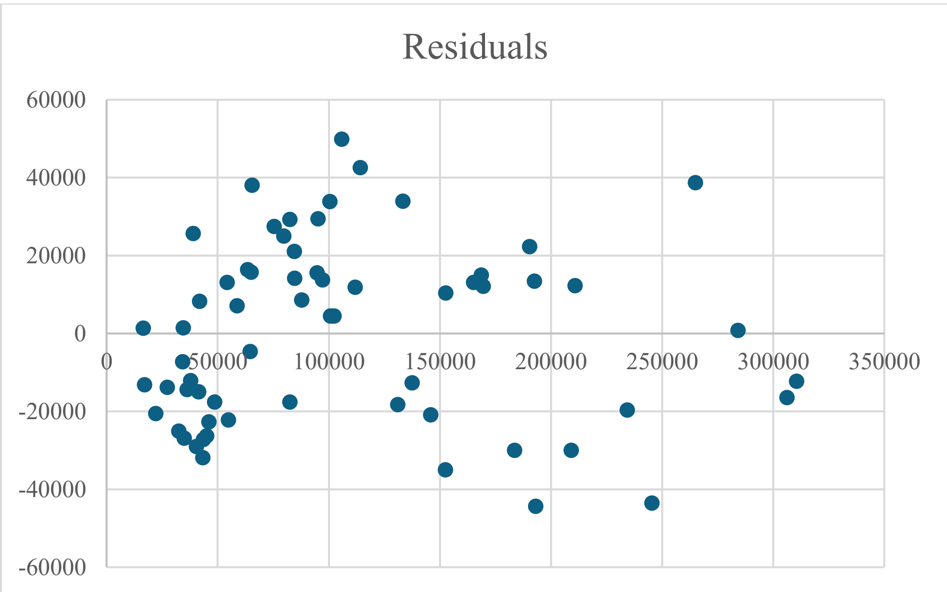

Figure 9: Heteroskedasticity scheme

Overall, while this regression model provides useful insights into profitability drivers, its effectiveness is somewhat constrained by dataset limitations, non-normal residual distribution, and the need for a larger, more diversified sample. Future research could improve upon these aspects by expanding the dataset, refining variable selection, and applying alternative regression techniques to better capture the complexities of profitability in different project types.

6. Bibliography

[1] Ahonen, J. J., Savolainen, P., Merikoski, H., & Nevalainen, J. (2015). Reported project management effort, project size, and contract type. *Journal of Systems and Software*, *109*, 205–213. https://doi.org/10.1016/j.jss.2015.08.008

[2] Andersen, B., Olsson, N. O. E., Onsøyen, L. E., & Spjelkavik, I. (2011). Post-project changes: occurrence, causes, and countermeasures. *International Journal of Managing Projects in Business*, *4*(2), 308–328. https://doi.org/10.1108/17538371111120261

[3] Calvo, E., Cui, R., & Serpa, J. C. (2019). Oversight and efficiency in public projects: A regression discontinuity analysis. *Management Science*, *65*(12), 5651–5675. https://doi.org/10.1287/mnsc.2018.3202

[4] Fink, L., & Lichtenstein, Y. (2014). Why project size matters for contract choice in software development outsourcing. *Data Base for Advances in Information Systems*, *45*(3), 54–71. https://doi.org/10.1145/2659254.2659258

[5] Ghadge, A., Dani, S., Ojha, R., & Caldwell, N. (2017). Using risk sharing contracts for supply chain risk mitigation: A buyer-supplier power and dependence perspective. *Computers and Industrial Engineering*, *103*, 262–270. https://doi.org/10.1016/j.cie.2016.11.034

[6] Gopal, A., & Koka, B. R. (2010). The role of contracts on quality and returns to quality in offshore software development outsourcing. *Decision Sciences*, *41*(3), 491–516. https://doi.org/10.1111/j.1540-5915.2010.00278.x

[7] Gopal, A., & Sivaramakrishnan, K. (2008). On vendor preferences for contract types in offshore software projects: The case of fixed price vs. Time and materials contracts. *Information Systems Research*, *19*(2), 202–220. https://doi.org/10.1287/isre.1070.0162

[8] Gupta, S., Agrawal, A., & Ryan, J. K. (2023). Agile contracting: Managing incentives under uncertain needs. *Production and Operations Management*, *32*(3), 972–988. https://doi.org/10.1111/poms.13909

[9] Jain, D. M., & Khurana, R. (2015). An empirical comparison of pricing models in information technology service outsourcing in Indian context. *Benchmarking*, *22*(4), 697–710. https://doi.org/10.1108/BIJ-03-2014-0019

[10] Jørgensen, M. (2016). A survey on the characteristics of projects with success in delivering client benefits. *Information and Software Technology*, *78*, 83–94. https://doi.org/10.1016/j.infsof.2016.05.008

[11] Jørgensen, M., & Grov, J. (2021). A field experiment on trialsourcing and the effect of contract types on outsourced software development. *Information and Software Technology*, *134*. https://doi.org/10.1016/j.infsof.2021.106559

[12] Jørgensen, M., Mohagheghi, P., & Grimstad, S. (2017). Direct and indirect connections between type of contract and software project outcome. *International Journal of Project Management*, *35*(8), 1573–1586. https://doi.org/10.1016/j.ijproman.2017.09.003

[13] Kotlarsky, J., Oshri, I., & Willcocks, L. P. (2016). *Revised Selected Papers Shared Services and Outsourcing: A Contemporary Outlook*. http://www.springer.com/series/7911

[14] Lind, S., Olsson, D., & Sundin, E. (2014). Exploring inter-organizational relationships in automotive component remanufacturing. *Journal of Remanufacturing*, *4*(1). https://doi.org/10.1186/2210-4690-4-5

[15] MacCormack, A., & Mishra, A. (2015). Trade-Offs from Partner Integration: Implications of Contract Choice in R&D Projects. *Production and Operations Management*, *24*(10), 1552–1569. https://doi.org/10.1111/poms.12374

[16] Mellewigt, T., Hoetker, G., & Lütkewitte, M. (2019). Avoiding high opportunism is easy, achieving low opportunism is not: A QCA study on curbing opportunism in buyer-supplier relationships. *Organization Science*, *29*(6), 1208–1228. https://doi.org/10.1287/orsc.2018.1227

[17] Mohagheghi, P., & Jorgensen, M. (2017). What contributes to the success of IT projects? Success factors, challenges and lessons learned from an empirical study of software projects in the norwegian public sector. *Proceedings - 2017 IEEE/ACM 39th International Conference on Software Engineering Companion, ICSE-C 2017*, 371–373. https://doi.org/10.1109/ICSE-C.2017.146

[18] Morgan, R., Doran, D., & Morgan, S. J. (2018). Strong contracts: the relationship between power and action. *International Journal of Operations and Production Management*, *38*(1), 272–294. https://doi.org/10.1108/IJOPM-02-2016-0064

[19] Feng, Z., Song, J., Yang, X., & Guo, R. (2023). Contractual flexibility, firm effort, and subsidy design: A comparison of PPP project contracts. *European Journal of Operational Research*, *307*(1), 484–496. https://doi.org/10.1016/j.ejor.2022.09.018

[20] Sturgeon, T., van Biesebroeck, J., & Gereffi, G. (2008). Value chains, networks and clusters: Reframing the global automotive industry. *Journal of Economic Geography*, *8*(3), 297–321. https://doi.org/10.1093/jeg/lbn007

[21] Albanese, G. (2023). Il project management nell'ambito ingegnerizzazione dello sviluppo prodotto automotive in offshoring, il caso Capgemini Engineering. *Polytechnic of Turin*

[22] https://en.wikipedia.org/wiki/Capgemini_Engineering