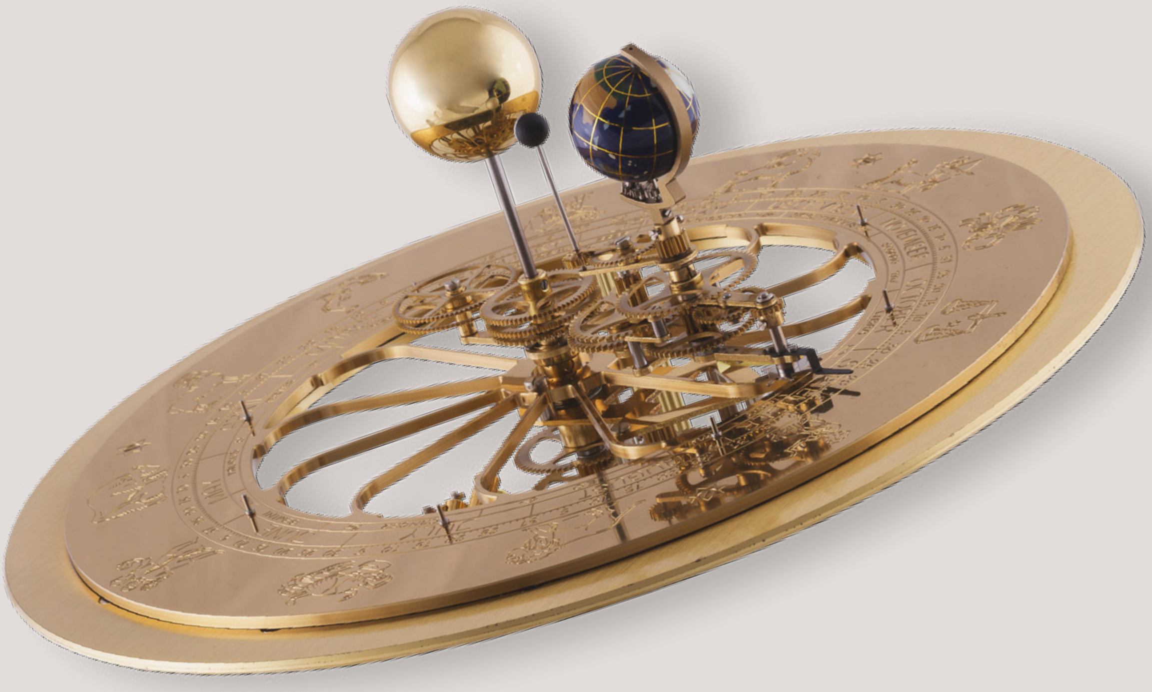
THE NEW PROJECT MANAGEMENT FRONTIER

Hidden dynamics arising from the interplay between the relational motive to co-create value, relational capital, and project performance



Jorge Sousa

Institute for Management Research

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The new project management frontier

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Jorge Sousa

The new project management frontier: Hidden dynamics arising from the interplay between the relational motive to co-create value, relational capital, and project performance
Jorge Alberto Barra Cancela De Sousa

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The new project management frontier

Hidden dynamics arising from the interplay between the relational motive to co-create value, relational capital, and project performance

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1. Introduction

1.1 Motivation

Having entered the software development field in 2001, I initially focused on enhancing financial market business knowledge for a company serving banks. As the industry surged in the early 2000s, I consistently observed recurring patterns in long-term projects and client relationships. These real-life examples, which I believe resonate with many professionals, include:

- Alienation - As projects extended over months or even years, the link between the project team and the company weakened, leading to colleagues feeling detached, sometimes even perceived as client employees.
- Dependence - Clients grew accustomed to specific staff, explicitly demanding them for new projects. This created challenges in staff motivation, resource allocation, and training opportunities.
- Knowledge management – Unchanged teams often neglected tasks like updating documentation, registering meeting outcomes, or updating reports. This reliance on tacit knowledge hindered new staff integration, increased assimilation time, and risked losing crucial information.

Two pivotal experiences deepened my determination to address these challenges. These situations underscored the detrimental effects of prolonged team-client relationships: diminishing company knowledge, increasing client dependency, and ultimately, leading to the loss of entire teams to competitors. In one instance, a competitor successfully hired our entire project team simply by offering more money, resulting in the immediate loss of the client who prioritized working with those specific individuals. In another, excessive proximity between the client's senior management and our development team prevented the identification and intervention of a structural problem, as the deeply involved client resisted any outside intervention.

My extensive experience vividly showcased the profound influence of interpersonal relationships between service providers and clients on project success and company growth. The software industry, then largely entrenched in a mechanical view where capacity was solely a function of human resources and labor hours, often disregarded these 'soft factors' due to their perceived intangibility and lack of measurability. Introducing such concepts to an engineering audience, accustomed to quantifiable metrics, proved particularly challenging despite their undeniable impact on driving success.

Fueled by these experiences, I pursued a Master's degree focusing on System Dynamics for corporate sustainable development. This academic endeavor illuminated the causal structure of the persistent challenges I observed. Yet, even armed with this understanding and after another decade in diverse professional settings (from small to large companies, and clients ranging from telecommunications to governments) the same problems repeatedly emerged. Short-term, experience-driven solutions remained the prevailing, yet insufficient, approach.

Frustrated by the slow pace of improvement, I sought further academic support, convinced that simulation models could better address these systemic issues. This led me to connect with Professor Etiënne Rouwette, who, recognizing the potential, involved Professor José Bloemer. Together, they provided the crucial theoretical foundation and missing links to address the complex questions arising from my professional experience.

This journey prompted a career pause, enabling me to delve into research aimed at preventing persistent problems arising from mismanaging personal relationships and motivations within project teams and clients. This thesis represents my contribution to improving project management practices. By integrating insights from marketing literature with project management and System Dynamics, I aim to underscore the critical role of relationships in an industry where this concept is yet to be fully appreciated. I sincerely hope this work serves as a catalyst, inspiring fellow researchers to explore and integrate these crucial findings into software development, thereby significantly improving project outcomes.

1.2 Knowledge gap and research questions

The software industry plays a transformative role in most organizations. Businesses rely increasingly on software tools, forcing a paradigm shift where information technology is not merely a support function but a strategic enabler of organizational success (CompTIA, 2019; Deloitte, 2019; Mckinsey&Company, 2018). This influences decision-making processes and fosters agility in an ever-evolving global marketplace. At the core of this intricate landscape lies the pivotal role of projects, the engines that turn ideas into solutions. Defined tasks and milestones within these projects, managed by methodologies ranging from traditional waterfall approaches to more adaptive Agile and hybrid methods, are essential for successful software creation.

Software projects consistently face overruns, a pervasive challenge highlighted by the fact that over two-thirds exceed planned budgets in terms of time and cost (Kuutila *et al.*, 2020). The increasing pace of evolving business requirements and demand for greater flexibility necessitated alternative methodologies, with Agile and Hybrid approaches emerging as most prominent (Reiff and Schlegel, 2022). These methodologies place the client at the heart of the software development process, fostering unprecedented client participation.

While customer involvement has grown with Agile and Hybrid methodologies, research on the impact of personal relationships within these collaborations remains limited (Rood et al., 2018). Moreover, existing methodologies, including Waterfall, Agile, and their Hybrid variations, are still basically process-oriented. They largely overlook relational dynamics' combined positive and negative consequences on project success, leaving this area underexplored. These gaps are concerning, particularly given the frequency of interactions and reliance on customer input in modern software development.

Our research aims to address these knowledge gaps by investigating the interplay between personal relationships and project outcomes within Agile and Hybrid software development settings. Two overarching research questions guided this thesis:

1. How do the relational motive to co-create value (RMCCV) and relational capital impact project results in terms of cost and schedule?
2. How can service providers leverage the relational motive to co-create value and relational capital for better project results in terms of cost and schedule?

While project quality is an integral part of the project trilemma, this thesis primarily focuses on cost and schedule as key project outcomes in its empirical analysis. This choice reflects a significant practical limitation within the software development industry, where qualitative project success metrics, such as client satisfaction and perceived service quality, are rarely systematically measured or tracked by companies. Our research, therefore, highlights this critical measurement gap, advocating for its future integration in project management practices as discussed further in Chapters 6 and 7.

Understanding the relational motive to co-create value and relational capital in software development is crucial for boosting project success, resulting in substantial cost savings, and keeping teams motivated and successful. On one hand, RMCCV fosters collaboration, leading to superior client-centric solutions, long-term relationships, and continuous stakeholder engagement, all critical in Agile and Hybrid approaches. On the other hand, relational capital facilitates knowledge sharing, strengthens customer ties, unlocks access to valuable external resources, and enhances risk management. Thus, delving into the combination of RMCCV and relational capital offers significant potential for enhancing project outcomes and driving long-term success in software development projects.

To improve our understanding of project management practices for the software development sector, we first provide an overview of project management's challenges and the argument for the overlooked importance of relationships in the software development process. Additional information regarding project management activities and the methodologies addressed in this thesis is presented in Appendix 6.

2.1 Project management in software development

2.1.1 Context

Gartner predicts the software industry will surpass 1 trillion US Dollars in 2024[1], maintaining its position as the fastest-growing segment within the Information Technology (IT) sector. This growth is fueled by continuous technological advancements, particularly in areas like artificial intelligence, with no anticipated slowdown (Gartner, 2024).

The software industry's growing importance stems from its transformative role in contemporary business. In recent years, IT companies have evolved into strategic partners for organizations across diverse industries (CompTIA, 2019; Deloitte, 2019; Mckinsey&Company, 2018). This shift is driven by the realization emanating at least 15 years ago that robust, adaptive software solutions are integral to enhancing operational efficiency, fostering innovation, and maintaining competitive advantage (Georgantzas and Katsamakas, 2008; Lusch, Vargo and O'brien, 2007). Consequently, IT companies are now pivotal contributors to core business functions and strategic enablers of organizational success (Mckinsey&Company, 2018; WorldBank, 2019).

1. Gartner Forecasts Worldwide IT Spending to Grow 8% in 2024

Software development fundamentally revolves around projects. These projects, with their defined tasks and milestones, are managed by methodologies ranging from traditional waterfall to more adaptive Agile approaches, ensuring successful software creation. This project-centric approach, emphasizing collaboration across diverse teams, highlights project management's critical role as a source of leverage in the global economy.

2.1.2 Addressing the problem: Overruns

Software projects consistently face overruns, with over two-thirds exceeding planned budgets for time and cost (Kuutila *et al.*, 2020). These overruns have far-reaching implications for companies and society. Any improvement in project management could yield substantial financial benefits, with marginal gains estimated to contribute over $100 million annually in worldwide savings[2]. Optimizing project management is thus paramount for both cost-effectiveness and broader societal advantages.

While precise estimation is difficult, industry studies indicate average software project cost overruns range from 20% to 50%, sometimes exceeding these thresholds[3]. Research identifies numerous reasons for these overruns, including:

- **Rework**: Errors are common in software development and lead to rework, a pervasive issue responsible for significant time and cost delays (Lyneis and Ford, 2007; Rahmandad and Hu, 2010; Li *et al.*, 2018; Abdel-Hamid, 1984).
- **Scope changes**: Alterations in project requirements or scope frequently translate into escalate costs (Godlewski, Lee and Cooper, 2012; Choi and Bae, 2009).
- **Unforeseen delays**: Delays in validation, authorization, and similar processes can force projects into a spiral of eroding schedules (Jalili and Ford, 2016; Li *et al.*, 2018).
- **Complexity and size**: Larger, more intricate projects, especially customized development, are more susceptible to cost overruns (Choi and Bae, 2009).
- **Inadequate planning and underestimation**: Deficient project planning and estimation significantly increase overrun likelihood. Estimate quality and accuracy depend on the scheduler's experience and judgment (Jalili and Ford, 2016; Ford and Sterman, 2003a).
- **Difficulty measuring progress and success**: Documented difficulties exist in reporting project progress (Ford and Sterman, 2003a), and assessing

2. Researcher conservative estimation based on market data.
3. See for example: 5 Reasons for Overruns in Custom Software Development - Pulsion Technology

overall project success—whether regarding quality or cost (Anantatmula, 2010), or providing new estimations during development (Austin, 2001).
- **Development methodologies**: Methodology selection (e.g., Agile or Waterfall) influences the probability and impact of cost overruns. While merits are debated, Waterfall's formal, sequential approach may yield better schedule adherence. Agile, designed for changing requirements, may perform better on quality and user experience, especially in uncertain projects (Reiff and Schlegel, 2022).

To mitigate project overruns, the software industry has heavily invested in enhancing existing methodologies and developing innovative ones. Understanding the historical context of project management methodologies is essential to grasp their evolution and impact. For years, sequential methodologies, notably the Waterfall method, dominated software development (Yahya and Maidin, 2023). This linear, step-by-step approach encompassed detailed analysis, software development, testing, and client acceptance. However, the increasing pace of evolving business requirements and the demand for greater flexibility necessitated the introduction of alternative methodologies. Agile emerged as most prominent (Reiff and Schlegel, 2022), embracing an iterative, adaptive approach by breaking projects into smaller phases or sprints. This allows continuous feedback and adaptation to changing requirements, enhancing responsiveness and aiming to minimize overrun risks.

The Agile methodology was first introduced in 2001 by 17 software developers in their Agile Manifesto (Beck *et al.*, 2001), and swiftly gained prominence in IT service and product development (Sarangee *et al.*, 2022; Fatema and Sakib, 2018; Patel, 2021; F. Tripp and Armstrong, 2018; Rebentisch *et al.*, 2018). It promised accelerated development cycles, accommodating client requirements without compromising timelines or quality (Chichakly, 2007), thus enhancing flexibility, responsiveness, and reducing time-to-market for software projects (Glaiel, Moulton and Madnick, 2014). However, the consistent delivery of these promises remains a topic of debate (Ching and Mutuc, 2018), and traditional software development challenges persist, prompting the emergence of critics of the Agile approach (Reiff and Schlegel, 2022).

To address the limitations of both plan-driven and Agile methodologies hybrid approaches emerged, combining their strengths for a more comprehensive approach (Yahya and Maidin, 2023). Hybrid methodologies integrate the structured planning and control of plan-driven methods with the adaptability and responsiveness of Agile. Given their increasing adoption and potential to enhance project success, understanding the characteristics of both Agile and Hybrid approaches is crucial.

Despite the increased client involvement inherent in modern Agile and Hybrid approaches, the subtle yet profound influence of personal relationships in these collaborations remains largely underexplored in methodological frameworks. This gap highlights a critical area of leverage that this thesis aims to address.

2.1.3 The Agile Method

Agile project management, an iterative, incremental, and adaptive approach (GAO, 2020; Beck et al., 2001), thrives in dynamic environments with frequent requirement changes. This flexibility (Conforto et al., 2016) is achieved through short development cycles ("sprints") and continuous feedback loops (Repenning, Kieffer and Repenning, 2017; GAO, 2020). Agile prioritizes minimal upfront planning (Cao, 2022; Imani, Nakano and Anantatmula, 2017) and welcomes evolving features, making it ideal for projects with uncertain requirements. In this collaborative model, clients often see the development team as an extension of their own, fostering shared responsibility for goals and coordination.

Sarangee et al. (2022) summarize numerous Agile benefits, including faster development cycles, lower costs, improved client satisfaction, enhanced quality, and improved communication and knowledge sharing among team members. However, they also identified challenges for Agile, such as the potential for inadequate documentation, limited scalability, and difficulty in managing large and complex projects[4]. Reiff and Schlegel (2022) further highlight inaccuracies in time and budget planning due to Agile's inherent continuous reprioritization. Our research identifies a growing client reluctance to accept Agile's flexible approach to time and cost planning, often perceived as a lack of service provider responsibility and commitment, which can lead to never-ending projects.

Scrum has emerged as one of the most widely adopted and recognized Agile frameworks among practitioners and organizations (Imani, Nakano

4. For a comprehensive literature review on Agile project management see Sarangee, K., Schmidt, J. B., Srinath, P. B. and Wallace, A. (2022) 'Agile transformation in dynamic, high-technology markets: Drivers, inhibitors, and execution', *Industrial Marketing Management,* 102, pp. 24-34.

and Anantatmula, 2017; Cooper and Sommer, 2018; Yahya and Maidin, 2023). Scrum's appeal lies in seamlessly integrating with complex project environments where uncertainty and frequent change are the norm. Yahya and Maidin (2023) highlight its suitability where requirements are dynamic, timely feedback is crucial, and project teams require flexibility to navigate change. Scrum's widespread adoption reflects a conscious organizational choice to embrace adaptability, responsiveness, and incremental delivery in software development.

2.1.3.1 Scrum Agile organization

Scrum relies on a structured approach to agility, building on a set of core roles, artifacts, and ceremonies to guide the project's progress. A full methodological description is outside the scope of the present thesis, nevertheless, Appendix 6 provides details on Scrum's roles, artifacts, and ceremonies to enhance understanding of software development dynamics.

As summarized in Figure 1, the generic Agile Scrum process illustrates the artifacts and ceremonies supporting project development. The process involves a diverse team with complementary responsibilities (see Appendix 6) and permanent participation from both clients and service providers. This client participation is materialized through roles such as the business team providing knowledge, the Product Owner, and often even Scrum Masters and developers, alongside their presence in all required meetings.

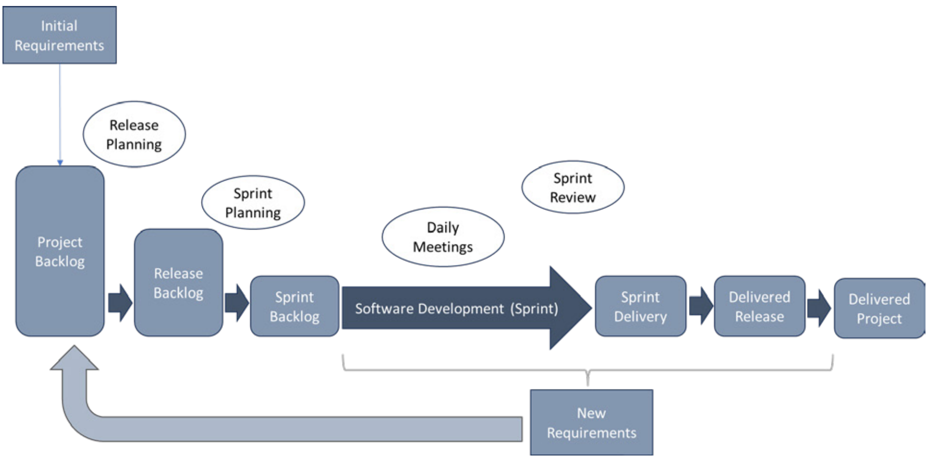


Figure 1 – Simplification of the Scrum Agile process

Direct involvement of client staff is a core principle of Agile development (Beck *et al.*, 2001). This constant collaboration ensures frequent feedback, rapid changes, and successful project outcomes (Cao, Ramesh and Abdel-Hamid, 2010; Rebentisch *et al.*, 2018). Clients actively participate in defining scope, prioritizing tasks, and providing feedback (Imani, Nakano and Anantatmula, 2017; Rebentisch *et al.*, 2018). They essentially become co-creators, fostering strong relationships between clients and service providers (Cummings and Dennis, 2018; Villena, Choi and Revilla, 2021).

2.1.4 The Hybrid methods

The rise of **hybrid methodologies** reflects the understanding that neither plan-driven nor Agile approaches alone fully capture the intricacies of software development, especially amid evolving requirements and market dynamics. These methods bridge the gap between upfront planning and iterative development, offering flexibility for changing requirements while maintaining structure for long-term success. While Agile can struggle with documentation and planning (Reiff and Schlegel, 2022), and plan-driven methods lack adaptability, hybrids aim for a "best of both worlds" solution (Yahya and Maidin, 2023), potentially improving project success and cost management (Imani, Nakano and Anantatmula, 2017).

The essence of the hybrid methodology lies in carefully integrating the planning aspects of traditional methods with the iterative cycles and adaptability of Agile approaches. This fusion creates methods that provide necessary structure and control while fostering adaptability and responsiveness to changing requirements. Hybrid methodologies promote clear commitments regarding time and cost, demanding a thorough understanding of initial requirements and goals. Common hybrid combinations include Water-Scrum-Fall, Waterfall-Agile, Hybrid V-Model, and Scrum-Stage-Gate (Reiff and Schlegel, 2022).

While Hybrid methodologies introduce structure and long-term planning to Agile principles, they firmly uphold the core Agile value of placing the customer at the center of the development process. This holds true even with the increasing prevalence of fixed budgets and schedules in today's Hybrid projects (Křivánková and Remta, 2023). In fact, the initial planning phase regains importance precisely to ensure alignment with client needs and optimize resource allocation within those constraints. Similar to pure Agile, the client in a Hybrid approach transcends the traditional "client" role. They become a co-creator, actively contributing throughout the project lifecycle. This involves sharing their business expertise, shaping project scope, continuously setting priorities, and providing invaluable feedback and validation. This deep collaboration ensures the final product delivers maximum value and resonates directly with the client's needs.

2.1.5 The overlooked importance of client participation in Agile and Hybrid software development projects

The rise of Agile and Hybrid methodologies has fundamentally shifted software development, placing the client at the very heart of the process. Gone are distant interactions and siloed teams; today, clients actively collaborate with development teams, providing constant feedback and shaping the project's trajectory. This intense co-creation demands dedicated client involvement and deep commitment. As a result, personal relationships between client and service provider teams naturally blossom, adding a crucial but often overlooked behavioral dimension to traditional, mechanistic project management.

The importance of behavioral aspects such as relationships in software development is gaining recognition (Madhavaram *et al.*, 2023). To understand these relationships, we consider two key concepts:

- Relational motive to co create value: the drive to co-create value through active client engagement.
- Relational capital: the valuable assets accumulated in sustained relationships.

Both concepts emphasize building strong relationships. However, RMCCV focuses on the dynamic process of co-creation, while relational capital highlights the long-term benefits of accumulated relational assets. Together, they form the foundation for successful value co-creation in software projects, underscoring the strategic importance of relationships in modern practices and advocating for a client-centric approach focused on long-term mutual value creation.

2.1.5.1 The relational motive to co-create value

The client's central role in Agile and Hybrid methodologies necessitates motivating both client and service provider teams to fully embrace co-creation, unlocking its immense leverage. Research underscores the competitive advantage gained from motivating clients to actively participate in value creation (Neghina *et al.*, 2017; Vargo, Maglio and Akaka, 2008; Bettencourt, Lusch and Vargo, 2014). This advantage is particularly pronounced in the Information

Technology (IT) sector, where client involvement heavily influences service delivery. In this context, strategically fostering a client's motivation to co-create is paramount to project success.

Neghina et al. (2015) identify six value co-creation dimensions – *individuated, relational, empowered, ethical, developmental and concerted joint actions*" (Neghina *et al.*, 2015, p. 221), and later on elaborate them as motives. They define the relational motive to co-create value (RMCCV) as "enhancing the social and emotional connection" between service provider and client teams. The focus on the RMCCV stems from the understanding that emotions are central to value co-creation and evolve through social relationships, potentially leading to friendship and intimacy, which further motivate participants to co-create (Pera, Occhiocupo and Clarke, 2016; Chan, Yim and Lam, 2010). The RMCCV emphasizes building long-term, interactive collaborative relationships over short-term transactions, fostering value co-creation through a history of shared interactions.

RMCCV holds a pivotal role in our research, building upon the established understanding of Agile and Hybrid methodologies, which foster unprecedented collaboration between clients and service providers. This collaborative environment demands a strong relational foundation, directly linked to service success by Yeniaras et al. (2021). Our focus on the RMCCV is rationalized by several key factors:

- **Customer expertise**: Customers possess unique knowledge about their own needs and requirements (Noordhoff et al., 2011), exerting significant influence on both project scope and expectations (Johnsen and Lacoste, 2016). This influence ultimately impacts the service quality delivered (Nordin and Kowalkowski, 2010; Jaakkola and Alexander, 2014).
- **Interpersonal relationships**: The intense collaboration inherent in Agile and Hybrid projects fosters interpersonal social relationships (Bagdoniene and Valkauskiene, 2018). These relationships are crucial for explaining and managing project outcomes related to cost, time, and quality.
- **Motivational influence**: Beyond expertise, understanding customer motivations allows us to explore how capacity, expectations, and goals shape and influence this dynamic relationship within software development projects.

By exploring the RMCCV driving these collaborations, we aim to understand how best to nurture productive partnerships between clients and service providers. This understanding will ultimately enhance project success through effective relational dynamics. The joint collaborative activity of value co-creation, fostering intense collaboration and interpersonal social relationships (Bagdoniene and Valkauskiene, 2018), highlights the critical role of the RMCCV in project development.

Nevertheless, a sole focus on understanding the relational motive to co-create value may prove insufficient, as it primarily addresses actions aimed at value co-creation without fully considering the resultant accumulation of relational assets. Thus, a comprehensive investigation into relational capital is warranted to bridge this gap and produce insights into the enduring consequences derived from sustained collaborative efforts. This holistic approach is imperative for fully grasping the intricacies of relationship-driven value creation in software development projects, thereby fostering project's success.

2.1.5.2 Relational capital

Managing social relationships in software development involves two critical aspects: the relational ability to motivate, and viewing relationships as invaluable assets. Continuous interaction fosters the accumulation of relational capital, defined as the network of personal relationships individuals develop over time (Cummings and Dennis, 2018). This relational capital is central to the success of Agile and Hybrid projects.

Relational capital, built on a foundation of trust, collaboration, and positive interactions (Villena, Revilla and Choi, 2011), fosters strong relationships within teams (Aisyah, Sukoco and Anshori, 2019), influencing behavior and expectations (Villena, Revilla and Choi, 2011; Chan, Yim and Lam, 2010). These close ties offer valuable assets for service providers, leading to benefits like reduced costs, increased client retention, and access to valuable resources (Martins, Duarte and Costa, 2018). However, a fine line exists between strong relationships and "cozy relationships" (Anderson and Jap, 2005; Villena, Choi and Revilla, 2021). While beneficial, overly familiar connections can foster nepotism, favoritism, and ethical violations (Anderson and Jap, 2005). As Anderson and Jap (2005, p. 78) point out, "while cozy relationships sound good in theory, such relationships provide an opportunity for covert activities designed to systematically cheat a partner".

Introducing the relational capital perspective alongside our focus on the relational motive to co-create value (RMCCV) opens new research avenues.

This expansion enriches theoretical contributions and enhances the practical implications of our novel approach. By uncovering the reciprocal interaction between both perspectives, we gain a comprehensive framework that addresses not only the dynamics of change but also the accumulation of those changes over time. Understanding both the driving force (RMCCV) and the accumulated reservoir (relational capital) is essential. This holistic view unlocks strategies that foster productive partnerships, elevate project success, and provide deeper insights into collaborative dynamics.

2.1.5.3 The overlap between the relational motive to co-create and relational capital

Together, the relational motive to co-create value (RMCCV) and relational capital offer a comprehensive framework that captures both the dynamics of value co-creation and its accumulated effects on software development projects. This section explores their convergence and divergence.

As summarized in Figure 2, combining these perspectives reveals their potential for mutual reinforcement, their contribution to long-term value creation, and their complementary roles in strategic relationship management. This integrated view guides organizations in fostering value co-creation and provides insights into the quality, strength, and strategic importance of these critical relationships.

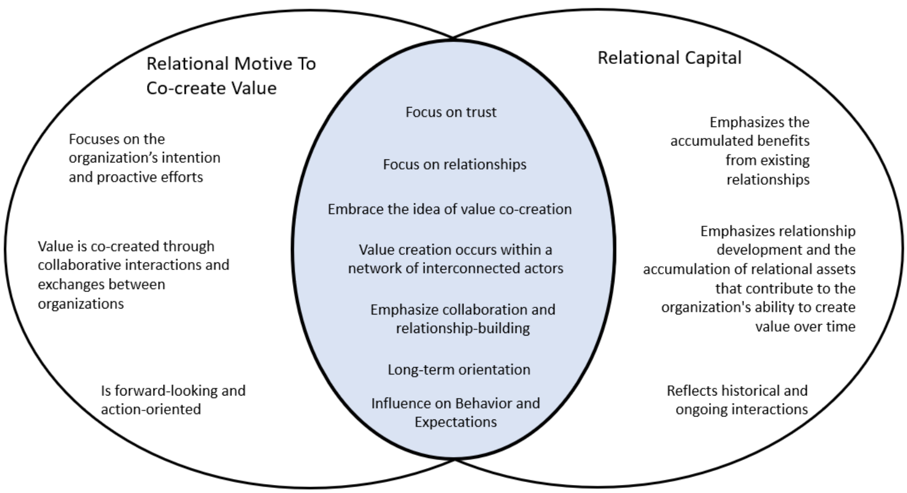


Figure 2 – Differences and commonalities between the relational motive to co-create value and relational capital

In essence, RMCCV acts as the driving force—the active push to enhance relationships for value co-creation. In contrast, relational capital represents the accumulated resource—the reservoir of benefits derived from sustained interpersonal relationships across various contexts. While RMCCV emphasizes the dynamic process, relational capital highlights the enduring value and accumulated benefits of these connections.

2.2 Approach

This thesis combines the relational motive to co-create value (RMCCV) with relational capital to explain their impact on software development projects and how leveraging relationships can improve project outcomes. Developed over a five-year research period, this work is supported by five individual articles, one of them under review by the System Dynamics Review, and presentations at the International System Dynamics Society Conferences (2020, 2022, 2024) and the QUIS 18 Services Conference (Hanoi, Vietnam, 2023).

This thesis formalizes a dynamic theory of software development project management, integrating insights from project management, marketing, and System Dynamics. The theory is articulated using a System Dynamics model, with constructs, causal linkages, and formulations grounded in existing literature and empirical evidence. Computer simulation is a well-established tool for theory validation (Oliva, 1996; Sterman, 2000), enabling testing of hypothesized relationships within a refutable causal model. System Dynamics particularly excels at integrating diverse fields, emphasizing causal linkages, rigorous formulation, and simulating how micro-level relationships generate macro-level project behaviors.

Validating this dynamic theory presented a challenge due to the fragmented and specific nature of existing evidence on project management relationships. To address this, we adopted a robust validation framework, consistent with approaches by Oliva (1996) and Sterman (2000) and aligning with the System Dynamics validation tests proposed by Barlas (1996). We focused on three key validity aspects:

- Direct structure tests: Assessing whether the model accurately reflects real-world project behaviors.

- Structure-oriented behavior Tests: Examining if observed relationships support the theorized connections.
- Behavior pattern tests: Determining if the model can explain large-scale project outcomes based on its internal structure.

For validation, an existing project management model was calibrated to a middle-sized Portuguese software development company. Structural validity was addressed via partial model estimations, using data from direct observation, 34 semi-structured interviews with project managers, and time-series operational metrics. Full-system-level tests addressed remaining validity concerns. Simulation results were compared to historical data, followed by sensitivity analysis. Extended simulations then tested both research-derived and previously untested policies.

The validation process yielded valuable, often unexpected, theoretical and managerial insights across three levels:

- Identification of leverage points: The simulation model identified leverage points within the overall system.
- Exploration of policies: The model exposed trade offs, enabling exploration of alternative policies for improving project outcomes.
- Generalizable insights: The model's applicability extends to other settings, offering managerial implications at three levels:
    - Project management: Providing new insights and heuristics for project managers.
    - Long-term recommendations: Specific recommendations for similar projects with high client involvement.
    - Broader applicability: Offering transferable insights useful in diverse project settings.

This approach is materialized in the thesis structure presented in Table 1, detailing each chapter's contribution to this research.

Table 1 - Thesis structure

Chapter	Study	Objective	Theoretical focus	Research design
1	Introduction	Introducing the relevance, and knowledge gap, research questions and approach	Project Management; Value co-creation and Motives to co-create; Relational capital (social capital) System Dynamics	
2	How the relational motive to co-create value impacts service quality over time	Review of the literature to develop a dynamic theory explaining the positive and negative impacts of relational motive on service quality, applied to generic provision of knowledge-intensive services.	Motives to co-create value; Dark Side of Relationships; Service quality; System Dynamics	Literature review; Interviews; Scenario-based experiment and sensitivity analysis using Vensim Software
3	Effects of relationships on the Dynamics of information technology projects	Deepen the analysis of the importance of the relational aspects applied to software development projects using waterfall methodology	Motives to co-create value; Dark Side of Relationships; Project Management; System Dynamics	Literature review; Interviews; Scenario-based experiment and sensitivity analysis using Vensim Software
4	Strategies to improve project's results using relational capital in Agile software development	Broadening the scope of the relational aspects, introducing importance of the relational capital to software development projects, using Agile and Hybrid methodologies where the importance of relationships may be even more critical than when using other methodologies	Relational Capital; Dark Side of Relationships, Project Management; System Dynamics	Literature review; Interviews; Project data; Scenario-based experiment and sensitivity analysis using Vensim Software

Table 1 - Continued

Chapter	Study	Objective	Theoretical focus	Research design
5	How the combination of the relational motive to co-create value and relational capital impact software development projects	Combining the RMCCV and relational capital and proposing a new simulation model integrating all previous. Validation of the model.	Motives to co-create value; Relational Capital; Dark Side of Relationships, Project Management; System Dynamics	Scenario-based experiment and sensitivity analysis using Vensim Software
6	Relationships based strategies to improve software development projects	Using the model to test different policies, providing managers with clear relationship-based strategies to improve project outcomes.	Motives to co-create value; Relational Capital; Dark Side of Relationships, Project Management; System Dynamics	Scenario-based experiment and sensitivity analysis using Vensim Software
7	Conclusions			

Chapter 1 identifies the knowledge gap and presents the overarching research questions. It highlights software development as a critical area with significant theoretical and practical opportunities. The chapter delves into the persistent challenge of project cost and schedule overruns, exploring relevant causal relationships and mitigation methodologies. It also establishes the theoretical foundation, project management, RMCCV, the dark side of relationships, relational capital, and System Dynamics, with further details in Appendix 6. Finally, this chapter introduces a novel argument structure for the thesis, summarized in Figure 3. As the thesis progresses, theoretical concepts are expanded, and practical application becomes increasingly focused.

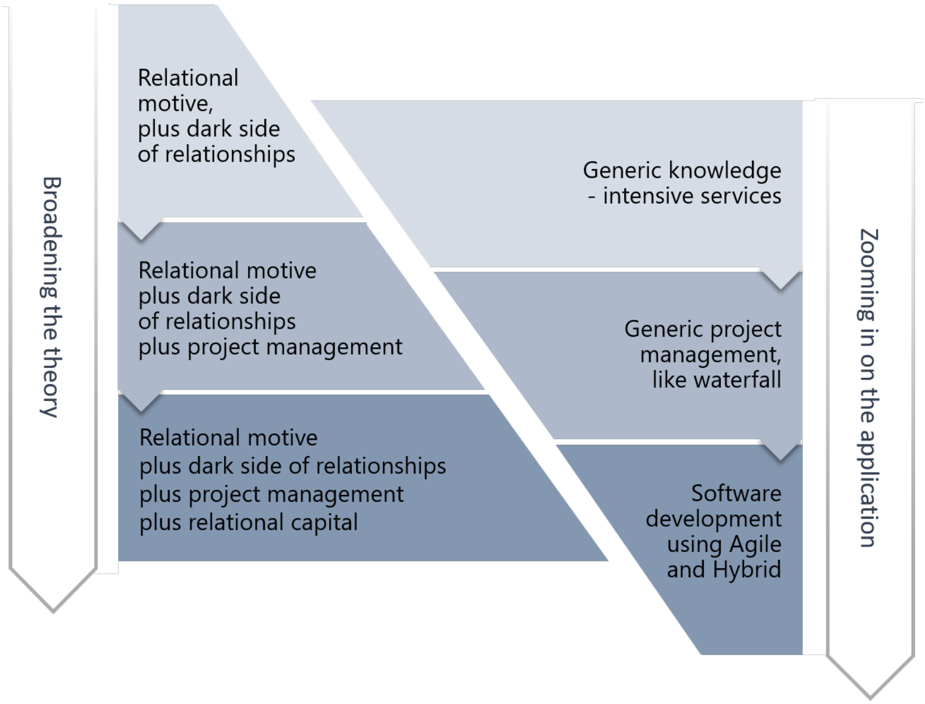


Figure 3 – Evolution of the structure of arguments during the thesis

Chapter 2 initiates a theoretical exploration focusing on the imperative of motivating clients to engage in co-creation within the context of IT services. This theoretical development synthesizes insights from literature on value co-creation, RMCCV, and the dark side of relationships. While the aspiration to quantitatively report on service quality is high, the complexities of its direct, comprehensive empirical validation in the dynamic and highly contextual IT environment pose significant challenges. Instead, our approach aligns with the principles of System Dynamics model validation (Homer, 1996), where we built an exploratory model based on indicative parameter values to understand the behavioral implications of these relationships. Nevertheless, this chapter lays the groundwork for explaining the critical influence of RMCCV on service delivery. Understanding this foundational link is essential for later strengthening the model's capacity to accurately replicate and mitigate cost and schedule overruns, which are the primary focus of this thesis.

The overarching objective of this chapter is to augment understanding regarding the pivotal role of relationships in influencing service provisioning, specifically focusing on the RMCCV's potential to motivate participants to co-create value. A central conclusion is that the RMCCV's underexplored application is crucial in mitigating challenges often associated with service provisioning in software development. A comprehensive examination of RMCCV in this chapter combines positive effects (from the value co-creation literature) with negative effects (from the overly-close relationships literature), identifying five distinct effects that elucidate inherent dynamics within service interactions. This chapter answers two research questions:

1. What is the relationship between the RMCCV and service quality erosion?
2. How and when do service capacity, expectations, and goals influence this relationship?

These research questions contribute to answering the thesis's overarching research questions. They establish how RMCCV affects operational aspects, partially addressing the first overarching research question, while also establishing a clear causal effect between RMCCV and operational aspects of project development, shedding light on strategic options that can use the relational motive to improve projects results and initiating the response to the second overarching question.

Chapter 3 advances the research, applying the theoretical framework developed in Chapter 2 to a generic project management model resembling Waterfall methodology, to provide answer to the following research question: how the development of relationships impacts project dynamics? This chapter integrates project management and System Dynamics literature, emphasizing the critical role of projects within software development companies. It meticulously investigates motivating participants to co-create and the impact of RMCCV on key project variables, shedding light on project dynamics under varying strategic approaches. Building on Chapter 2, this study's purpose is to enhance knowledge of how relationship development impacts project dynamics and establishes a clear causal relationship between RMCCV and project outcomes, further addressing both overarching research questions.

Chapter 4 delves into the complexity of relationship dynamics, focusing on a complementary view of relationships. The exposure of this research to the scientific community triggered the need to broaden the lens to observe the importance of relationships in projects, exploring the accumulation process underneath relationships. While the relational motive has an action-oriented focus, Chapter 4 expands the lens to include the accumulation of relational capital that results from the ongoing experiences acquired during the project development. This expansion, delving into the relational capital literature, enriches and complements our understanding of the impacts of relationships on project outcomes in terms of cost and schedule. The research extends further by developing and applying a simulation model, this time narrowing further the research to the context of software development using the Agile and Hybrid methodologies, which accentuates the importance of relationships.

Chapter 4 answers two research questions:

1. How does relational capital impact project results in terms of cost and schedule?
2. How can service providers leverage relational capital for better outcomes in terms of cost and schedule?

Chapter 5 integrates all elements from Chapters 2, 3, and 4, applying the resulting theoretical framework to software development projects utilizing Hybrid methodologies. To capture their inherent complexity, Chapter 5 details the development of a System Dynamics simulation model. The model incorporates theoretical concepts from RMCCV (Chapters 2 and 3), the dark side of relationships (Chapters 2, 3, and 4), project management (Chapters 3 and 4), and relational capital (Chapter 4), alongside major challenges identified through extensive project manager interviews and relevant literature. Chapter 5 meticulously dissects the model's components, causal relationships, and data sources, presenting rigorous validation tests that demonstrate its ability to replicate real-world project behavior, allowing answering the study’s research question: How does the relational motive to co-create and relational capital impact project results in terms of cost and schedule?

Ultimately, Chapter 5 offers a robustly grounded simulation tool for exploring policy interventions and refining answers to the second overarching research question. The theory, formalized through this System Dynamics model, is unique: it not only explores the overlooked importance and impact of RMCCV and relational capital separately but also combines them to provide a complete explanation of relationships' critical role in software development. This unified theory empowers organizations to leverage relationships for improved project outcomes in terms of cost and schedule.

Leveraging the robust simulation model from Chapter 5, Chapter 6 evaluates the effectiveness of various project management policies identified through interviews with project managers and the wider literature. Chapter 6 answers the following research question: How can service providers leverage the relational motive to co-create value (RMCCV) and relational capital for better project results in terms of cost and schedule? This analysis extends to explore the synergistic effects of combining these policies, ultimately aiming to provide concrete strategies for improving project outcomes in cost, schedule, and quality. Chapter 6 embodies the thesis's dedication to actionable knowledge, presenting novel strategies and highlighting areas ripe for further research. While the results from policy testing are summarized in Chapter 6, Appendix 5 offers a comprehensive listing of all explored policies, including a detailed analysis.

Building on the theoretical frameworks developed in Chapters 2, 3, and 4, and the extensive simulation analyses presented in Chapters 5 and 6, Chapter 7 synthesizes the findings to provide the overarching conclusions of this thesis. This chapter systematically addresses the two guiding research questions, presenting the nuanced answers derived from the dynamic theory and simulation model. It delineates how the RMCCV and relational capital dynamically impact project results in terms of cost and schedule, clarifying their dual positive and negative effects over time. Furthermore, Chapter 7 outlines actionable strategies for service providers to effectively leverage the RMCCV and relational capital, demonstrating the efficacy of combined policies, strategic staffing decisions, and robust control mechanisms in improving project outcomes, even in the face of challenges like scope creep.

Beyond answering the research questions, Chapter 7 articulates the significant theoretical implications of this interdisciplinary research, highlighting novel contributions to the fields of project management, marketing, and System

Dynamics by establishing new bridges between these previously distinct literatures. Finally, this chapter concludes with a discussion of the study's limitations and outlines promising avenues for future research, solidifying the thesis's contribution to both academic understanding and practical application in software development project management.

2.1 Contributions

This thesis offers significant contributions across research, methodology, practice, and society, primarily by introducing a novel lens to understand and improve software development project outcomes.

Research and Methodological Contributions

The central contribution is the development of a unique interdisciplinary framework that comprehensively integrates the Relational Motive to Co-Create Value (RMCCV) with Relational Capital. This framework provides a novel perspective for project management within Agile and Hybrid software development, emphasizing the critical role of client-provider relationships.

Methodologically, this thesis expands traditional research approaches by formally applying System Dynamics. This enables the integration and simulation of soft behavioral variables (such as client and team interactions) and interdisciplinary knowledge (from project management, marketing, human resources, and economics). This approach overcomes limitations of conventional project management research and offers new analytical tools for studying time-evolving phenomena in various fields.

Practical Contributions

This research provides organizations with actionable insights and dynamic strategies derived from a formal simulation model. These strategies directly address the persistent challenge of project cost and schedule overruns, offering managers concrete guidance on how to leverage strong client-provider relationships for improved project outcomes.

Societal Contributions

Beyond academic and practical advancements, this thesis yields important societal benefits. By offering empirically grounded strategies to mitigate costly project overruns—a problem costing vast sums annually—it directly contributes to economic stability and growth by reducing waste and inefficiencies. Furthermore, it promotes the cultivation of managed, long-term collaborative relationships that can foster healthier working environments within the industry.

2.2 Data Management

"The data supporting this thesis were meticulously collected in accordance with all ethical guidelines and Radboud University's data management policies, as detailed on the official webpages: "Writing a data management plan"[5] and "Archiving and publishing research data"[6]. All participants provided informed consent prior to data collection. Primary data comprised semi-structured interviews, supplemented by questionnaires, which were subsequently transcribed into Word documents. To ensure accuracy and participant agency, interview summaries were validated by the respective interviewees. The data was coded at the point of transcription.

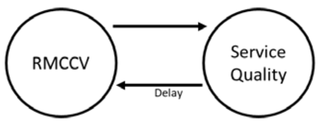
To uphold participant privacy, all personally identifiable information within the primary data was pseudonymized. Any pre-existing data utilized were legitimately obtained from their original sources, with appropriate permissions. Throughout the research period, all privacy-sensitive data were stored exclusively on secured, password-protected computer systems or university-approved server environments, adhering to Radboud University's security protocols.

Upon completion of this PhD project, the research data will be securely archived for a minimum of ten years in encrypted storage solutions, ensuring scientific integrity and compliance with institutional requirements. Anonymized datasets, along with comprehensive metadata and documentation, will be deposited in the Radboud Data Repository. Access to these anonymized data will be granted only upon formal request and approval by the data owner, maintaining controlled dissemination. Furthermore, in all publications and publicly released datasets, it will be impossible to link data to individual participants, unless explicit consent for such linkage has been separately and specifically obtained.

5. Writing a data management plan | Radboud University
6. Archiving and publishing research data | Radboud University

2. How the relational motive to co-create value impacts service quality over time

Chapter 2 initiates a theoretical exploration focusing on the imperative of motivating customers to engage in co-creation within the context of IT services. This theoretical development synthesizes insights from literature on value co-creation, motives to co-create, and dark side of relationships. The overarching objective is to augment understanding regarding the pivotal role of relationships in influencing service provisioning focusing on the potential of using the relational motive ("enhancing the social and emotional connection") to motivate participants to co-create value.

Causal relationship	
Gaps addressed	• The ability to motivate clients using the relational motive is under-explored in the knowledge intensive services, especially in software development. • The effect of the RMCCV on service quality is overlooked. • Combination between positive and negative effects of motivating participants to co-create using the relational motive in the ITB2B setting is under-explored.
Research questions	• What is the relationship between the RMCCV and service quality erosion? • How and when do service capacity, expectations, and goals influence this relationship?
Overarching research questions	• How do the relational motive to co-create value (RMCCV) and relational capital impact project results in terms of cost and schedule? • Which strategies can be used to leverage the relational motive to co-crate value and relational capital for better project results in terms of cost and schedule?

This research was presented at the 2020 International System Dynamics Conference in Bergen and a version of it was presented at the QUIZ 18 conference in Hanoi Vietnam in 2023: Sousa, J., Bloemer, J.M.M., Rouwette, E.J.JA, (2020). *How the relational motive to co-create value impacts service quality over time.*

2.1 Abstract

Client participation and the desire to co-create value are crucial for service quality in business-to-business contexts. However, existing explanations often overlook how a client's relational motive to co-create value (RMCCV) can counterintuitively lead to service quality erosion over time. This study breaks new ground by employing a System Dynamics model to develop a formal theory for RMCCV's impact on service quality. We are the first to integrate client motivations, resources, and capabilities within this model framework. Calibrated through literature analysis and semi-structured interviews with project managers, the model reveals an unintended feedback loop that can reinforce service quality erosion. This study provides important theoretical implications and practical advice for service managers on identifying and theoretically preventing this service erosion process.

2.2 Introduction

A surprising paradox exists in information technology (IT) services: while the relationships arising from close client collaboration are crucial for value creation, our System Dynamics model explores how they can also theoretically lead to service quality erosion over time. IT services involve intense participation of the client (Bardhan et al., 2010), resulting in a critical process of value co-creation (hereinafter, VCC) (Vargo and Lusch, 2004). This VCC is critical for service success (Yeniaras, Di Benedetto and Dayan, 2021), as clients are the principal source of knowledge about their own needs (Noordhoff et al., 2011) and influence the requirements and expectations of the service (Johnsen and Lacoste, 2016), thus affecting service quality (Nordin and Kowalkowski, 2010; Jaakkola and Alexander, 2014). The emergent relationships within this collaboration process highlight the importance of motivating the participants to co-create, exploring the potential of the relational motive to co-create value (hereinafter, RMCCV) defined as “enhancing the social and emotional connection” between teams from the service provider and the client (Neghina *et al.*, 2017, p. 160).

While VCC literature focuses on the positive impact of relationships (Ellram and Murfield, 2019), the Dark Side of Relationships (hereinafter, DSR) literature (Anderson and Jap, 2005) focuses on their negative impacts on service quality through co-creation as well, ultimately leading to service erosion. However, few studies explore how both positive and negative effects can co-exist within the same dynamic system. We address this gap by combining both literature streams, employing a System Dynamics model to theoretically investigate the relationship between the RMCCV and service quality erosion in an IT business-to-business (B2B) context. We propose that RMCCV can have both positive and negative impacts on service quality, mediated through service capacity, expectations, and goals. We investigate our proposition using a longitudinal analysis, through the development of a System Dynamics simulation model. This longitudinal approach enables a better understanding of the changes in RMCCV over time (Neghina et al., 2017) and the evolution of its effects, which take time to manifest (Autry and Golicic, 2010). Specifically, we formulate and answer the following research questions:

1. What is the relationship between the RMCCV and service quality erosion?
2. How and when do service capacity, expectations, and goals influence this relationship?

The results show that the RMCCV has significant impact on service capacity, expectations, and goals, and generates an unintended process of service quality erosion that reinforces itself over time. Alongside important theoretical implications, this study provides advice to service managers on how to identify and theoretically mitigate this service erosion process.

The next section introduces the theoretical background of service quality, DSR, and VCC, followed by the identification of five impacts of the RMCCV on service quality, revealing dynamics and long-term effects that are absent in previous studies. Then, we introduce the System Dynamics method, which is the basis for the development of a simulation model. In the concluding sections, we summarize the results, offer two propositions, discuss the theoretical and managerial implications, explain the limitations, and suggest future research directions.

2.3 Theoretical background

In this section, we review the drivers and consequences of service quality in knowledge-intensive business services, particularly within an IT business-to-business (ITB2B) setting. We also examine the positive and negative effects of Value Co-Creation (VCC) on service erosion. Finally, we narrow our focus to a specific motive for VCC - the Relational Motive to Co-Create Value (RMCCV) - and explore how this motive influences dynamics that can lead to or mitigate service erosion.

2.3.1 Service quality in knowledge-intensive business services

This research leverages the established definition of service quality by Parasuraman, Zeithaml, and Berry (1985, p. 46): "The quality of a service that a client perceives is a function of the gap between expected service and perceived service." Their seminal work highlights the client's experience of service delivery as a key driver. This is particularly significant for IT services, where extended delivery periods and active client participation characterize interactions. This intense collaboration fosters a VCC process (Neghina *et al.*, 2017) that demonstrably impacts service quality (Jaakkola and Alexander, 2014).

Moving beyond drivers, service quality also has documented consequences. It influences customer behavior (Zeithaml, Berry and Parasuraman, 1996), expectations (Gronroos, 2007), and client satisfaction (Storbacka, Strandvik and Grönroos, 1994). Given these effects, it is reasonable to posit that service quality also impacts VCC. Research demonstrated that VCC is a non-linear process shaped by accumulated experiences (Grönroos and Voima, 2013), where relationships play a crucial role in how experiences are perceived. This creates a feedback loop: service quality influences VCC, which in turn influences service quality. This dynamic relationship likely introduces delays and non-linear effects, making a longitudinal analysis more insightful than a cross-sectional one.

A longitudinal perspective has been applied to IT services in several literature fields, providing powerful, albeit partial, explanations for the development of service quality in long-term B2B IT–client engagements. Project management literature using System Dynamics has examined quality in this IT B2B service setting since the seminal work of Abdel-Hamid (1984), focusing on the tangible side of quality and measuring it as the number of errors. Using a different approach, Oliva (1996) and Oliva and Sterman (2001; 2010) use Parasuraman et al.'s (1985) definition of service quality and provide powerful explanations, though they focus on a business-to-consumer setting with short-term interactions (less than one day) between the service provider and the client. Their analysis explains how service quality tends to erode as a result of management decisions that try to balance work pressures. Nonetheless, previous explanations of service quality using a longitudinal perspective lack an endogenous view of service co-creation and address neither client participation nor their motivations to co-create. To address these missing perspectives, it is necessary to understand the role of client participation and motivations in service quality.

2.3.2 Positive effects of relationships

VCC represents "a joint collaborative activity between service employees and customers" (Neghina *et al.*, 2015, p. 221). This intense collaboration offers several advantages in knowledge-intensive business services. First, it fosters a deeper understanding of client needs (Noordhoff *et al.*, 2011), leading to more precise service requirements and expectations (Johnsen and Lacoste, 2016). This precision, in turn, demonstrably improves service quality and client satisfaction (Bettencourt *et al.*, 2002; Nordin and Kowalkowski, 2010; Jaakkola and Alexander, 2014). Furthermore, such intense collaboration can cultivate interpersonal social relationships (Bagdoniene and Valkauskiene, 2018) by leveraging the informal contacts that are ingrained in the daily routines of service professionals (Taminiau, Ferguson and Moser, 2016). However, this intense collaboration is challenged by the contextual and subjective nature of VCC (Neghina *et al.*, 2017; Aarikka-Stenroos and Jaakkola, 2012), by the type of client (Baumann, Le Meunier-FitzHugh and Wilson, 2017), and by the effects of co-creation that change over time (Neghina *et al.*, 2017), making short-term evaluations ineffective (Bagdoniene and Valkauskiene, 2018).

Value Co-creation (VCC) literature traditionally emphasizes the positive aspects of relationships in service quality (Ellram and Murfield, 2019). This highlights the importance of social interactions and emotions in the IT B2B context. A complementary view has been arguing the potential downsides of close relationships within VCC (Anderson and Jap, 2005). However, a critical gap exists in understanding the combination of those positive and negative effects. We propose the action-oriented RMCCV as a key factor influencing these relationships. We argue that RMCCV can have both positive and negative effects on service quality over time. This research delves deeper into the under-explored negative aspects of relationships within VCC, focusing on how RMCCV shapes those effects.

2.3.3 Negative effects of relationships

While the literature reviewed in the previous sections focuses on the positive consequences of co-creation, the dark side of relationships (Anderson and Jap, 2005) literature balances this picture by highlighting the adverse consequences of intense client-provider contact.

From the range of adverse consequences identified in the literature, four are particularly relevant to the present research. First, biased judgments and evaluations emerge from losing objectivity (Villena, Revilla and Choi, 2011; Rood *et al.*, 2018). Second, the acceptance of suboptimal performance from complacency (Villena, Revilla and Choi, 2011; Autry and Golicic, 2010; Mitręga and Zolkiewski, 2012) and blurred lines between the roles of the service provider and the client (Rood *et al.*, 2018). Third, complacency and blurred lines also contribute to the development of lower expectations and poor goal definition (Johnsen and Lacoste, 2016; Villena, Choi and Revilla, 2021). Finally, poor decision making is exacerbated by redundant knowledge and thinking alignment (Villena, Revilla and Choi, 2011; Anderson and Jap, 2005), excess reciprocity (Anderson and Jap, 2005), and opportunistic self-seeking behavior ((Johnsen and Lacoste, 2016; Noordhoff *et al.*, 2011; Mitręga and Zolkiewski, 2012). Overall, too much collaboration can negatively affect performance (Villena, Revilla and Choi, 2011). This impact is more corrosive in the long run because these effects may go unnoticed for long periods and introduce slow, destructive, unperceived forces, giving cover to opportunistic behaviors (Anderson and Jap, 2005; Villena, Choi and Revilla, 2021).

2.3.4 Impact of relationships on service quality

This research bridges the gap between studies that explore the positive and negative effects of relationships on service quality. We follow Noordhoff et al.'s (2011) suggestion to combine these perspectives by using the concept of RMCCV, allowing us to capture the dynamic interplay between relationship-based benefits and drawbacks over time. To account for the evolving nature of these effects, we adopt a longitudinal approach that considers the influence of accumulated experiences (Autry and Golicic, 2010). While various motives for co-creation exist (e.g., (Pera, Occhiocupo and Clarke, 2016; Komulainen, 2014; Roberts, Hughes and Kertbo, 2014; Schüler, Fee Maier and Liljedal, 2020), we specifically leverage Neghina et al.'s (2017) framework encompassing six co-creation motives: individuated, relational, empowered, ethical, developmental, and concerted joint actions.

We focus on the relational motive within this framework, which Neghina et al. (2017, p. 160) define as the desire to "enhance the social and emotional connection" between service providers and client teams. This focus is crucial because the RMCCV can generate both positive and negative consequences for service quality. Understanding this dynamic is essential to effectively manage relationships and prevent quality erosion.

Building on the literature review and exploratory interviews detailed in the methodology section, we identified five key effects of RMCCV on service quality. Before moving forward, it is necessary to explain the meaning of the symbols in the Figures below. Boxes describe variables that accumulate over time, such as the RMCCV, while the double arrow describes the rate of change of that variable over a certain period. The arrows represent a direct link between variables, in which one variable is a function of the other and is represented by a mathematical expression. The plus and minus signs inform if the dependent variable changes in the same direction (plus) or the opposite direction (minus).

Effect number one: Positive feedback loop from dialogue capability (Figure 4). Increased RMCCV improves dialogue capability (Luna-Reyes *et al.*, 2008; Anantatmula, 2010; Meng and Boyd, 2017), which improves knowledge transfer and the ability to exploit synergies (Villena, Revilla and Choi, 2011). This enhances productivity and service capacity, leading to improved service quality (Oliva and Sterman, 2001; Oliva and Sterman, 2010), defined as the difference between the real and the expected service capacity (see Parasuraman *et al.*, (1985; 1988)). This, in turn, positively influences RMCCV (Neghina *et al.*, 2017), completing a reinforcing loop. As one interviewee stated: "When the client is deeply involved, he becomes more cooperative and collaborative, making the operation and the optimization of joint processes easier".

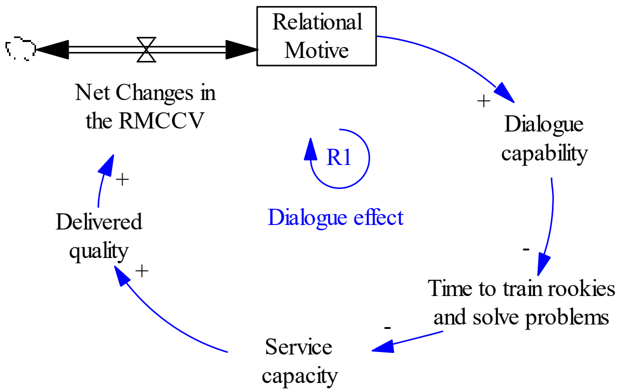


Figure 4 – Positive feedback loop from dialogue capability

Although intuition acknowledges this positive feedback loop, experience and literature reporting low rates of IT project success suggest the existence of powerful secondary effects that counterbalance this positive effect.

Effect number two: Negative feedback loop from lack of training (Figure 5). A rise in RMCCV can reduce the willingness to change team members due to accumulated project-specific knowledge and interdependencies (Frow, McColl-Kennedy and Payne, 2016; Maglio and Spohrer, 2008; Johnsen and Lacoste, 2016). This hinders professional development, causing a decline in skill, knowledge, and ultimately, service capacity. Limited capacity then theoretically leads to a decline in service quality, which can reduce RMCCV levels. As one interviewee stated: "I was trapped in the project, without opportunities to learn new things".

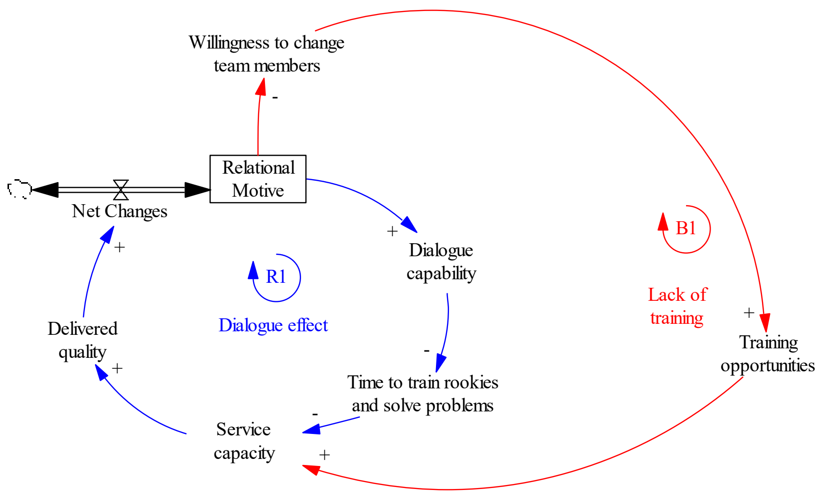


Figure 5 – Negative feedback loop from lack of training

Effect number three: Negative feedback loop from alienation (Figure 6). Increased team dependence (as in Effect 2) can lead to the service provider's team immersing itself in the client's processes and culture as the service provider's team continues working at the client's facilities. As one of the project managers described, he had team members who felt they belonged to the client's team more than to the service providers, with most of their friends being the client's employees. This unintentional alienation fuels blurred lines (Rood *et al.*, 2018) and complacency (Villena, Revilla and Choi, 2011), potentially leading to neglected procedures, poor compliance, decreased work efficiency, and theoretically, lowered delivered quality.

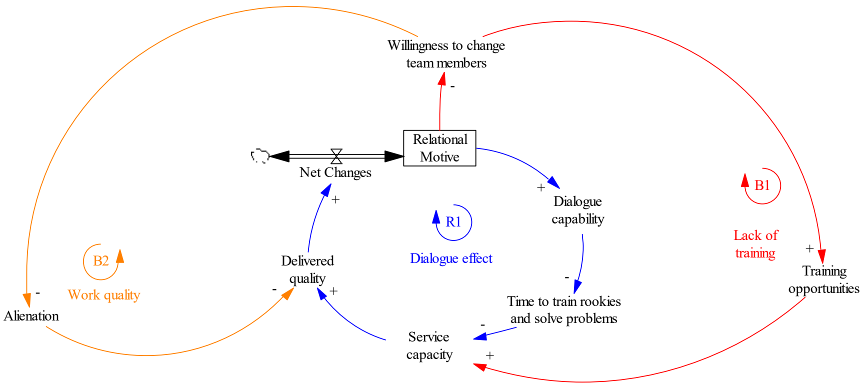


Figure 6 – Negative feedback loop from alienation

Effect number four: Negative feedback loop from schedule pressure (Figure 7). Increased RMCCV can foster emotional involvement, resulting in biased judgment and irrational decision-making (Johnsen and Lacoste, 2016; Rood *et al.*, 2018). This leads to an increased acceptance of missed deadlines. The diminished sense of schedule pressure can decrease productivity, reducing service capacity, and then theoretically lowering perceived quality, ultimately decreasing RMCCV. As interviewees reported, as clients get more involved in the project, they understand project constraints, making it easier to reach a consensus when setting new deadlines. As another interviewee stated: "When there is cooperation it becomes easier to overcome obstacles even managing the overruns".

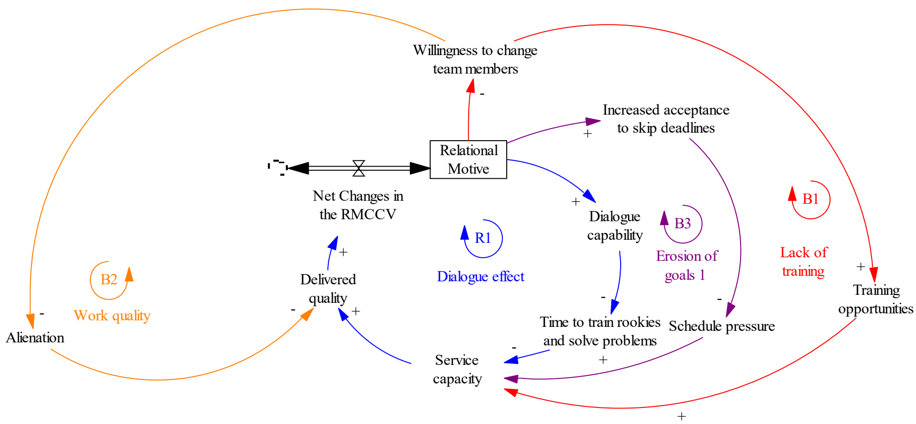


Figure 7 – Negative feedback loop schedule pressure

Effect number five: Negative feedback loop from quality cuts (Figure 8). The inherent difficulty of measuring service quality (Oliva and Sterman, 2001; Oliva and Sterman, 2010; Johnsen and Lacoste, 2016) is exacerbated when clients evaluate their own work due to intense participation. This means that increasing RMCCV can theoretically result in accepting quality cuts, thus lowering quality pressure and, ultimately, delivered quality. As one interviewee stated: “When there is team work, the client shares the pression with you”.

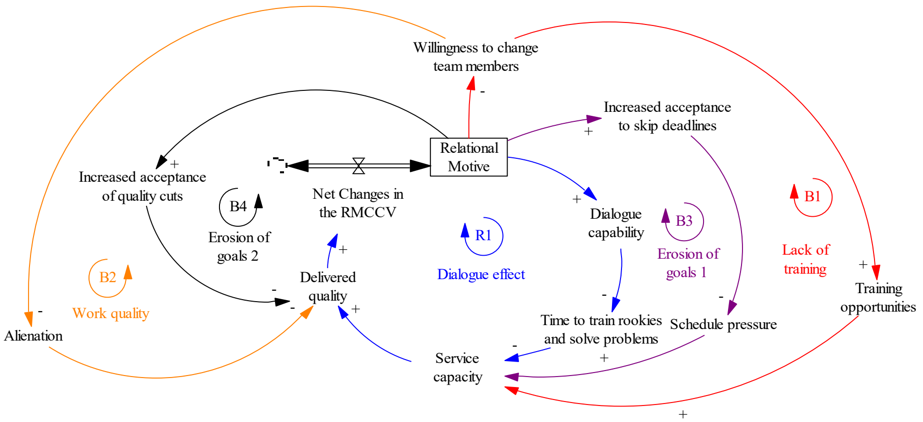


Figure 8 – Negative feedback loop from quality cuts

This section outlines a complex and dynamic system, featuring one positive and four negative feedback loops. While some of these loops may dominate in the short run, others exert more influence in the long run. In combination, these dynamics, driven by increasing RMCCV, can result in service erosion, as argued in the DSR literature. To fully understand the behavior that results from this dynamic complexity, we use System Dynamics as our methodology, which we describe next, followed by the simulation model.

2.4 Methodology

This study uses System Dynamics modeling to capture the effects of the RMCCV on service quality. System Dynamics is a well-established method for building and developing formal theory (Homer, 1996; Schwaninger and Grösser, 2008; Luna-Reyes *et al.*, 2008) and explaining the behavior of a complex phenomenon over time (Sterman, 2000). It is particularly useful when mental, written, and numerical data all have important roles in building and testing model structure (Homer, 1996).

The use of System Dynamics is justified by several characteristics of our study. IT services operate in a complex and dynamic environment (Spohrer and Maglio, 2008; Jaakkola and Alexander, 2014) with strong interdependencies between activities. They require a multidisciplinary approach (Meng and Boyd, 2017) and involve processes like Value Co-Creation (VCC) that evolve over time, characterized by significant delays and non-linear dynamics. These characteristics collectively make System Dynamics a suitable method for developing a comprehensive theoretical explanation (Sterman, 2000).

The study follows the iterative theory-building approach of Oliva (1996), Homer (1996), and Schwaninger and Grösser (2008), where assumptions are stated, and qualitative data are collected to inform and refine the theoretical model. Our simulation model is conceptualized based on insights from the Dark Side of Relationships (DSR) and VCC literature. Its structure and parameters are informed by a literature review spanning System Dynamics, marketing, service quality, and project management, alongside exploratory interviews with 23 project managers from seven distinct IT companies in Portugal.

These semi-structured interviews were critical for grounding the model in practice. Interviewees were selected based on having (1) over three years of project management experience, (2) a focus on software implementation, and (3) experience managing projects with the same client for more than six months. To ensure diversity, companies of varying sizes (one <50, two <100, one <200, three >500 workers) were included. The semi-structured interviews, averaging one hour, provided deep insights into client participation, co-creation motives, relationship development, and their impact on project outcomes and service quality variations. The questionnaire consisted of 26 open questions addressing project managers' experiences with client participation, motives to participate and co-create, the development of relationships between the teams and their importance, and project managers' perceptions of the success of their projects. Interviews also addressed the consequences of the evolution of the team relationships, the consequences of service quality variations, and the delays that occur between realizing something and acting on it. Questions guided each interview but allowed project managers ample freedom to express their opinions.

The results were analyzed qualitatively and quantitively, producing basic statistics. Confirming what has been described in the literature, all interviewees had projects in which a client was an active participant. From the 23 interviews, 15 explicitly recognized that clients were always involved, 7 reported that clients were not always involved, and only one reported that they were rarely involved. In addition, 21 of the interviewees considered client participation very relevant, and 17 explicitly recognized that their relationship with the client was critical to the outcome. Finally, 14 recognized that their relationships usually evolve into a friendship, which is also considered critical to building trust and is understood to be important in winning new projects with the same client.

2.5 Model structure

To formally analyze the impact of the RMCCV on service quality over time, we developed a System Dynamics simulation model. This model goes beyond static analysis by capturing the evolution of RMCCV's effects and their influence on service quality. Furthermore, the model serves as a decision-support tool, allowing us to test and evaluate different strategies aimed at mitigating forces that lead to service quality erosion.

Building trust in this theoretical framework is crucial. Therefore, the literature review presented in Section 2.3 provides robust evidence for each causal relationship and theoretical foundation underpinning the model. For a comprehensive understanding of the model's functionality, detailed information on all policy parameters can be found in the Appendix 1.

2.5.1 Service capacity

This study proposes a direct effect of RMCCV on service capacity, mediated by changes in team productivity. Our model of service capacity builds upon established project management System Dynamics models (Sterman, 2000; Lyneis and Ford, 2007):

$$Service\ capacity = Workforce \times Average\ Productivity \tag{1}$$

Average team productivity is defined as a weighted average reflecting the mix of experienced and inexperienced team members. This weighting incorporates the finding by Oliva and Sterman (2010) that inexperienced employees typically have only 30% of the productivity of experienced workers.

2.5.2 Accumulated experience

This research places significant emphasis on accumulated experience because it directly influences the development of relationships and triggers the five feedback loops identified in Section 2.4. To capture this dynamic, our model tracks the "work done" on a project. This variable represents the cumulative effort invested in the project, which takes time for participants to fully absorb and translate into improved knowledge and collaboration.

$$Experience\ development = \frac{Work\ done}{Time\ to\ absorb\ experiences}. \tag{2}$$

2

2.5.3 Service quality

The model adopts the established service quality definition by Parasuraman et al. (1985; 1988), focusing on the perceived gap between what the client expects and the service delivered. To represent this gap, the model utilizes the concept of a performance gap, which reflects the difference between the service capacity (the team's ability to deliver) and the client's expectations of that capacity. For calculating service quality, the model leverages the non-linear function developed by Oliva and Sterman (2010) (see Figure 9). This function incorporates a critical concept – the tolerance zone. The tolerance zone suggests that when the performance gap is small, the impact on perceived service quality is minimal. However, as the gap widens, the negative effects on service quality become more pronounced and even exponential.

$$\begin{aligned} &Delivery\ quality \\ &\quad = f\big((Service\ Capacity - Client\ Expected\ Service\ Capacity) \\ &\quad \div Client\ Expected\ Service\ Capacity\big). \end{aligned} \tag{3}$$

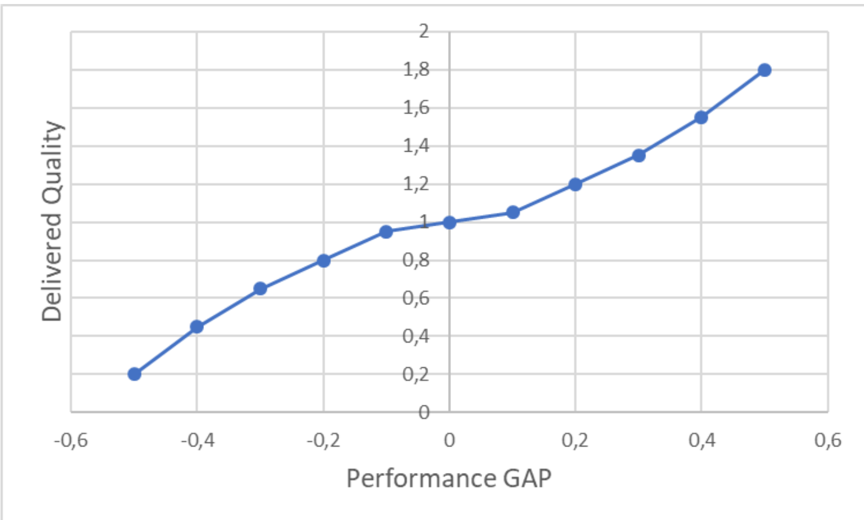


Figure 9 – Effect of performance gap on delivered quality

2.5.4 The relational motive to co-create value

To capture how changes in the Relational Motive to Co-Create Value (RMCCV) affect the system, the model introduces the concept of relational pressure. This variable reflects the deviation of the current RMCCV from its normal or desired state. When relational pressure is at 1, the system is in equilibrium, meaning the RMCCV is at its desired level and there is minimal impact on other variables.

$$Relational\ Pressure = \frac{RMCCV}{Desired\ RMCCV}. \tag{4}$$

The model formalizes all five effects explained in Section 2.3.4.

Effect number one: Relational pressure on dialogue capability (Figure 10). An increase in RMCCV (i.e., relational pressure greater than 1) positively affects dialogue capability; conversely, if RMCCV is lower than desired (relational pressure less than 1), dialogue capability decreases. Dialogue capability boosts knowledge sharing, simplifies information flows (Anantatmula, 2010), and reduces the time needed to train new employees. This increases time for development tasks, thereby increasing productivity. The model incorporates a saturation point where increasing dialogue capability no longer affects training time.

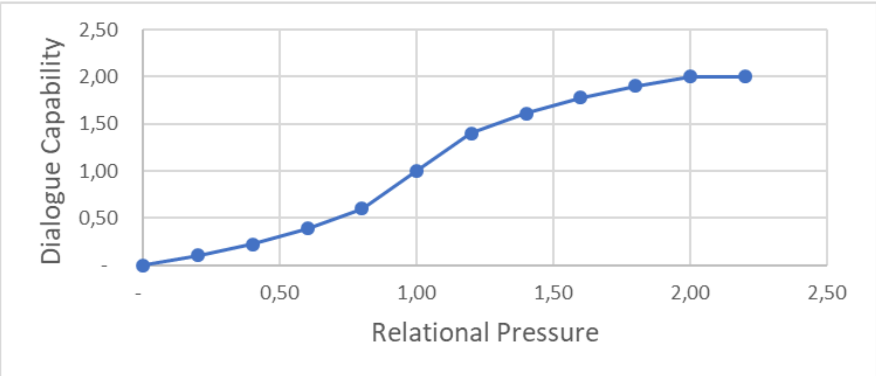


Figure 10 – Effect of relational pressure on dialogue capability

Effect number two: **RMCCV's impact on willingness to change team members.** As RMCCV increases, the willingness to change team members decreases. This is because strong relationships and efficient routines foster resistance to team composition changes. The model uses a non-linear function to capture this. If the willingness to change falls below 1 (completely unwilling), the client becomes "locked in" to the existing team, potentially missing opportunities for skill development or training. This ultimately leads to a decline in overall team productivity. Values above 1 have a neutral impact.

Effect number three: Willingness to change team members and alienation. The willingness to change team members also triggers alienation from the original team, particularly when staff work for extended periods within the client's team, weakening their ties to their company of origin. The model captures this through an effect on productivity: if the willingness to change team members is below 1, it activates the alienation process, decreasing productivity. Values above 1 have a neutral effect.

Effect numb er four: RMCCV's impact on resistance to missed deadlines. Increased RMCCV decreases resistance to skipping or ignoring deadlines, a feedback loop thoroughly described in literature (Lyneis and Ford, 2007; Oliva and Sterman, 2010). The model uses two non-linear variables: when schedule pressure is high (>1), productivity increases up to a point; when it's low (<1), complacency can lead to a gradual decline in productivity. A strong RMCCV, fostering a collaborative and trusting environment, can exacerbate this tendency.

Effect number five: RMCCV's impact on quality standards erosion. Increased RMCCV promotes the erosion of quality standards. Research by Oliva and Sterman (2001; 2010) and Abdel-Hamid (1999) confirm that goals influence project performance. The model utilizes two non-linear relationships to represent the influence of relational pressure on quality tolerance. When relational pressure is zero, the client has no motivation to accept quality reductions. As pressure increases, a tolerance zone emerges (around an expected service capacity of 1), where client quality expectations are more resistant to change, reflecting flexibility in accepting minor variations for relationship maintenance. When relational pressure is high, the client may become more accepting of significant quality reductions, up to a maximum tolerance level of 20%. This highlights the potential for a downward spiral, where a strong desire to maintain a positive relationship leads to a gradual erosion of quality standards. Research by Lusch et al.(2007), Payne et al.(2008), Komulainen (2014), and Neghina et al. (2017) supports this concept of expectation adjustment following the acceptance of quality cuts.

The model structure, including these five feedback loops, is depicted in Figure 11. In the model, arrows indicate direct causal relationships and represent mathematical expressions. A plus sign indicates that variables change in the same direction, while a minus sign indicates a change in the opposite direction. Green variables represent management decisions - parameters managers can use to simulate policies.

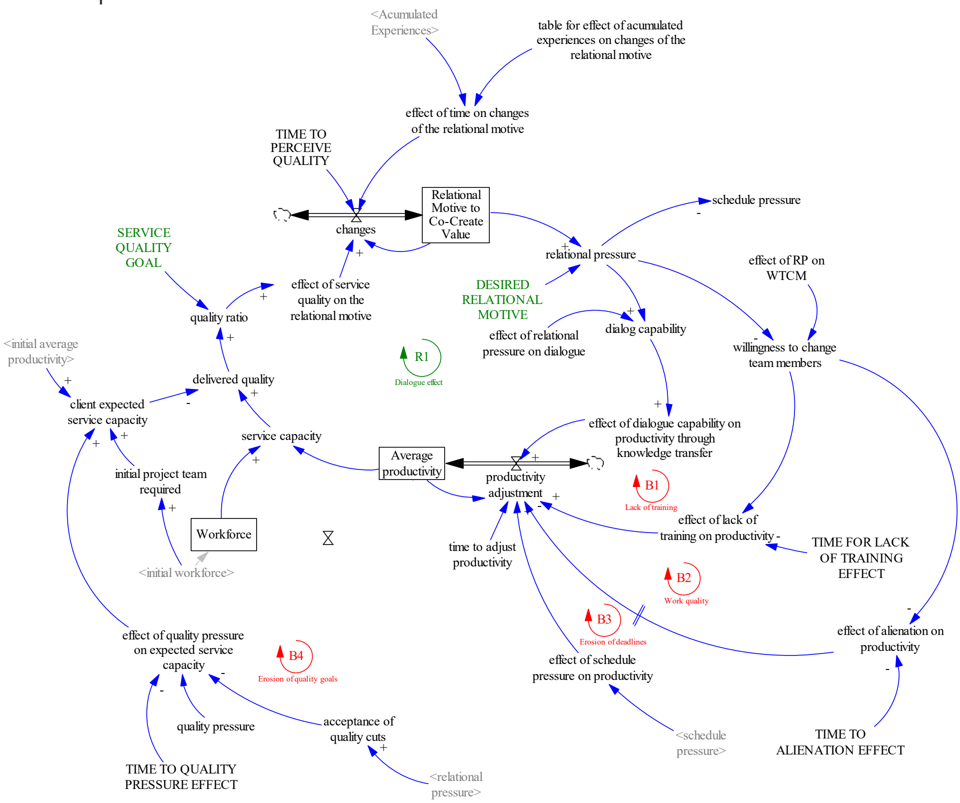


Figure 11 – Aggregate feedback structure

2.5.5 Model validation

The validation of the System Dynamics model developed in this Chapter adheres to an iterative theory-building approach. This methodology is consistent with established System Dynamics best practices (Schwaninger and Grösser, 2008; Homer, 1996; Oliva, 1996) and draws broadly from Sterman's (2000) principles for building confidence in dynamic models. Conceptualized based on insights from the Dark Side of Relationships (DSR) and Value Co-creation (VCC) literature, the model's structure (Figure 11) and its initial parameters (Appendix 1) were primarily informed by a literature review spanning System Dynamics, marketing, service quality, and project management. Critically, as an exploratory model, its development and calibration extensively utilized qualitative data and expert judgment derived from 23 in-depth interviews with project managers across seven distinct IT companies in Portugal (Appendix 2). These interviews were instrumental in refining model assumptions, validating conceptual relationships, and ensuring the model's behavior resonated with real-life experiences. The model was also presented back to these interviewed project managers to further validate relationships and assumptions, and to reflect on its simulated results in correlation with their practical experiences. Further confidence in the model's underlying structure and dynamic behavior is derived from the integration of elements and relationships previously developed and tested in published System Dynamics work.

2.6 Simulation results

The model demonstrates a significant, dynamic interplay between the RMCCV, service capacity, expectations, and ultimately, service quality. This addresses our two research questions. Firstly, the model confirms the positive impact of RMCCV on service capacity and expectations in the short term. However, the simulation results in Figure 12 reveal a critical finding: without management intervention, initial service quality gains eventually erode over time, despite the continued growth of the RMCCV. The observed pattern aligns with established concepts in the Dark Side of Relationships (DSR) literature and shares characteristics with the "death spirals" described by Oliva and Sterman (2010). This leads to our first proposition:

Proposition 1: While enhancing social and emotional connections can initially improve service quality through increased RMCCV, unmanaged relationships can lead to a long-term decline in service quality.

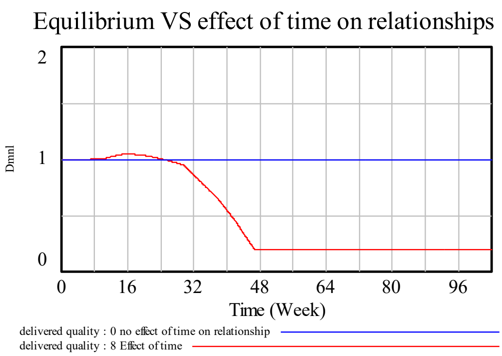


Figure 12 – The effect of the RMCCV on service quality

Our analysis of the model's management decision points underscores their critical role in influencing the system's behavior. The model highlights two key policies:

Managing the RMCCV: Figure 13 (left chart) illustrates the difference in service quality from an impact of a 25% and a 50% increase in the desired RMCCV (from 1 to 1.25, and to 1.5) implemented from week 16 onwards. This targeted intervention demonstrably stabilizes service quality levels, preventing the erosion observed without intervention. However, more aggressive increases in the desired RMCCV resulted in growing oscillations, highlighting the need for a balanced approach.

Setting service quality goals: Figure 13 (right chart) showcases that implementing service quality goals not only halted the erosion but also led to a modest increase in service quality. Interestingly, doubling the service quality goal yielded minimal additional benefit. The most significant improvement stemmed from the combined application of both policies, demonstrating a synergistic effect.

These findings inform our second proposition:
Proposition 2: Management decisions to stabilize the RMCCV and to set quality goals have a positive effect on service quality.

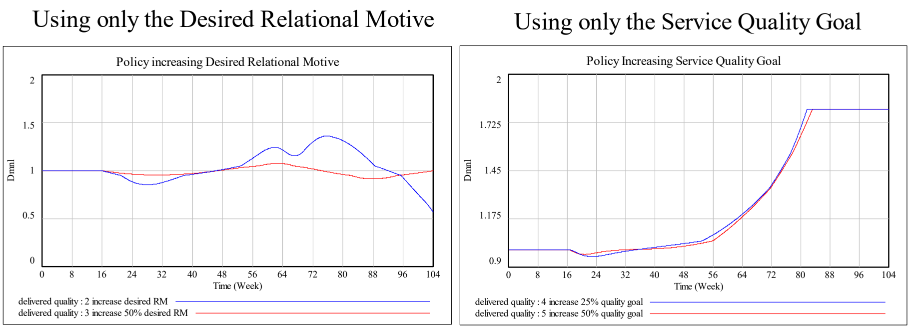


Figure 13 – Policy results

Our research demonstrates that the RMCCV plays a critical role in the long-term evolution of service quality, particularly in IT service delivery. Static assessments of RMCCV provide an incomplete picture. Left unmanaged, the positive influence of RMCCV on service quality can erode over time due to four distinct negative feedback effects on service capacity and expectations. These effects, only observed in the later stages of service delivery, highlight a previously unexplored dynamic in the relationship between RMCCV and service quality.

2.7 Discussion and conclusion

This research underscores the crucial role of the RMCCV in shaping service quality within knowledge-intensive business services. It moves beyond traditional views, proposing a nuanced management of RMCCV that acknowledges both its potential benefits and drawbacks on service quality over time.

While value co-creation (VCC) literature emphasizes the positive aspects of strong relationships (Ellram and Murfield, 2019), and the Dark Side of Relationships (DSR) field identifies potential downsides (Anderson and Jap, 2005), our model demonstrates a complex interplay. Initially, the positive effects of RMCCV are dominant, improving service capacity and service quality, which aligns with VCC literature (Jaakkola and Alexander, 2014). However, our model also reveals that this initial improvement can erode into counterintuitive service decline if left unchecked, confirming arguments from the DSR literature (Villena, Choi and Revilla, 2021). The research further acknowledges the reciprocal relationship between RMCCV and service quality: a strong RMCCV can initially improve service quality, but declining service quality can, in turn, weaken the relationship. This highlights the need for a holistic approach to managing client relationships.

To aid managers, the research presents a System Dynamics model. This tool allows for the visualization of the long-term dynamics between RMCCV and service quality, enabling proactive management to address potential issues before they arise. The model contributes to the understanding of how RMCCV affects quality over time, facilitating the development of strategies to leverage positive effects while minimizing the risks of overly close relationships (Anderson and Jap, 2005). Grounded in established theories, the model provides a valuable framework for strategic decision-making, enabling managers to tackle the root causes of service quality problems, not just their immediate symptoms.

2.7.1 Theoretical implications

Discovering that the RMCCV is critical for service quality development over time leads to some important theoretical implications:

- First, it explains service erosion (Proposition 1). While initially positive, unmanaged RMCCV can lead to a paradoxical decline in service quality over time. The positive effects arising from the RMCCV include a deeper understanding of client needs (Noordhoff *et al.*, 2011) and precise service requirements and expectations (Johnsen and Lacoste, 2016), which improve service quality (Jaakkola and Alexander, 2014). However, as the DSR literature argues, the negative effects from the resulting initial improvement in interpersonal social relationships (Bagdoniene and Valkauskiene, 2018), such as losing objectivity (Rood *et al.*, 2018), acceptance of bad performance (Villena, Revilla and Choi, 2011), lower expectations and poor goal definition (Villena, Choi and Revilla, 2021), create the conditions to a decline in service quality.

- Second, this research offers a formal, dynamic theory that bridges the gap between positive and negative relationship perspectives (Noordhoff *et al.*, 2011). Following Proposition 1, which explains why relationships can have both positive and negative impacts on service quality, the model explicitly unites these previously separate literature streams. Moreover, it explains how these impacts change over time, following the suggestion from Neghina et al. (2017) to produce unexpected behaviors. The model demonstrates that these impacts can shift in dominance: positive effects are felt following relationship initiation (Autry and Golicic, 2010), making them dominant in the short-run, while the negative effects, operating with long delays, tend to dominate in the long-run, making them even more pervasive (Villena, Choi and Revilla, 2021). This provides a micro-level understanding of the dynamic interplay between relational benefits and drawbacks through a formalized causal structure.
- Third, this research introduces a novel theoretical context by endogenizing the RMCCV within a dynamic service quality model. This study is the first to formally integrate a specific client motivation (the RMCCV) as an endogenous variable influencing service quality dynamics, moving beyond static views of client participation. Furthermore, it applies this analysis to a B2B IT environment with long-term service delivery, an area previously unexplored in the motives to co-create value literature. Following the calls from Spohrer and Maglio (2008) and Neghina et al. (2017) for longitudinal analysis, this research takes the first steps towards a System Dynamics-supported understanding, uniquely capturing the changes in dominance and the varied impacts of RMCCV that generate such complex behaviors over time.
- Fourth, Proposition 2 highlights the importance of strategically managing RMCCV and setting quality goals to prevent service erosion. The adoption of a framework to manage the RMCCV, inspired by existing Value Co-Creation (VCC) frameworks such as that proposed by Aarikka-Stenroos and Jaakkola (2012) may prove highly efficient as their analysis of collaborative activities

can provide actions to improve RMCCV management. Additionally, in line with previous System Dynamics research emphasizing the importance of goals since the 1990s (Abdel-Hamid, 1999), the use of adequate goals proves to be a very efficient strategy to counteract service erosion.

- Finally, this research demonstrates the significant value of System Dynamics as a complementary method for service research. These models effectively capture the dynamic nature of RMCCV, feedback loops, and non-linear relationships, directly addressing a limitation recognized by Spohrer and Maglio (2008) since 2008. This synergy between marketing (VCC) and System Dynamics offers promise for both fields (Lyneis and Ford, 2007; Spohrer and Maglio, 2008; Bettencourt, Lusch and Vargo, 2014).

2.7.2 Managerial implications

The findings offer valuable managerial insights for fostering positive relationships while mitigating potential downsides:

Goal setting and avoiding erosion. This research highlights the importance of setting clear service quality goals anchored in industry benchmarks. This helps counteract the potential erosion of goals that can occur as service provider-client relationships develop. These goals should be widely communicated throughout the organization and used as a continuous reference point for service delivery.

Strategy development. The study builds upon existing frameworks by suggesting a two-pronged approach. One aspect focuses on maximizing the Value Co-Creation (VCC) process (Neghina et al., 2017, p. 158), involving the development and implementation of strategies that leverage the collaborative nature of B2B IT service delivery. However, the research also acknowledges potential pitfalls associated with the Dark Side of Relationships (DSR). Managers should therefore develop relationship management strategies to prevent these negative effects. This may involve rethinking traditional power dynamics and acknowledging clients as active participants in service delivery.

Knowledge management and staffing. The research emphasizes the importance of knowledge management practices. Managers should promote activities that facilitate knowledge creation and formalization (Xu *et al.*, 2021). This not only enhances the value of the relationship but also improves knowledge transfer and integration of new staff or during staff rotation. Additionally, strategies that encourage knowledge exchange (Mandolfo, Chen and Noci, 2020) are crucial. This might involve implementing mandatory processes for knowledge sharing. Complementary to these practices, companies can adopt a staffing strategy that prioritizes co-creation skills and develop project structures that promote shared responsibility.

Monitoring and system investment. The study calls for investment in monitoring and planning systems. Managers need to track the evolution of client relationships and remain vigilant for signs of potential objectivity loss or relational inertia. This can be achieved through IT performance management systems that offer data analytics and facilitate benchmarking against industry standards. Furthermore, investing in simulation models, similar to the one developed in this research, serves as a valuable tool for learning, strategic planning, and operational optimization. This investment should be complemented by formal governance mechanisms and explicit contractual terms regarding performance expectations, service requirements, and challenging goals. Additionally, regularly conducting external audits and service quality evaluations can provide valuable data for continuous learning processes. Crucially, the model highlights that optimal service quality improvements are often achieved not through isolated interventions, but through the synergistic combination of these various management strategies.

Simple guidelines for service management. The identification of five feedback loops allows for the development of simple, actionable guidelines that can be readily integrated into existing service management processes. Introducing collective knowledge platforms and rotating personnel are effective strategies for improving knowledge transfer, preventing overly familiar relationships, and reducing client dependency. Additionally, implementing standardized procedures and outcomes combined with time limits on client engagements can help prevent client alienation and overdependence. Finally, increasing the frequency of independent quality testing allows for early problem identification and acts as a safeguard against overly comfortable relationships. While some of these practices have been successfully implemented in existing organizations, further research is needed to develop a comprehensive approach.

2.7.3 Limitations and future research

As with any model, ours is a simplification (Sterman, 2000) , with assumptions and limitations working as boundaries of the research. However, some of those simplifications and limitations, coupled with our research findings, provide exciting research opportunities.

One relevant limitation arises from the lack of empirical measurements of service quality over time (Neghina *et al.*, 2017). Longitudinal studies on service quality in this specific IT B2B setting are rare because they present difficult challenges to overcome, such as the demand for high availability of time from both the service provider and the customer that arises from a study with multiple measurements over a long period (preferably over one year). Nevertheless, this presents a promising research opportunity for developing empirical service quality measurements using appropriate methods, such as the SERVQUAL scale (Parasuraman, Zeithaml and Berry, 1985). These empirical measurements would be critical to understanding the long-term behavior of service quality, improving the ability to address our Proposition 1 (While enhancing social and emotional connections can initially improve service quality through increased RMCCV, unmanaged relationships can lead to a long-term decline in service quality).

Another inherent limitation of this theoretical model lies in the conceptualization and parameterization of its internal relationships. While robustly informed by extensive literature and exploratory qualitative interviews with experienced project managers, the specific functional forms, parameter values, and precise magnitudes of some feedback effects are based on qualitative insights and informed judgment rather than extensive quantitative empirical data. Future research could focus on more rigorous empirical parameter estimation, perhaps through in-depth case studies or data collection tailored to specific model relationships, to further refine the model's quantitative accuracy.

An opportunity that arises from the previous discussion is the research on relational motive strategies combined with benchmark goals for this new ITB2B setting. Such research would shed new light on Proposition 2 (Management decisions to stabilize the RMCCV and to set quality goals have a positive effect on service quality). Testing our Proposition 2 in case study format would help us understand which strategies are more useful for the service setting we are focusing on.

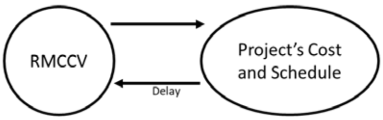
Another limitation results from focusing on the relational motive. Our research questions aim at understanding the impacts of relationships, where the relational motive is an integral part. However, other motives may significantly influence service quality in the ITB2B setting. Research has been highlighting the importance of motivating teams to co-create (Neghina *et al.*, 2017; Karpen, Bove and Lukas, 2012; Pera, Occhiocupo and Clarke, 2016; Roberts, Hughes and Kertbo, 2014; Schüler, Fee Maier and Liljedal, 2020; Fernandes and Remelhe, 2016; Amin *et al.*, 2021), which might have a higher leverage potential in a service setting where collaboration is so intensive. Researching the individualized impact from other motives, as well as in combination with the RMCCV, may prove to be an unexplored source of competitiveness.

A final limitation arises from addressing the ITB2B service setting. Our limited focus aims to support the industry in overcoming challenges such as low customer satisfaction and high-quality costs. However, the ITB2B setting is similar to other settings that share the characteristics of knowledge-intensive business services. Future research on the impact of the RMCCV in similar B2B service settings will contribute to the generalization of the theory. Starting with knowledge-intensive services such as consulting could provide important insights as they share some important service characteristics already identified by Oliva and Sterman (2001) back in 2001, such as being intangible, production and consumption occurring simultaneously, being perishable and not inventoried, and being labor and knowledge-intensive. This research opens doors for a deeper understanding of the dynamic relationship between the RMCCV and service quality in B2B contexts.

In conclusion, this study unveils the dynamic interplay between the RMCCV and service quality, challenging the traditional view of relationships as solely beneficial. It demonstrates that while motivating participants to co-create is crucial (operationalized by RMCCV), its impact on service quality can be double-edged. Unmanaged, the relationships that result from the co-creation process can trigger an unintended downward spiral through interactions with service capacity, expectations, and goals. However, proactive management through targeted policies on both RMCCV and service quality goals offers a powerful tool to break free from this erosion and establish a new, virtuous cycle. This research significantly advances our understanding of relational dynamics in service contexts, particularly through its formalization using a System Dynamics approach. This opens exciting avenues for future exploration of dynamic service management strategies that leverage the power of relationships while ensuring sustained service excellence.

3. Effects of relationships on the dynamics of information technology projects

In Chapter 3, the research advances to the second phase, wherein the theoretical framework is applied to a generic project management model similar to the ones using the waterfall project management methodology. This chapter introduces the project management and System Dynamics literature to apply the theoretical framework developed in chapter 2 to the critical project setting. The application of the relational motive to co-create to project management involves a meticulous investigation into motivating the participants to co-create and the impact of the relational motive on key project variables, shedding light on the dynamics of projects under varying strategic approaches.

Causal relationship	
Gaps addressed	• The ability to motivate clients using the relational motive is under-explored in the knowledge intensive services, especially in software development. • The combination of the positive and negative effects of the RMCCV on project results in terms of cost and schedule has been neglected in project management literature and in System Dynamics applied to project management.
Research questions	• How the development of relationships impacts project dynamics?
Overarching research questions	• How do the relational motive to co-create value (RMCCV) and relational capital impact project results in terms of cost and schedule? • Which strategies can be used to leverage the relational motive to co-crate value and relational capital for better project results in terms of cost and schedule?

This research was presented at the 2022 International System Dynamics Conference in Frankfurt, Germany: Sousa, J., Bloemer, J.M.M., Rouwette, E.J.JA, Jacobson, J., Malczynski, L. (2022). *Effects of relationships on the dynamics of information technology projects.*

3.1 Abstract

Despite established project management practices, IT projects often suffer from rework, scope changes, and knowledge gaps, contributing to the low success rates reported by industry journals. Research highlights the importance of controlling rework, scope creep, and labor allocation. However, the impact of relationships between the service provider and the client on management decisions has been underexplored, especially in IT services where client involvement is critical. This study uses a simulation model to investigate how the Relational Motive to Co-Create Value (RMCCV) influences management decisions and, consequently, project outcomes. This study makes two key contributions. First, it integrates relationship dynamics into traditional project management approaches. Second, it demonstrates the importance of relationship management for improved project results. The research concludes with practical implications and recommendations for future research.

3.2 Introduction

The importance of relationships between the service provider and the client in project management is underrated and has been absent from System Dynamics studies. Project management is a much-debated topic in the fields of System Dynamics and information technology due to the persistence of problems that have been known for decades, yet unfortunately remain common. These issues include changing project scopes, delivery and cost overruns, excessive rework, poor reliability, and user dissatisfaction (Abdel-Hamid, 1984; Abdel-Hamid, 1999; Lyneis and Ford, 2007; Jalili and Ford, 2016; Li *et al.*, 2018). In software projects, the criticality of relationships is amplified by distinct characteristics such as intangibility, invisibility, and inseparability. These pose specific challenges for estimation (Abdel-Hamid, 1984; Ruiz, Ramos and Toro, 2001), control processes (Austin, 2001) and evaluation (Bardhan *et al.*, 2010).

System Dynamics has extensively studied software project management. Several studies identified the major challenges for software projects, uncovered the structure behind their execution, discussed the problems resulting from that structure, and proposed solutions to address some of them (Abdel-Hamid, 1984; Abdel-Hamid and Madnick, 1989; Abdel-Hamid and Madnick, 1989; Abdel-Hamid and Madnick, 1991; Abdel-Hamid, 1999; Ford, 1995). Later studies deepened the focus on specific issues impacting project performance, such as the effect of time pressure (Austin, 2001), staffing delays (Sengupta, Abdel-Hamid and Bosley, 1999), concurrent activities (Rahmandad and Weiss, 2009), and multiple defects per task (Rahmandad and Hu, 2010). Other studies took a behavioral approach stressing the importance of soft factors such as the psychological behavior of project stakeholders (Choi and Bae, 2009), leadership (Thite, 1999), and the role of the project manager (Anantatmula, 2010; Meng and Boyd, 2017).

Surprisingly, previous studies largely neglect the importance of relationships in project success, especially for software projects where client participation is intense. Relationships play a critical role in the service delivery of IT projects because they involve intense client participation (Bardhan *et al.*, 2010) leading to a co-creation process (Vargo and Lusch, 2004). This intense participation requires a collaborative approach, which is critical for service success (Yeniaras, Di Benedetto and Dayan, 2021), as clients are the principal source of knowledge about their own needs (Noordhoff et al., 2011) and influence the requirements and expectations of the service (Johnsen and Lacoste, 2016), thus affecting service quality (Nordin and Kowalkowski, 2010; Jaakkola and Alexander, 2014). Given that relationship management is now recognized as a focus for the next generation of project management (Meng and Boyd, 2017), it's surprising that System Dynamics research has yet to fully incorporate the importance of relationships into its project management studies.

Relationships evolve and often present both positive and negative consequences, with varying dominances and effects over time. On the one hand, relationships can improve communication (Luna-Reyes *et al.*, 2008; Anantatmula, 2010; Meng and Boyd, 2017), allowing the exploitation of synergies (Villena, Revilla and Choi, 2011) and enhancing knowledge transfer, which boosts productivity. On the other hand, relationships often result in biased judgments and evaluations (Rood *et al.*, 2018; Villena, Choi and Revilla, 2021), acceptance of suboptimal performance through complacency (Mitręga and Zolkiewski, 2012), lowered expectations (Johnsen and Lacoste, 2016; Villena, Choi and Revilla, 2021), poor definition of goals (Johnsen and Lacoste, 2016), and poor decision making (Anderson and Jap, 2005; Rood *et al.*, 2018; Villena, Revilla and Choi, 2011). These consequences are particularly dangerous as they may go unnoticed for long periods (Villena, Choi and Revilla, 2021). Both positive and negative effects create feedback loops that can drag a project into a reinforcing process of eroding results, leading to increased costs, missed deadlines, declining quality, or escalating work pressure that can result in higher employee attrition and client loss.

The purpose of the present research is to improve knowledge regarding how the development of relationships impacts project dynamics. This is achieved by developing new structures to capture the positive and negative effects of relationships on service capacity, expectations, and goals, integrating them into a generic formal System Dynamics model of project management (Ford, Lyneis and Taylor, 2007; Jalili and Ford, 2016; Li *et al.*, 2018; Oliva and Sterman, 2001; Oliva and Sterman, 2010). The model is presented iteratively, beginning with the new structure explaining how relationships impact project development, followed by the basic workflow structure of projects and the dynamics introduced by rework and changes in requirements. Additional structures are then added, including staff, hiring and training, the workweek, standards for customer service, and client responses to service quality. The analysis explores how the dynamics change as the model boundary expands. A documented version of the model is available for experimentation.

This chapter is organized as follows. The next section details the impact of relationships on projects, laying the theoretical foundation for the structures that follow. Subsequently, the model development process is presented. Then, the model is explored through simulations of different policies. Finally, the results are discussed, concluding with policy recommendations.

3.3 Impact of relationships on projects

The critical role of service provider-client relationships has been extensively researched across industries. Value co-creation (VCC) literature emphasizes collaborative activities between service employees and clients (Neghina *et al.*, 2015). This collaboration fosters a deeper understanding of client needs (Noordhoff *et al.*, 2011), allowing service providers to influence client behaviors (Chan, Yim and Lam, 2010), expectations (Johnsen and Lacoste, 2016), and goals (Bardhan *et al.*, 2010). These influences ultimately translate into improved service quality and satisfaction (Bettencourt *et al.*, 2002; Nordin and Kowalkowski, 2010; Jaakkola and Alexander, 2014). Furthermore, intense collaboration can foster interpersonal social relationships (Bagdoniene and Valkauskiene, 2018), often built on informal interactions (Taminiau, Ferguson and Moser, 2016), which are a routine aspect of service professionals' work. These relationships can enhance service capacity (Payne, Storbacka and Frow, 2008).

While VCC literature emphasizes the positive aspects of strong service provider-client relationships, the dark side of relationships (DSR) literature explores their potential downsides. Although DSR acknowledges the benefits of relational capital for performance (Villena, Revilla and Choi, 2011), it highlights the negative consequences of excessive relational investment. Four key issues emerge:

1. Loss of objectivity: Close relationships can lead to biased judgments and inaccurate evaluations (Villena, Revilla and Choi, 2011; Rood *et al.*, 2018).
2. Complacency and blurred roles: Acceptance of subpar performance and confusion about responsibilities can arise (Villena, Revilla and Choi, 2011; Autry and Golicic, 2010; Mitręga and Zolkiewski, 2012).
3. Lower expectations and goals: Complacency fosters lower expectations and poor goal definition (Johnsen and Lacoste, 2016; Villena, Choi and Revilla, 2021).
4. Poor decision-making: Factors like redundant knowledge (Villena, Revilla and Choi, 2011; Anderson and Jap, 2005, opportunistic behavior (Johnsen and Lacoste, 2016; Noordhoff *et al.*, 2011; Mitręga and Zolkiewski, 2012), and excess reciprocity (Anderson and Jap, 2005) can hinder decision-making.

These issues can have a corrosive long-term impact, with negative effects remaining undetected for extended periods (Anderson and Jap, 2005; Villena, Choi and Revilla, 2021). Despite their importance, relationships have been largely absent from System Dynamics models in project management. This research aims to bridge this gap by incorporating both positive and negative relationship effects into software project management models.

3.4 Model development

3.4.1 Scope of the model

The model explores the effects of relationships on four common decision points in software projects: hiring additional capacity, working overtime, working faster, and postponing scheduled deadlines. As confirmed by the literature review in the previous chapter, the development of relationships affects the choice between the combination of the four policies. This option allows the model to support different combinations between policies, providing a deep understanding of its consequences and providing managerial insights to improve project performance. The consequences of these policies are well documented in previous System Dynamics studies (Lyneis and Ford, 2007; Jalili and Ford, 2016; Li *et al.*, 2018; Oliva and Sterman, 2010).

3.4.2 The effects of relationships on project dynamics

This study leverages the concept of the Relational Motive to Co-Create Value (RMCCV) to capture both the positive and negative impacts of relationships over time. The RMCCV focuses on strengthening social and emotional connections between service providers and clients (Neghina *et al.*, 2017). This allows us to unify the positive (e.g., knowledge transfer) and negative (e.g., complacency) effects of relationships, enabling the improvement of performance regarding cost, schedule and quality. Figure 14 depicts a first feedback loop that illustrates how stronger relationships enhance knowledge transfer, which in turn increases service capacity and reinforces the relationship itself.

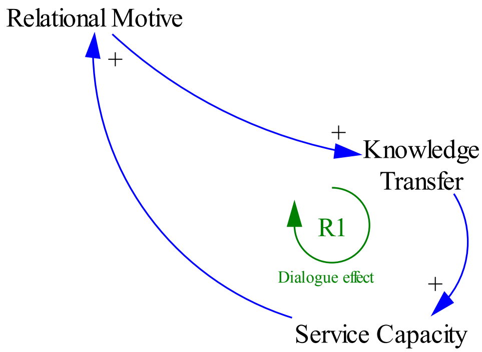


Figure 14 – Positive effect from Relational Motive on Service capacity

However, relationships can also bring several negative, balancing, impacts. The first negative loop (Figure 15) stems from the RMCCV's impact on schedule pressure. Emotional involvement can result in biased judgment and irrational decision-making (Johnsen and Lacoste, 2016; Rood *et al.*, 2018), leading to the acceptance of missed deadlines. This contributes to a permanent decrease in standards, potentially locking the company into sub-optimal future solutions. The decreasing schedule pressure that results from increasing social and emotional connection makes the decision to extend project deadlines easier, leading to time overruns and potentially hindering the development of relationships, similar to the process of goal erosion.

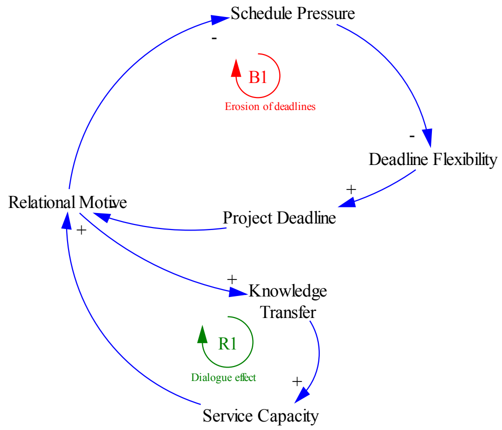


Figure 15 – consequences of schedule pressure

The second negative feedback loop (Figure 16) shows how relationships can decrease the willingness to changing team members, leading to a decrease in service capacity through less training and increased alienation (Frow, McColl-Kennedy and Payne, 2016; Maglio and Spohrer, 2008; Johnsen and Lacoste, 2016). The third negative consequence (Figure 16) also stems from the willingness to change team members. As the service provider's team becomes immersed in the client's processes and culture, their sense of belonging changes when working at the client's facilities. This alienation can lead to skipping internal procedures and non-compliance with original planning, potentially generating more errors in the future. Altogether, these effects decrease work efficiency and consequently lower delivered quality.

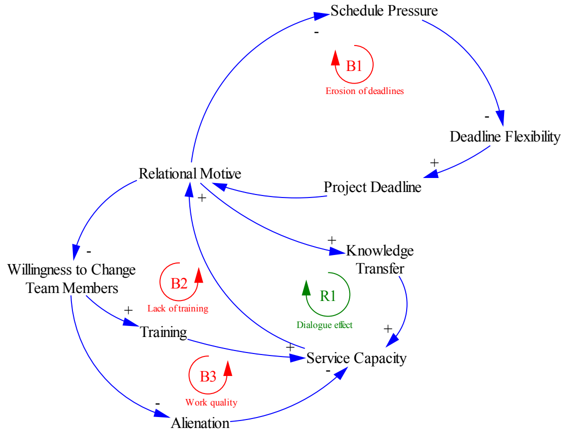


Figure 16 – consequences of willingness to change team members

Finally, relationships can generate a process of lowering quality levels by accepting new, lower standards, which quickly become the new normal (Figure 17). The inherent difficulty in measuring services (Oliva and Sterman, 2001; Oliva and Sterman, 2010; Johnsen and Lacoste, 2016), compounded by a general lack of explicit quality reporting by stakeholders, further increases when clients evaluate their work due to their intense participation in service delivery. This implies that as social and emotional connections develop, client resistance to accepting quality cuts will decrease, thereby lowering quality pressure, increasing errors and rework, and ultimately degrading delivered quality.

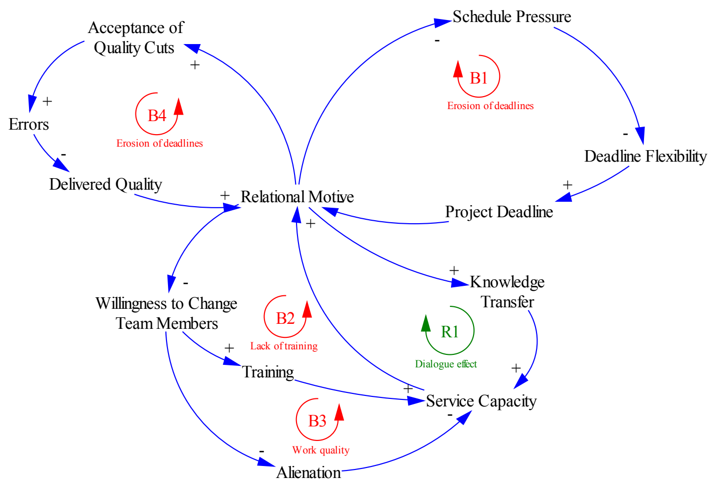


Figure 17 – consequences of accepting quality cuts

Figure 17 shows a complex and dynamic system, largely absent from previous project management models, featuring one positive and four negative feedback loops. Some of these loops may dominate in the short term, while others assert their influence in the long term. Combined, these loops challenge the widespread view that "enhancing the social and emotional connection" (Neghina *et al.*, 2017, p. 160) is always positive. The overall system depicted in Figure 17 explains that developing "cozy" relationships between service providers and clients can indeed result in decreasing project performance.

However, these relational dynamics do not emerge instantaneously. They are a function of the project's history and the duration of interaction. To capture the longitudinal evolution of these relationships described by value co-creation and DSR literature, the model uses the concept of "Accumulated Experiences" (Figure 18). This variable is a function of the experiences project members accumulate while the project is being developed. As these experiences accumulate, they fundamentally shift the relational motivation, explaining why the performance-eroding loops identified in Figure 17 may only assert dominance after a specific threshold of collaboration is reached.

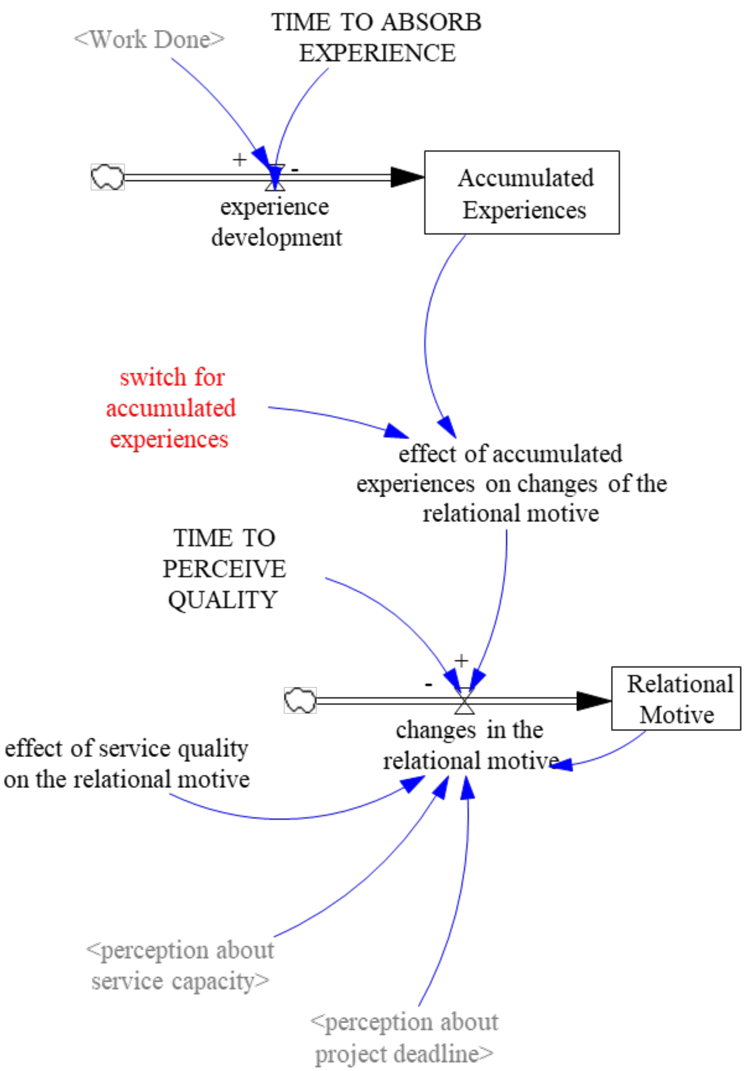


Figure 18 – Development of relationships

3.4.3 Workflow structure

The simulation model presented in this chapter replicates a traditional software development project flow and builds upon established research (Sterman, 2000; Lyneis and Ford, 2007; Jalili and Ford, 2016; Li *et al.*, 2018). The model depicted in Figure 19 starts with an "INITIAL PROJECT SCOPE" that defines the initial workload, referred to as “Work to Do”. Throughout the project lifecycle, teams complete tasks each week, contributing to the overall progress. While some tasks are completed flawlessly, others inevitably encounter errors, necessitating rework that returns to the "Work to Do" pool. This iterative process, known as rework, represents a significant pressure point in projects and is directly influenced by the "probability of error generation" (further elaborated upon later).

A second prominent challenge in software development arises from changing requirements. As clients gain a deeper understanding of the project's potential, they may introduce changes to the initial requirements. However, these changes not only introduce new work but also render some previously completed tasks obsolete, as noted by Lyneis and Ford (2007).

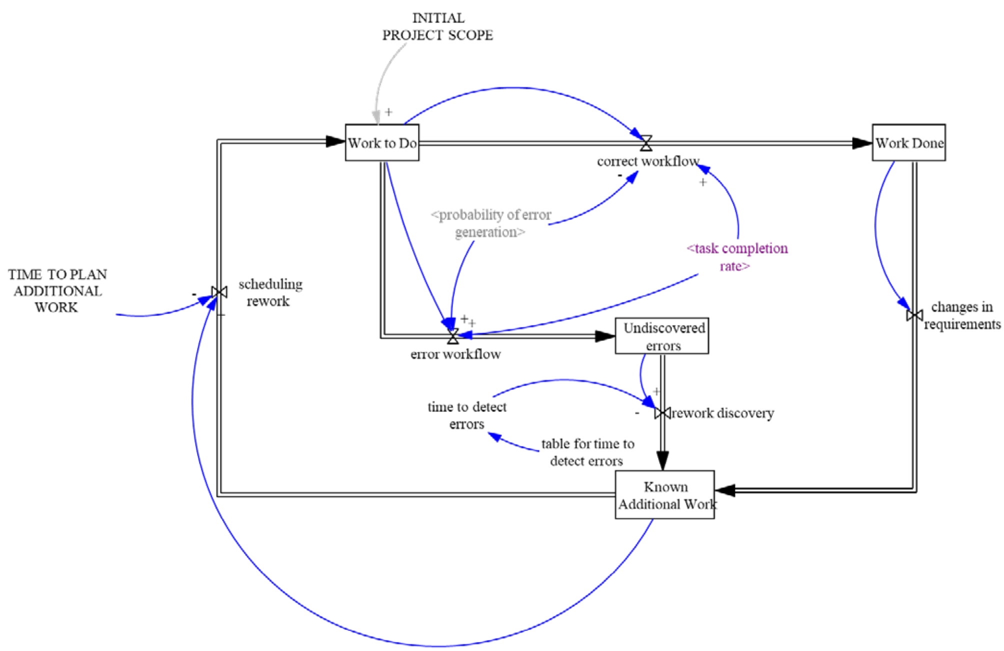


Figure 19 – Project workflow

3.4.4 Service capacity, experience curve and the effect of relationships on service quality

To calculate service capacity, the model builds on the structure used by Oliva and Sterman (2010), adding the necessary customization to software development. Service capacity is given by:

$$\begin{aligned}&\textit{Service capacity}\\&= \Big(\big(\textit{Experienced}\\&- \textit{Rookies } x \ (\textit{fraction of time spent on proposals}\\&+ \textit{fraction of time spent training rookies})\big)\\&+ \textit{Rookies } x \textit{ Rookie productivity fraction}\Big) \ x \ f(\textit{effects of relationships on service capacity})\end{aligned}$$

The model introduces two changes to the experience chain structure that inspired us. First, projects can hire experienced employees during the project. When projects need rapid capacity increases, require specific knowledge, or are overrunning their deadlines, it is not uncommon to hire experienced employees to address these challenges. By including this option, it becomes necessary to incorporate another decision point regarding the level of experience required for hiring, leading to a structure depicted in Figure 20:

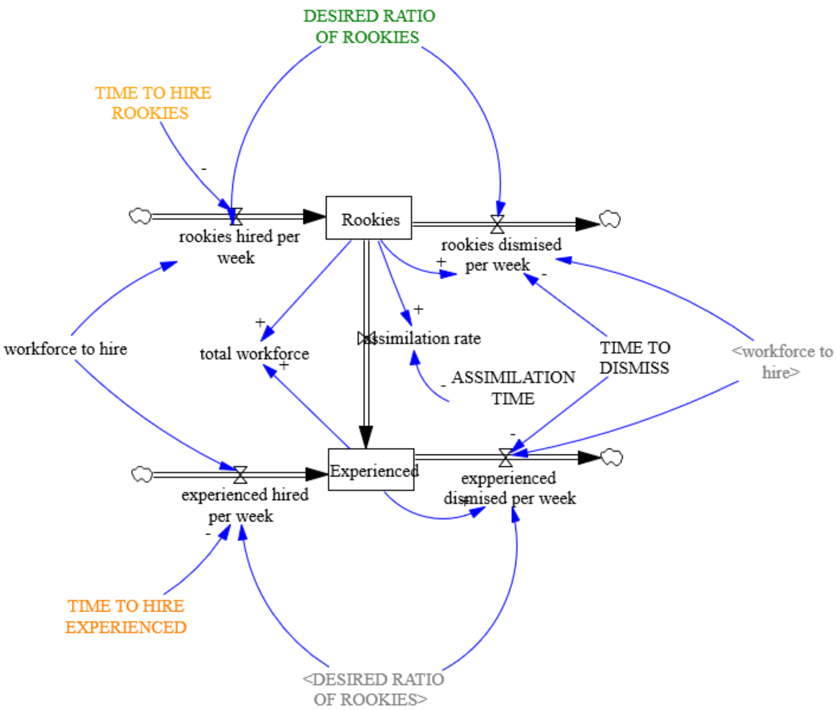


Figure 20 – Experience chain structure

3.4.5 Task completion rate and desired completion rate

As explained previously in Figure 19, the model uses the variable "*Task completion rate*" to simulate the number of tasks that are developed every week in the project. Task completion rate is a function of service capacity given by the number of equivalent experienced people, the number of hours people work during the week, and the time it takes to develop one task:

$$Task\ Completion\ Rate = \frac{service\ capacity\ \times workweek}{standard\ time\ per\ task}$$

By analyzing the remaining workload, project time remaining, and current task completion rate, project managers can estimate the time required to complete the project. This assessment influences two crucial project management steps:

- Feasibility of deadline extension: Project managers evaluate the possibility of adjusting the project deadline. This decision is heavily influenced by the strength of the relationship between the service provider and client teams. A strong, collaborative relationship can facilitate open communication and potentially lead to flexible deadline adjustments.
- Calculating the desired completion rate: The formula to calculate the desired completion rate is as follows:

$$Desired\ Completion\ Rate = XIDZ\ (\frac{work\ to\ do}{schedule\ time\ remaining}, maximum\ task\ development\ rate)$$

The XIDZ function ensures that when there is no time left to complete the project, the "*Desired Completion Rate*" is the maximum possible. Desired completion rate will be critical for project management decisions, driving management decisions regarding (1) hiring staff, (2) working longer hours and (3) working faster. Figure 20 presents the causal relationships considered when looking at project controls (Li *et al.*, 2018) conditioned by the possibility of using the policy to extend project deadlines.

An increased desired completion rate presents project managers with a dilemma. If the strength of the service provider-client relationship allows (relational motivation), they may postpone the project deadline. This action, however, can lead to a phenomenon known as "adjustment to new, lower standards" (Sterman, 2000; Oliva and Sterman, 2010). The decreased pressure to meet the revised deadline may subtly decrease quality expectations, potentially eroding the initial commitment to excellence. This erosion is particularly insidious as actual quality issues are often not explicitly reported, making problems harder to detect and address. This cycle can continue until the relationship weakens and deadline extensions become unavailable.

When deadline extensions are not an option, project managers must address the service capacity deficit. Three policy options exist: hiring additional staff, increasing overtime, or implementing faster work practices. However, each approach carries unintended consequences. All three can contribute to a higher probability of errors, leading to rework and ultimately, an increase in workload. While previous research has explored these consequences in detail (Lyneis and Ford, 2007; Jalili and Ford, 2016; Li *et al.*, 2018), the present model incorporates them into the feedback loops described in Figure 21. These loops highlight how the relational motive impacts the effectiveness of these policies, significantly influencing project dynamics. Ultimately, both service capacity and project expectations are critically influenced by the RMCCV, shaping the available policy options for project managers.

3.4.6 Service quality and the effect of relationships on the perceptions of quality

The model in the present research follows the approach used by Oliva and Sterman (2001; 2010). While traditional project management models take an engineering approach looking at quality as a function of errors (Lyneis and Ford, 2007), Oliva and Sterman adopt a broader perspective from service quality literature, centering the client in the discussion. They argue that service quality should be measured using the SEVQUAL scale developed by Parasuraman et al. (1985; 1988). However, to simplify the model efforts, quality is modelled as a function of the performance gap – the difference between Time per Task and the clients' expectations about it. Consequently, our model uses the traditional approach of several effects impacting the probability of error generation but adds the difference between expectations and perceptions for time per task, service quality, and project deadline. This approach is paramount to us because this evaluation will affect the relational motive and project dynamics. This simplification is particularly relevant given that, in real-world projects, explicit reporting of service quality results, especially concerning these perception gaps, is often lacking, making issues harder to detect and manage.

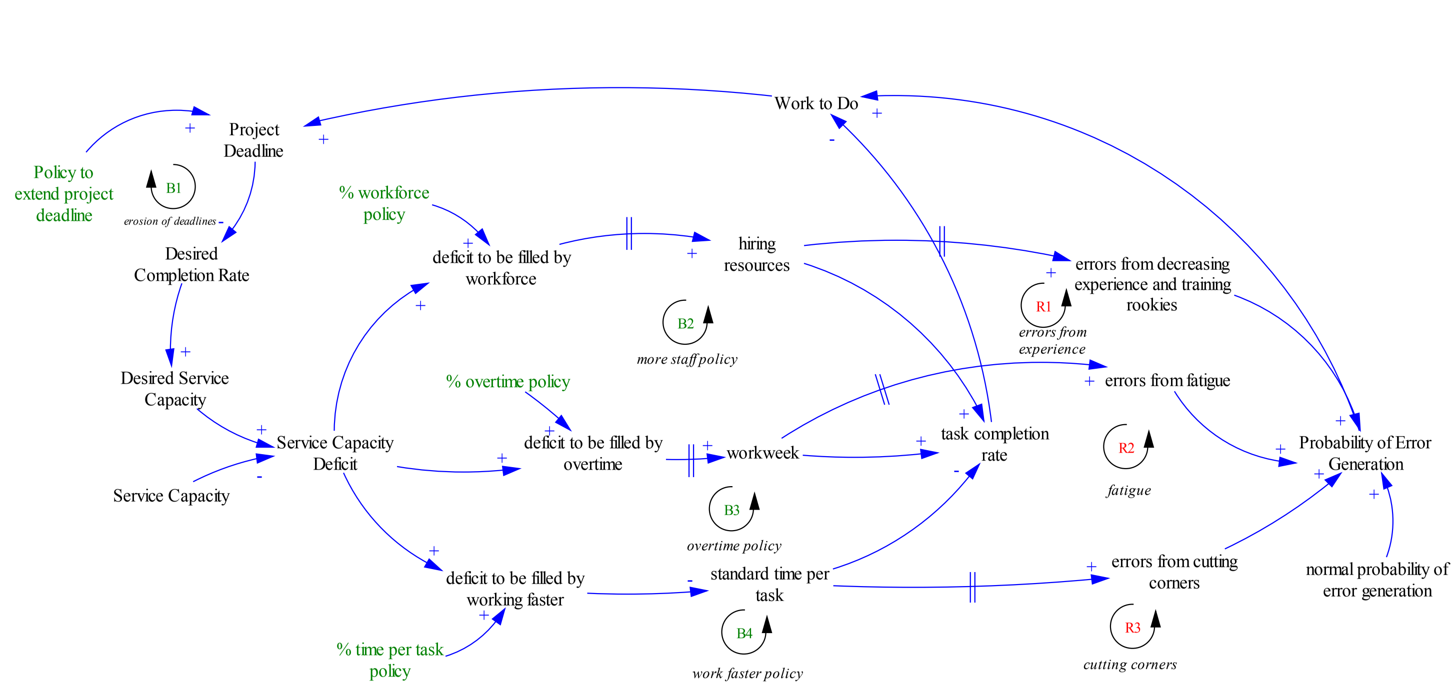


Figure 21 – Conceptual causal relationships of project decisions on schedule and service capacity

To reuse as much as possible validated structures, the nonlinear function developed by Oliva and Sterman (2010) (Figure 22) was adopted for the three aforementioned variables (time per task, service quality, and project deadline). In this formulation, delivered quality is one when the performance gap is zero, meaning service capacity is equal to the client's expectation of service capacity. This formulation includes a "tolerance zone" for service quality that suggests a limited effect when the performance gap is small but increases exponentially with the gap.

$$
\begin{aligned}
&\mathit{Delivery\ quality} \\
&\qquad = f((\mathit{Service\ Capacity} - \mathit{Client\ Expected\ Service\ Capacity}) \\
&\qquad \div \mathit{Client\ Expected\ Service\ Capacity})
\end{aligned}
$$

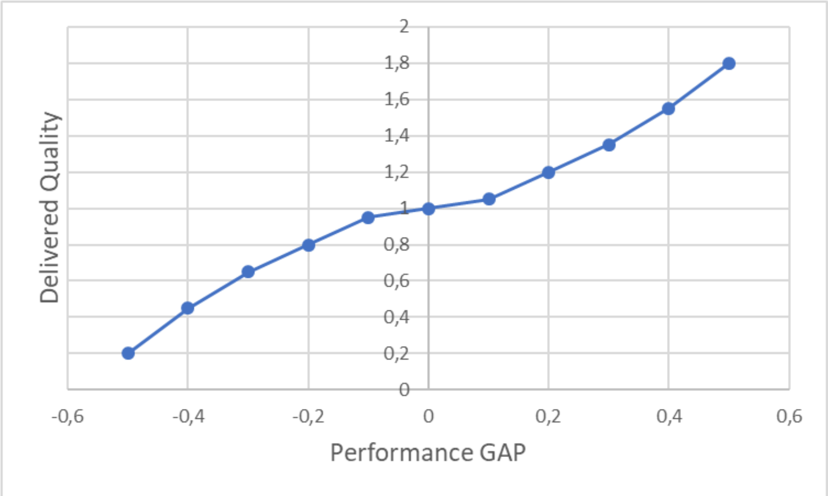


Figure 22 – Effect of performance gap on delivered quality

3.5 Results and validation

Model validation was conducted using Sterman's (2000) approach. Real-world project data from a Portuguese software development company, collected in 2020 and 2022, was utilized to test the model's behavior under typical conditions. The results demonstrated consistency with established project management models and the reference modes observed in the analyzed projects. This alignment with existing knowledge strengthens confidence in the model's structure and behavior. Additionally, the model utilizes units directly comparable to those used in real projects, eliminating the need for ambiguous conversion factors.

The initial simulated project was assigned a 60-week deadline, with the first scenario reflecting typical software development conditions based on previous research. As expected, pressure from rework led to increased overtime, error rates, and unplanned delays. Consistent with Section 3.3, adopting a deadline extension policy reduced pressure initially but weakened the service provider-client relationship over time, limiting its future effectiveness. This policy heavily relies on fostering collaborative relationships that enable flexible scheduling. However, it should be paired with control mechanisms like benchmark goals to prevent chronic deadline overruns.

Similar to prior studies, policies solely relying on overtime or faster work practices proved inefficient, particularly the "work faster" approach, which resulted in project incompletion. Hiring additional staff allowed project completion, but on its own, still caused delays. Combining workforce expansion with short-term overtime yielded positive results. However, the option to postpone deadlines emerged as particularly attractive because it avoided a significant rise in hiring and overtime, minimizing pressure on error rates. Finally, incorporating quality goals further improved outcomes by counteracting potential standard erosion. This emphasis on goals aligns with System Dynamics research, value co-creation literature, and the emerging understanding of the dark side of close relationships.

The pressure introduced by allowing clients to change requirements is significant. Even without considering the knock-out effects described in previous research (Lyneis and Ford, 2007), the increase in the number of tasks and the obsolescence of knowledge pressures the project to significant overruns. The service provider needs to use combinations of the traditional four policies (overtime, working faster, hiring staff, and postponing schedules) and complement them with setting adequate goals and managing expectations. Setting goals is especially important if one of the policies used is working faster. Overall, the results show that policies such as postponing deadlines, setting adequate goals, and avoiding changing requirements are very powerful in improving projects' outcomes, and they frame or limit the use of policies such as hiring staff, working overtime, and working faster, which are the most common in System Dynamics studies.

3.6 Discussion and conclusion

Relationships between service providers and clients are critical to project success, and the ability to motivate clients to co-create can become a source of competitive advantage for IT companies. The model shows that the positive and negative effects argued by value co-creation and the dark side of relationships literature play an important role in software development projects, highlighting the importance of managing relationships between service providers and clients. The model is supported by literature review where compelling evidence is provided to support the effects on service capacity (Spohrer and Maglio, 2008; Komulainen, 2014), goals (Jaakkola and Alexander, 2014; Rood *et al.*, 2018; Grönroos and Voima, 2013; Villena, Choi and Revilla, 2021) and expectations (Lusch, Vargo and O'brien, 2007; Komulainen, 2014; Neghina et al., 2017). Although the model is generic, it is helpful for managers to make decisions to address the structure of the problem and not only the symptoms, often more easily observable.

Our System Dynamics simulation model introduces a novel element – relationship dynamics – to the field of project management studies using this approach. This addition is particularly critical for knowledge-intensive service industries like software development, where client involvement is high throughout the project lifecycle (Bardhan *et al.*, 2010). Intense client participation necessitates a collaborative approach, which can influence both project requirements and client expectations (Johnsen and Lacoste, 2016), ultimately impacting service quality (Nordin and Kowalkowski, 2010; Jaakkola and Alexander, 2014). By incorporating variables like goals, expected behaviors, motivations, and a client-centric service quality concept, our model addresses the previously overlooked impact of relationships in software development projects. This novel layer allows for the definition of a new set of relationship-focused policies that influence project dynamics. For instance, knowledge management policies designed to formalize and transfer project knowledge offer long-term benefits and positive side effects beyond the immediate project scope. Additionally, policies that promote joint decision-making on goals and manage expectations can combat the potential erosion of goals and expectations. As highlighted by Meng and Boyd (2017), relationship management is poised to become the central focus of the next generation of project management strategies.

There are two theoretical implications the present study highlights. First, the realization that relationships between service providers and clients are important for project outcomes (Bardhan *et al.*, 2010; Komulainen, 2014) and its conceptualization in our model described in the present study opens a research avenue for deepening a behavioral approach to project management, especially in sectors where clients are active participants. Improving our knowledge about how clients perceive the quality and success of the services provided is paramount to improving project results. Second, integrating different knowledge areas deepens and widens System Dynamics models (Gao and Zhang, 2022), hoping they start to contribute to the development of those other areas of knowledge (Sterman *et al.*, 2015). In the present study, integrating knowledge from value co-creation and the dark side of relationships in a project management setting was important to uncover and understand previously hidden dynamics, and maybe those fields may start to see the utility of Systems thinking and System Dynamics as tools to their improvement.

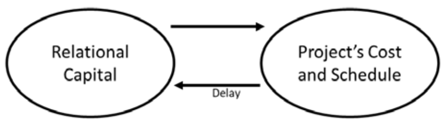
This study offers valuable insights for software development project managers. First, this study recommends the adoption of active relationship management practices. Both service providers and clients should actively manage project relationships. This includes adopting value co-creation frameworks (like the one proposed by Aarikka-Stenroos and Jaakkola (2012) and establishing clear boundaries for relationship evolution. Specific measures could involve standardizing procedures, formalizing knowledge, creating knowledge-sharing protocols, setting limits for extended client engagements, and monitoring the evolution of the relationships developed while the projects are being delivered. Second, this study reinforces the need to build a collaborative project environment. Promote a collaborative setting that integrates client resources (Jaakkola and Alexander, 2014), fosters knowledge creation amongst all stakeholders, and establishes a joint decision-making process supported by defined procedures.

The third insight for project managers is the importance of adopting active quality management using benchmarks. System Dynamics focused on project management has been arguing the importance of goals in project management (Abdel-Hamid, 1999; Lyneis and Ford, 2007; Li *et al.*, 2018) to which we include the specific goals on quality, preferably using market benchmarks, to prevent trend to eroding quality standards. The final insight for project managers is the need to continuously monitor the project's relationship dynamics and quality, integrating the recommendations from value co-creation and dark side of relationships literature (Neghina *et al.*, 2017; Tommasetti, Troisi and Vesci, 2017). This may require investment in activity monitoring systems and regular data collection. Furthermore, consider utilizing simulation models like the one presented here as a tool for learning, strategic planning, and optimizing project operations.

The present study acknowledges several limitations that present exciting opportunities for future research. First, the limited scope of goals. The model primarily focused on service quality goals and the relational motive, reflecting the established importance of goals in System Dynamics research (Abdel-Hamid, 1999; Lyneis and Ford, 2007; Li *et al.*, 2018). This opens the door for further exploration of managing diverse project goals, particularly quality goals. Additionally, future models could integrate the joint negotiation and decision-making processes around project goals (Morrison and Oliva, 2018). Second, the focus on relationship dynamics. To emphasize the impact of relationships, the model deliberately focused on quality perceptions (Satzger *et al.*, 2020) and their influence on the relational motive. Future research can investigate other potential balancing feedback loops, such as cost overruns, to gain a more comprehensive understanding of project dynamics. Lastly, project context. This study is focused on software development projects and services are context dependent (Amin *et al.*, 2021; Neghina *et al.*, 2017). Future research can explore generalizing the model and its findings to other project settings, potentially revealing broader insights into project management.

4. Strategies to improve project results using relational capital in Agile and Hybrid software development

Chapter 4 delves into the complexity of relationship dynamics, focusing on a complementary view of relationships, exploring the accumulation process underneath relationships. While the relational motive has an action-oriented focus, this chapter switches the lens to explore the accumulation of relational capital that results from the ongoing experiences acquired during the project development. This additional perspective, delving into the relational capital literature, enriches and complements our understanding of the impacts of relationships on project outcomes in terms of cost, schedule, and quality. Furthermore, the research narrows the focus to the context of software development using the Agile and Hybrid methodologies, which accentuates the importance of relationships.

Causal relationship	
Gaps addressed	Expanding the research to include the accumulation of relational capital, an asset that has been absent from project management. Narrowing the research to Agile and Hybrid software development where the importance of relationships is pronounced. Despite its central role in Agile and Hybrid software development, relational capital remains an under-researched aspect of project success.
Research questions	• How does relational capital impact project results in terms of cost and schedule? • How can service providers leverage relational capital for better outcomes in terms of cost and schedule?
Overarching research questions	• How do the relational motive to co-create value (RMCCV) and relational capital impact project results in terms of cost and schedule? • How can service providers leverage the relational motive to co-crate value and relational capital for better project results in terms of cost and schedule?

This research was presented at the 2024 International System Dynamics Conference in Bergen, Norway, and was submitted to System Dynamics Review: Sousa, J., Rouwette, E.J.JA, Bloemer, J.M.M., Jacobson, J., Malczynski, L. (2024). *Strategies to improve project's results using relational capital in Agile and hybrid software development.*

4.1 Abstract

Improvements in Agile and Hybrid Agile project management hold immense potential, promising significant cost savings. These methodologies place the client at the center of the software development process, providing valuable business insights and offering feedback, validation, and guidance. This continuous interaction between clients and developers fosters the accumulation of relational capital, which remains an under-researched aspect of project success. We fill this gap by investigating the development of relational capital in software development projects using Agile and Hybrid Agile projects, focusing on the interaction of relational capital and project results. Our findings reveal a significant effect of relational capital on project outcomes in terms of cost, schedule, and quality, which will ultimately affect the relational capital's accumulation process in continuous feedback. The study offers a dynamic understanding of the causes and consequences of relational capital in the software development context, offering theoretical and managerial recommendations to enhance project results and potential future research avenues.

4.2 Introduction

Agile project management has become a dominant force (Sarangee *et al.*, 2022; Fatema and Sakib, 2018; Patel, 2021; Tripp and Armstrong, 2018) since its 2001 introduction (Beck et al., 2001), promising better results in software development than waterfall methods (Repenning, Kieffer and Repenning, 2017; Conforto et al., 2016). Despite widespread adoption, including hybrid approaches, time and cost overruns persist[1]. This highlights the potential for improvement within Agile and Hybrid Agile, crucial for an $1.09 trillion industry in 2024 expected to grow 14% in 2025[2].

Agile software development emphasizes an iterative, incremental, and adaptable approach, characterized by ongoing feedback and validation throughout the project's lifecycle (Sarangee et al., 2022). The interactions

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1. Ex: Essential Software Project Failure Statistics in 2023 • ZipDo; Project Management Statistics 2023: New Trends | TeamStage
2. Gartner Forecasts Worldwide IT Spending to Grow 9.8% in 2025 For a comprehensive literature review on Agile project management see Sarangee, K., Schmidt, J. B., Srinath, P. B. and Wallace, A. (2022) 'Agile transformation in dynamic, high-technology markets: Drivers, inhibitors, and execution', *Industrial Marketing Management,* 102, pp. 24-34.

must be understood within the Agile concept of planned iterative development for continuous improvement. Agile places client involvement at the heart of the software development process (Beck et al., 2001), engaging clients as active participants in the development cycle. Clients provide valuable business insights, test the software, and offer continuous feedback, validation, and guidance (Glaiel, Moulton and Madnick, 2014). This continuous interaction fosters the accumulation of relational capital, a valuable asset that, originating from the relationship management literature from a marketing perspective, is defined as the network of personal relationships individuals develop with others over time (Cummings and Dennis, 2018). These relationships form an essential foundation for the success of Agile and Hybrid software development projects.

Relational capital's influence on the behaviors and expectations of team members (Villena, Revilla and Choi, 2011; Chan, Yim and Lam, 2010) manifests itself as a dynamic interplay of positive and negative outcomes (Villena, Revilla and Choi, 2011) that change over time (Autry and Golicic, 2010), producing experiences that feed back to reshape relational capital. On the one hand, fostering strong relational capital can increase performance through enablers such as knowledge sharing/transfer (Aisyah, Sukoco and Anshori, 2019; Villena, Choi and Revilla, 2019), and improved communication (Rood et al., 2018). On the other hand, it can trigger opportunistic behaviors, where individuals prioritize their short-term gains over the long-term well-being of the relationship (Anderson and Jap, 2005; Villena, Choi and Revilla, 2019), create redundant knowledge (Noordhoff et al., 2011), loss of objectivity (Villena, Choi and Revilla, 2021), and a reluctance to challenge or change established relationships (Villena, Choi and Revilla, 2019; Rood et al., 2018).

Despite its central role in Agile and Hybrid software development, relational capital remains an under-researched aspect of project success. Existing studies primarily focus on the positive impacts of relational capital, neglecting both the potential downsides and the dynamic interplay between positive and negative consequences. The present research aims to fill this gap by conducting an in-depth investigation of relational capital development in software development projects using Agile and Hybrid Agile methodologies, analyzing its impact on project outcomes, and exploring effective strategies for its management to improve project results in terms of cost and schedule, from a service provider's perspective.

Two research questions drive this study:

- How does relational capital impact project results in terms of cost and schedule?
- How can service providers leverage relational capital for better outcomes in terms of cost and schedule?

Addressing these research questions requires a combination of theoretical development and empirical validation through a multi-method approach. Our research strategy combines a literature review, semi-structured interviews, project data analysis, and the construction of a System Dynamics simulation model.

This chapter is structured as follows: First, we review the literature on relational capital's impact on software development, focusing on Agile and Hybrid Agile methodologies. Next, we analyze qualitative and quantitative data from semi-structured interviews with project managers and real-life project data to assess relational capital’s influence on project success. We then introduce our System Dynamics model to address the two research questions. Finally, we summarize key findings and discuss implications, limitations, and future research directions.

4.3 Literature review

To address the research questions, an interdisciplinary literature review on project management and relational capital was conducted. This approach informed the theoretical framework and model development. Specifically, project management literature provided a foundation for relational capital in Agile and Hybrid Agile projects, while the relational capital body of work offered insights into its complex influence on project outcomes.

4.3.1 Agile and Hybrid Agile in software development

“Agile” project management, an iterative, incremental, and adaptive software development method (GAO, 2020; Beck et al., 2001), thrives on the continuous evolution of requirements and technology (Conforto et al., 2016). Through short, iterative development cycles known as "sprints", Agile teams can adapt plans and deliver working software in manageable increments. The Agile Manifesto (Beck et al., 2001) prioritizes collaboration between the project team, that includes members from the service providers and from the client organization, throughout the development. This ensures software requirements and user feedback are continuously incorporated, embracing continuous improvement, leading to ongoing evaluation of quality, functionality, and client satisfaction (Repenning, Kieffer and Repenning, 2017; GAO, 2020).

To understand Agile project management it is essential to grasp its core roles, artifacts, and ceremonies. The primary roles are the Product Owner (PO), Scrum Master (SM), and Development Team. The PO ensures the team delivers maximum value by prioritizing features. The SM facilitates Agile events—Sprint Planning, Daily Scrum, Sprint Review, and Sprint Retrospective—and supports the team by coaching, resolving conflicts, and tracking progress. The Development Team focuses on software development, converting prioritized backlog items into functional software.

Agile artifacts are the Project Backlog and Sprint Backlog, and their function is to maintain transparency and track progress. The Project Backlog, a prioritized list of features, can be intentionally high-level in pure Agile approaches (Cao, 2022). The Sprint Backlog is a subset of the Product Backlog, detailing tasks for the current sprint. Finally, Agile ceremonies drive collaboration and continuous improvement:

- Sprint Planning: The team (client and service provider) selects and estimates tasks for the sprint backlog.
- Daily Scrum: A brief daily meeting for progress updates and issue identification.
- Sprint Review: Stakeholders review completed work and provide feedback.
- Sprint Retrospective: The team reflects on the sprint to identify improvements.

Despite extensive research highlighting numerous benefits of Agile (Sarangee *et al.*, 2022; Repenning, Kieffer and Repenning, 2017; van Oorschot, Sengupta and Van Wassenhove, 2018; F. Tripp and Armstrong, 2018; Reiff and Schlegel, 2022), such as faster development cycles, lower costs, and improved communication, challenges remain. These include the potential for inadequate documentation, limited scalability, difficulties in managing large projects, and client reluctance toward Agile adoption due to the perception of higher risks[3]. Consequently, hybrid Agile implementations are emerging, introducing fixed elements like budgets and schedules into Agile projects, effectively blending traditional plan-driven methodologies with Agile principles (Imani, Nakano and Anantatmula, 2017).

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3. In the project following Agile, we cannot take any conclusions regarding overruns due to their lack of commitment to fixed cost and schedule.

Figure 23 simplifies the Agile or Hybrid process. The project is initiated with a definition of preliminary requirements, forming the Project Backlog. At each sprint's outset, the project team, including client representatives, gathers for sprint planning to define sprint tasks, which are then added to the sprint backlog. Throughout the sprint, development is coupled with immediate testing. This allows for rapid error detection and correction; if feasible, errors are fixed within the sprint. Otherwise, they are returned to the project backlog for future planning. Additionally, the team holds a daily 15-minute meeting to discuss progress, issues, and potential obstacles. Finally, the sprint review concludes the sprint, assessing outcomes, extracting lessons, and informing future strategy.

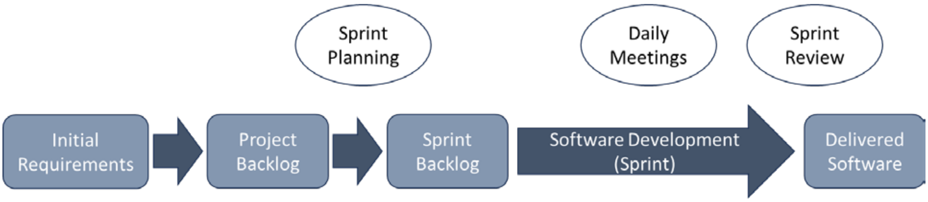


Figure 23 – Simplification of the Agile Process

The Agile process embodies continuous collaboration, iterative feedback, and adaptive responses to change, fostering a unique dynamic between clients and service providers. Clients are no longer passive recipients but active co-creators, playing an essential role in the project's lifecycle (Rebentisch *et al.*, 2018). Their sustained commitment is pivotal for project success (Cao, Ramesh and Abdel-Hamid, 2010). This active involvement extends to collaborative scope definition (Imani, Nakano and Anantatmula, 2017), continuous prioritization, and real-time validation through daily/weekly meetings and reviews (Rebentisch *et al.*, 2018). This intense and sustained interaction serves as a forge for the development of relational capital.

Relational capital, defined as the network of personal relationships cultivated over time (Cummings and Dennis, 2018), is significantly enhanced through Agile's collaborative practices. In this context, it shapes the evolving relationship between client and service provider (Villena, Revilla and Choi, 2011), transforming it from a transactional exchange to a strategic partnership. The frequent interactions, shared decision-making, and mutual problem-solving inherent in Agile create a foundation of trust and understanding, which are essential components of robust relational capital. This accumulated relational capital, in turn, facilitates smoother project execution, fosters mutual adaptation, and enables more effective responses to emergent challenges, ultimately contributing to sustained project success and long-term strategic alignment (Aaltonen and Turkulainen, 2018; Martins, Duarte and Costa, 2018).

4.3.2 Relational capital

Agile and hybrid methodologies underscore the significance of relational capital, a construct rooted in the strength of enduring relationships forged through trust, and collaboration, throughout a history of interactions (Villena, Revilla and Choi, 2011; Cummings and Dennis, 2018). These sustained interactions cultivate close relationships (Aisyah, Sukoco and Anshori, 2019), shaping team member behaviors and expectations (Villena, Revilla and Choi, 2011; Chan, Yim and Lam, 2010). While these relationships are typically advantageous, they can evolve into overly familiar "cozy relationships," potentially compromising objective decision-making and project efficacy (Anderson and Jap, 2005; Villena, Choi and Revilla, 2021).

While the majority of scholarly work emphasizes the positive effects of strong relationships (Ellram and Murfield, 2019), ranging from nuanced client needs comprehension (Noordhoff *et al.*, 2011) and refined expectations management (Johnsen and Lacoste, 2016) to heightened client satisfaction (Jaakkola and Alexander, 2014), practitioners in this study (detailed in Section 3.1) articulate a more nuanced, yet simplified perspective, represented by the reinforcing feedback loop (R1) in Figure 24. They perceive a cyclical process, supported by literature, wherein project progress and accumulated experience catalyze the development of relational capital (Villena, Revilla and Choi, 2011). This augmented relational capital, in turn, enhances communication efficacy (Gligor and Holcomb, 2013) and deepens shared business knowledge (Noordhoff *et al.*, 2011; Lee and Ha, 2018; Martins, Duarte and Costa, 2018), thereby bolstering software development capacity (Aisyah, Sukoco and Anshori, 2019; Bagdoniene and Valkauskiene, 2018; Zardini, Ricciardi and Rossignoli, 2015). This increased capacity fuels further project advancement, which, in a positive feedback loop, further develops relational capital. This simplified feedback loop, identified by practitioners, effectively encapsulates the positive feedback mechanisms highlighted by relational capital theory, ultimately leading to enhanced capacity and enriched practitioner experience.

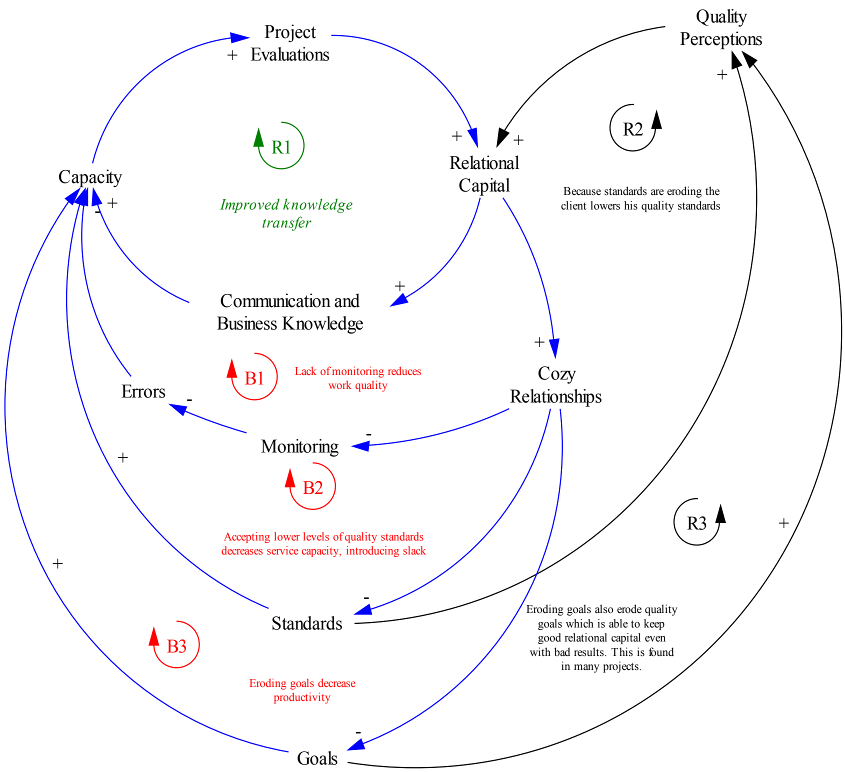


Figure 24 – Theoretical framework. Combination of Positive and negative effects of relational capital

Conversely, excessively close relationships may be detrimental in a number of ways (Anderson and Jap, 2005). The development of relational capital can generate overly close relationships (Rood *et al.*, 2018; Autry and Golicic, 2010), termed "cozy relationships" by Anderson and Jap (2005). Among the spectrum of adverse consequences, three are particularly pertinent to this research, as they are consistently identified in the literature for settings similar to the software development. Firstly, as illustrated in balancing loop B1 of Figure 24, cozy relationships diminish the willingness to monitor activities (Villena, Choi and Revilla, 2019), skipping control and coordination activities, subsequently amplifying the number of errors (Oliva and Sterman, 2010). This, in turn, depletes software development capacity, as resources are diverted towards error rectification rather than new feature development.

Secondly, as depicted in balancing loop B2 of Figure 24, cozy relationships can precipitate an erosion of performance standards (Villena, Choi and Revilla, 2021), where the project team adhere to continuous new lower performance standards, leading to a similar decline in software development capacity, mirroring the dynamic elucidated by Oliva and Sterman (2010; 2001). Thirdly, cozy relationships contribute to the blurring of boundaries between service providers and clients (Pillai *et al.*, 2017), hindering the formulation of adequate goals (Villena, Revilla and Choi, 2011; Johnsen and Lacoste, 2016; Villena, Choi and Revilla, 2021) regarding schedules, milestones, capacity, and functionalities, and hindering unbiased evaluation as clients are evaluating work to which they made an important contribution (Villena, Choi and Revilla, 2021). Collectively, these effects erode overall performance, ultimately decreasing relational capital over time (Villena, Revilla and Choi, 2011).

Drawing on the insights from our literature review, we delve into the concepts and relationships underlying relational capital. This exploration reveals both positive and negative consequences, laying the groundwork for addressing our first research question: how does relational capital impact project results in terms of cost and schedule? However, a comprehensive answer to this question, as well as our second question (How can service providers leverage relational capital for better outcomes in cost and schedule?), demands a deeper understanding of the strengths and delays within the interacting feedback loops. To address this gap, we employed a System Dynamics model to explain the dynamic consequences of the complex interactions identified in the literature review. Additionally, semi-structured interviews and project data provided the essential empirical grounding for the model.

4.4 Methodology

The study employed a multi-method approach to test the theoretical framework. Semi-structured interviews with experienced practitioners provided qualitative data on project management processes, decision-making, and software development dynamics. Project data of various sizes enabled the model's calibration and enhanced its real-world applicability. Finally, building upon the theoretical framework, qualitative data, decision rules, and project data, a System Dynamics simulation model was developed for simulating project scenarios, evaluating strategies, and identifying performance improvements.

4.4.1 Semi-structured interviews

4.4.1.1 Process

To inductively explore the research questions, we collaborated with Company A, a leading Portuguese software developer with over 200 employees and diverse clients. 11 experienced project managers were interviewed (10 male, 1 female, averaging 6.5 years of Agile/Hybrid experience) from various industries, and managing projects longer than six months.

From mid-April to mid-May 2023, we conducted 11 semi-structured interviews (see Appendix 4), each lasting one to one-and-half hours each, to understand their software development processes and gather project data. A 32-question guide, divided into framing, methodology, and relationship sections, provided structure while allowing for flexible exploration of their experiences, decisions, and mental models. We then used content analysis (Miles and Huberman, 1994) to summarize the process and systematically code interview transcripts in Excel, identifying key themes. These findings both confirmed existing research and revealed novel insights, which we discuss later.

4.4.1.2 Results

Project managers overwhelmingly favored Agile methodologies, with only one preferring Waterfall. There is also a predominant dislike for Hybrid Agile with only one interviewee finding Hybrid valuable, while all others believe it compromises Agile's flexibility. Most current projects, however, followed a Hybrid Agile approach, lasting from 3 months to 3 years and an average team of 4.2 people. Interviewees prioritize team stability over augmentation due to resource limitations and base their project budget estimates on client requirements and past experiences. Most interviewees indicated they had grown increasingly cautious with validating all project assumptions and client-added requirements. As one interviewee noted: "All estimates are based on initial client requirements and then aligned with resource availability."

The interviewees' response to the relationship’s questions highlights the prevalence of intense client participation in both Agile and Hybrid Agile projects, perceived by all participants as critical to success. Notably, 10 of 11 project managers reported developing friendships with clients, referring to its positive effects on project outcomes (questions 20-21), identifying relational capital as key to improved communication, knowledge transfer, expectations management, relationships, and resource investment. This result reinforces the representation of the positive feedback loop depicted in Figure 24 from Section 4.3.2.

While project managers recognized the benefits of relational capital, their perceptions on potential drawbacks varied. While only one interviewee explicitly cited quality cuts, several alluded to related challenges. Some admitted strong relationships led to client tolerance of project shortcomings, potentially delaying lower-priority tasks like documentation. Interestingly, regarding quality perceptions, only one manager observed fluctuations in client views. The remaining managers believed that continuous evaluation and robust relational capital led to more consistent quality perceptions. Notably, despite acknowledging project overruns and quality issues, 10 out of 11 reported positive client evaluations. A consistent pattern emerged in overrun responses. Faced with a potential project overrun, project managers first consider schedule adjustments, followed by increasing work intensity. Third, project managers use overtime, and lastly, they change the workforce. This prioritization aligns with their preference for Agile methodologies. It is important to acknowledge that these actions represent a subset of potential strategies, and project managers' decisions are influenced by various contextual factors. These preferred actions by practitioners influenced our decision to test different policy choices aiming at reproducing standard practices.

The interviews uncovered three key findings:

- Intense client participation is crucial: All project managers reported constant involvement from clients in both Agile and Hybrid projects.
- Relationships develop over time: Intense participation often leads to friendships between project managers and clients, extending beyond work hours.
- Relational capital is a double-edged sword: While managers unanimously agree strong relationships improve outcomes, some acknowledged potential drawbacks, in line with our theoretical framework. For example, Table 14 in Appendix 7 shows project managers recognize the benefits of relational capital (improved outcomes, stronger relationships, increased resource investment), but also recognize potential downsides such as overlooking project shortcomings.

Notably, while project managers recognized the potential negative consequences of client-provider relationships, they tended to overlook them, a finding consistent with the "dark side" of relationships theory (Anderson and Jap, 2005; Villena, Revilla and Choi, 2011; Villena, Choi and Revilla, 2021). This tendency highlights a novel aspect of our study, as it suggests that even experienced practitioners may not fully account for the detrimental effects of overly close relationships, despite acknowledging their existence.

4.4.2 Cross-project analysis of Company A's financial market projects

4.4.2.1 Process

We collected quantitative data from five real software development projects (one Agile and four Hybrid Agile) in Company A. These are all projects in the financial sector, executed after 2020. Access to their project management system provided details on hours worked, subcontracts, expenses, and other relevant features. The data, collected between August and October 2023 and organized in Excel, allowed us to compare initial project plans with actual execution, identify discrepancies, and understand their causes and resulting decisions. Collaboration with the company's planning and controlling department ensured data accuracy and interpretation. This multi-project approach provided a deeper understanding of the software development process (Miles and Huberman, 1994) and any potential variations between Agile and Hybrid Agile approaches, and allowed us to identify patterns and ensure that the policies and behaviors observed were consistently applied across multiple projects within the company.

4.4.2.2 Project data results

Figures 25 to 29 summarize project plans and results across the five projects developed by Company A for the financial market. Following Sterman's (2000) recommendations, these figures provide critical reference modes for the System Dynamics model presented in Section 4.5. These include planned and actual data on hours, staff, and experience level for each project. Figure 29 presents the Agile project, which due to its flexible nature, lacked the initial cost and schedule estimations.

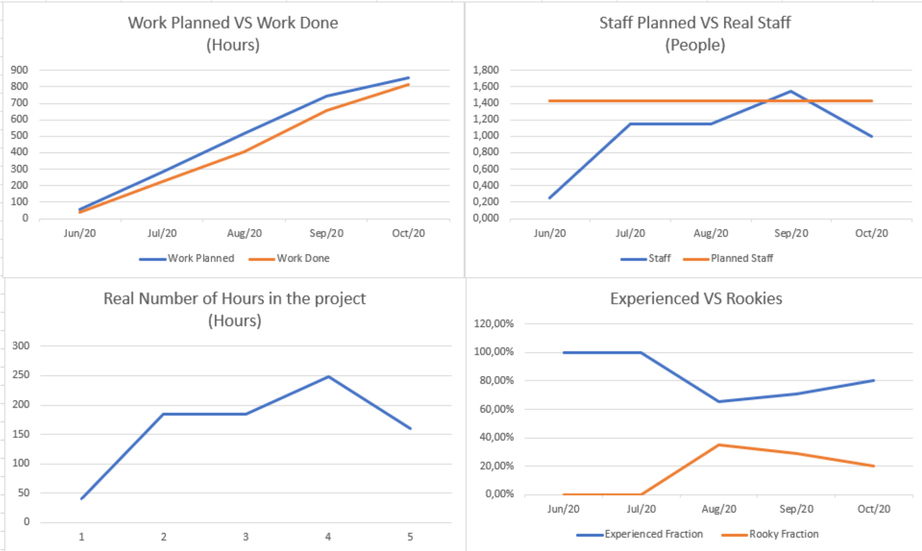


Figure 25 – Project 1 data summary

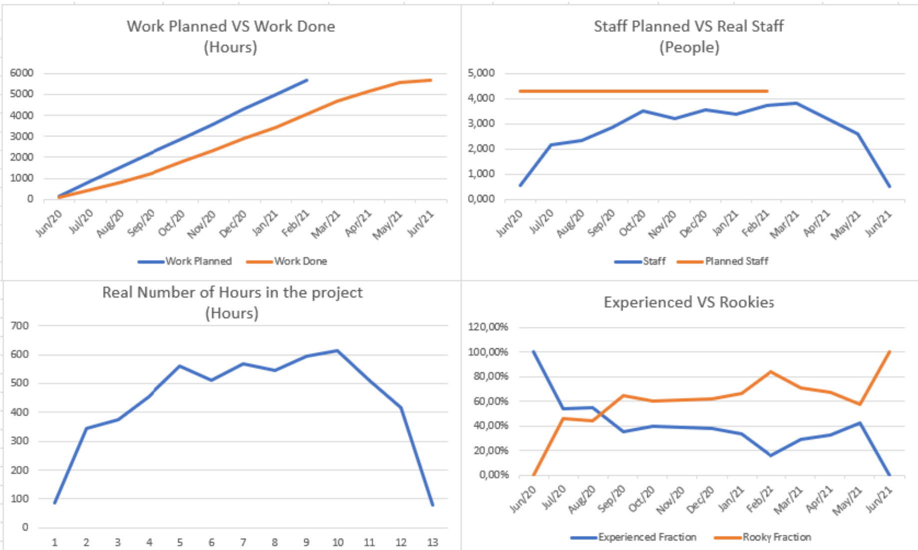


Figure 26 – Project 2 data summary

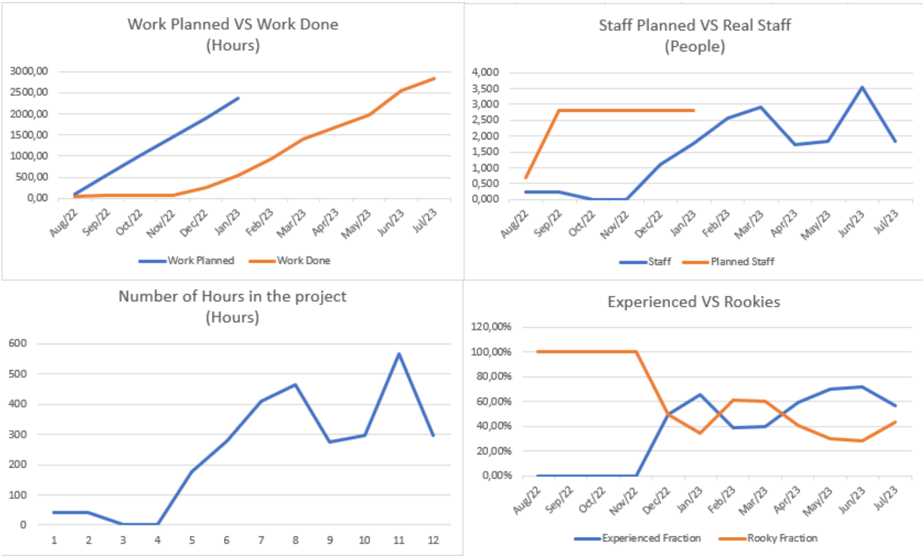


Figure 27 – Project 3 data summary

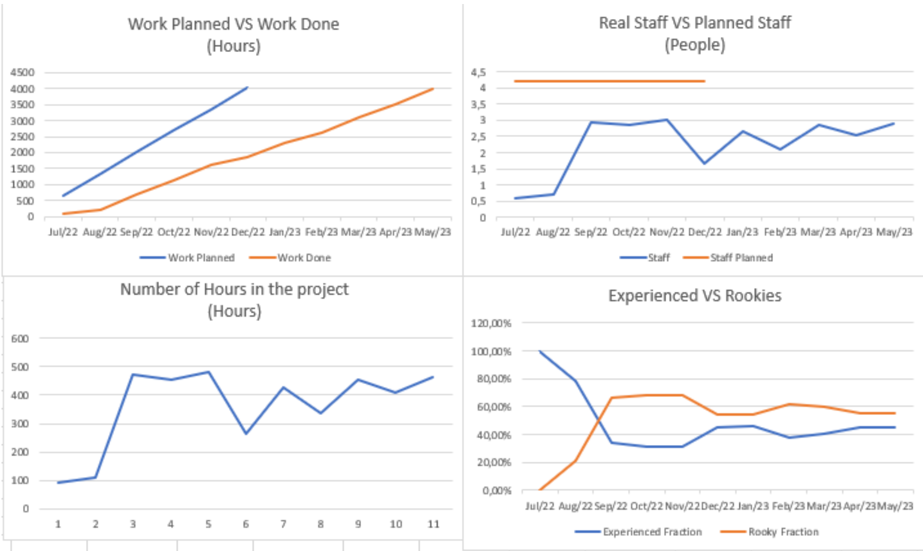


Figure 28 – Project 4 data summary

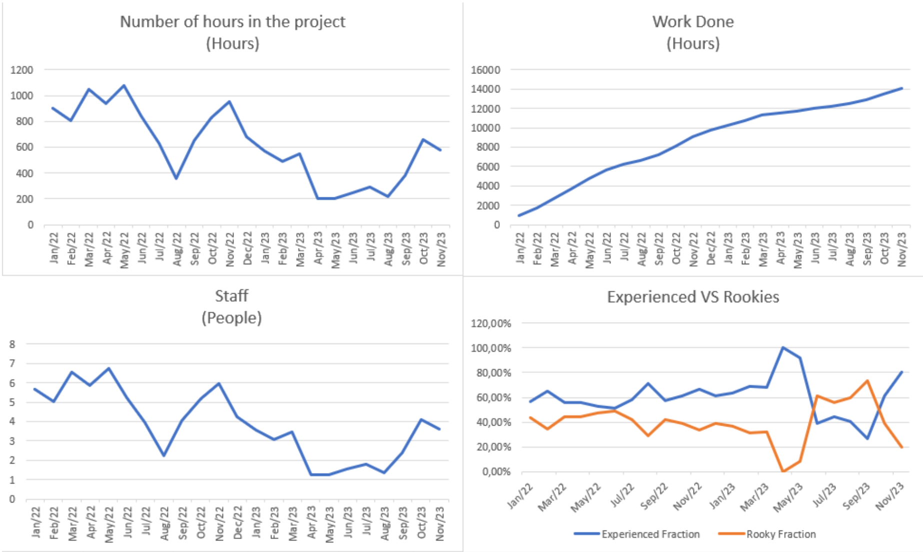


Figure 29 – Project 5 data summary

Data analysis reveals a discrepancy between initial project plans and actual implementation across five projects. Although initial plans aligned with project managers' expectations regarding experienced staff and team stability, as evidenced by interviews, all five projects experienced understaffing, averaging 32.57% lower personnel count than planned (Figures 3-7). Furthermore, all Hybrid Agile projects[4] exhibited overruns, with schedule overruns averaging 58.15% and cost overruns averaging 17%. These consistent overruns across multiple projects indicate a systemic pattern, providing critical reference modes for our System Dynamics simulation model.

Finally, going beyond data on single projects and looking at follow-up projects for the same client, an interesting dynamic was observed clearly demonstrating the importance of relationships in longer periods with multiple projects over time. Despite project overruns, clients continue to sign new contracts with Company A, often choosing the same team for new projects. Both parties appear to accept overruns as the norm, raising concerns about setting lower project goals or adhering to decreasing standards reinforcing our theoretical framework presented in Figure 24 in Section 2.2.

4.4.3 System Dynamics

System Dynamics emerged as the ideal choice for our research due to its proven track record and ability to handle complex problems involving feedback loops, nonlinearities, delays, and accumulation over time (Sterman, 2000; Gao and Zhang, 2022). System Dynamics has been extensively employed in project management since the late seventies (Ford, Lyneis and Taylor, 2007; Lyneis and Ford, 2007; Ford and Sterman, 2003a; Jalili and Ford, 2016; Li *et al.*, 2018; Lyneis, Cooper and Els, 2001) including *the* software development sector (Abdel-Hamid, 1984; Abdel-Hamid and Madnick, 1989; Abdel-Hamid and Madnick, 1989; Abdel-Hamid, 1989; Abdel-Hamid and Madnick, 1991; Abdel-Hamid, 1999; Rahmandad and Weiss, 2009; Ford, 1995). In the context of Agile projects, System Dynamics has been applied to study overall project dynamics (Cao, Ramesh and Abdel-Hamid, 2010; Glaiel, Moulton and Madnick, 2014; Van Oorschot, Sengupta and van Wassenhove, 2009), the transition from traditional to Agile methods (Sarangee *et al.*, 2022), and the potential of hybrid approaches (Imani, Nakano and Anantatmula, 2017). Additional studies have examined team dynamics and productivity (Ching and Mutuc, 2018; Fatema and Sakib, 2018), iteration length effects (van Oorschot, Sengupta and Van Wassenhove, 2018), product development (Rebentisch et al., 2018), and project performance (F. Tripp and Armstrong, 2018).

The present research delves into the significance of relational capital in Agile and Hybrid Agile project management, adopting a rigorous approach that builds a theory through a logical sequence of steps, testing and refining it iteratively with data (Homer, 1996; Schwaninger and Grösser, 2008). The resulting simulation model expands upon existing models of Agile projects (Cao, Ramesh and Abdel-Hamid, 2010; Glaiel, Moulton and Madnick, 2014), adding a Hybrid approach (Imani, Nakano and Anantatmula, 2017), and incorporating new structures that capture the impact of relational capital accumulation and specific variables from the interviews. The next section presents a detailed description of the model, its validation and parameter estimation strategy, which allowed for testing its robustness and reliability.

4.5 Model structure

Building upon the theoretical model in Figure 24, our System Dynamics simulation model incorporates five sectors (Figure 30), leveraging structures from previously published System Dynamics studies whenever possible. The **software development sector** tracks work completion and defect generation/ discovery. The **quality sector** reflects the impact of management decisions on quality and error probability and tracks the quality measurements of the existing and proposed project KPIs. These interact with project development rate and quality through service capacity and planning and control. The **service capacity sector** considers the team's ability to deliver tasks, accounting for experience, productivity, and time allocation. The **plan and control sector** reflects ongoing work oversight and management responses to deviations from goals. Finally, the **relational capital sector**, novel to project management System Dynamics models, explains how relational capital development impacts all previous sectors over time, either by increasing service capacity through communication and knowledge sharing or decreasing it through the emerging cozy relationships introduced in section 4.3.2. This sector also incorporates policies for managing relational capital to enhance project outcomes.

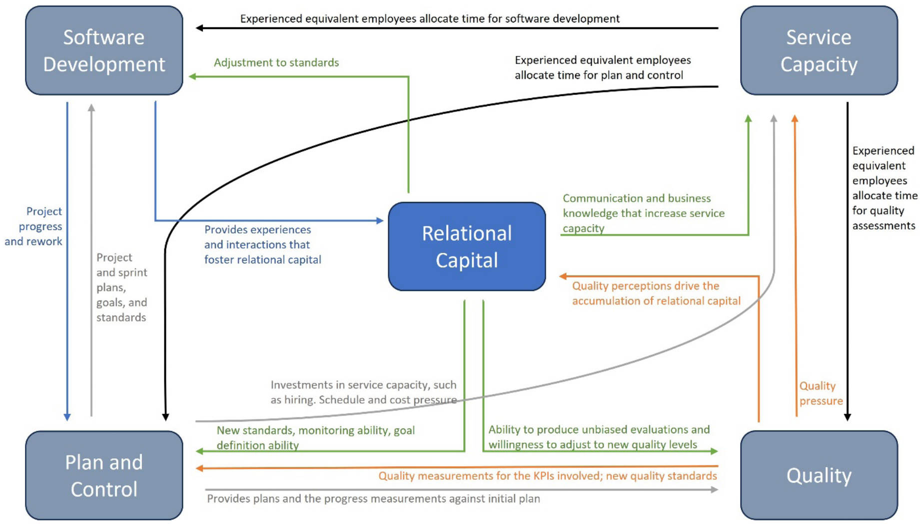


Figure 30 – Sector model

Next, we provide an overview of the software development sector for a thorough understanding of the software development process. We then delve into the novel relational capital sector structure for managing relational capital and improving project outcomes. Due to space limitations, we briefly discuss the remaining sectors, which are grounded in prior research.

4.5.1 Software development sector

Based on existing research on Agile development with System Dynamics (Cao, Ramesh and Abdel-Hamid, 2010; Glaiel, Moulton and Madnick, 2014; Rebentisch *et al.*, 2018), we build a model of the software development process

(Figure 31). It uses stocks like Project Backlog to show work piles and flows like sprint planning to show how work moves between them. Like Company A's projects, the model starts with a backlog of all planned work (in hours). This backlog is then broken down into smaller chunks called "sprints" where the software is developed, being affected by factors like team capacity and error rates. We exclude a "Release Backlog" because Company A doesn't use it.

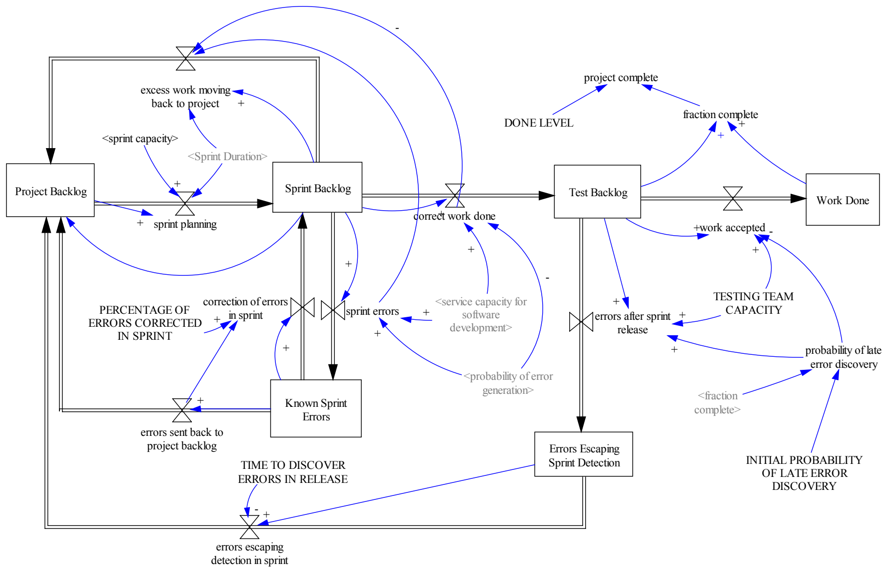


Figure 31 – Agile Software development structure

Within a sprint, completed tasks are stockpiled for testing. Errors detected during testing are addressed either within the sprint or sent back to the Project Backlog for subsequent replanning. A sprint concludes upon task completion or time expiration. In the latter scenario, unfinished work is returned to the Project Backlog for rescheduling. This model introduces a novel modeling approach to units for backlog measurement, departing from traditional metrics like tasks, delivered source instructions (DSI), or lines of code (LOC), which, while valuable, may not fully capture the complexities of contemporary software development. These traditional units are inherently heterogeneous, potentially yielding variable outputs per task, DSI, or LOC. In contrast, utilizing hours as the unit of measurement offers a more practical and consistent approach to project planning and tracking, particularly within Agile and Hybrid environments emphasizing flexibility and adaptability. Furthermore, hours provide a readily comprehensible metric for clients, facilitating clearer communication compared to technical units. Finally, the adoption of hours aligns with prevalent industry practices. Project proposals are formulated in hours, budgets are allocated based on hours, and project management systems, including those utilizing DevOps, convert tasks to hours for work registration.

4.5.2 Relational capital sector

The relational capital structure presented in Figure 32 provides a novel representation of the causes and consequences of changes in relational capital. Departing from prior models that predominantly emphasized client participation, our model encompasses the holistic impact of relational capital on project outcomes. We integrate relational capital theory, accounting for both its positive and negative effects. While a dimensionless unit could have been employed, we have adopted the 1-5 scale developed by Barão and Silva (2011) to measure relational capital, aligning with established research in this domain. In this scale, 1 signifies the lowest level of relational capital, 3 represents a neutral baseline devoid of biases from prior projects and interactions, and 5 denotes the highest attainable level. Consequently, each new project involving a new client and team commences at level 3. This approach not only establishes a stronger theoretical alignment with relational capital theory but also enhances the model's applicability and facilitates the integration of empirical data.

As projects progress, relational capital develops through interactions and the accumulation of experiences, enhancing communication and knowledge sharing, thereby boosting service capacity through a nonlinear function (explained in detail in Appendix 5) employed as a multiplier. The initial rapid accumulation of relational capital as the team and client establish their working relationship, is followed by a more gradual increase as the relationship matures, as argued by value co-creation literature, where interactions are seen as a form of value creation. This continuous collaboration ensures the incorporation of software requirements and user feedback, and this is the basis for an ongoing evaluation of quality, functionality, and client satisfaction (Repenning, Kieffer and Repenning, 2017; GAO, 2020). This process does not require any additional investment other than the normal project development when clients and service providers work together in the development of projects using Agile or Hybrid project management methodologies. However, relational capital brings with it the risk of creating cozy relationships as detailed in section 4.3.2, leading to reduced monitoring, lower standards and goals, and impacting quality perceptions, ultimately affecting performance in terms of cost, schedule, and quality. The model continuously adjusts the relational capital value based on performance indicators such as the difference between expected and perceived errors, software development capacity, and schedule, ensuring responsiveness to changing dynamics. This is done through Average Indicated Relational Capital where the model calculates an arithmetic average of the three effects: the effect of accumulated experiences on changes in relational capital, the quality impact, and the deadline impact. While a multiplicative effect could have been used, we chose to utilize an additive approach based on Sterman's (2000) guidance (pp. 528), which supports additive relationships when the effects of each item are strongly separable, which is the case. Furthermore, while additive relationships might be less sensitive to extreme situations, the Agile and Hybrid methodologies, which is the context of our study, inherently help to mitigate and minimize such extreme situations. Therefore, we believe the additive approach aligns well with the model's assumptions and the empirical research context.

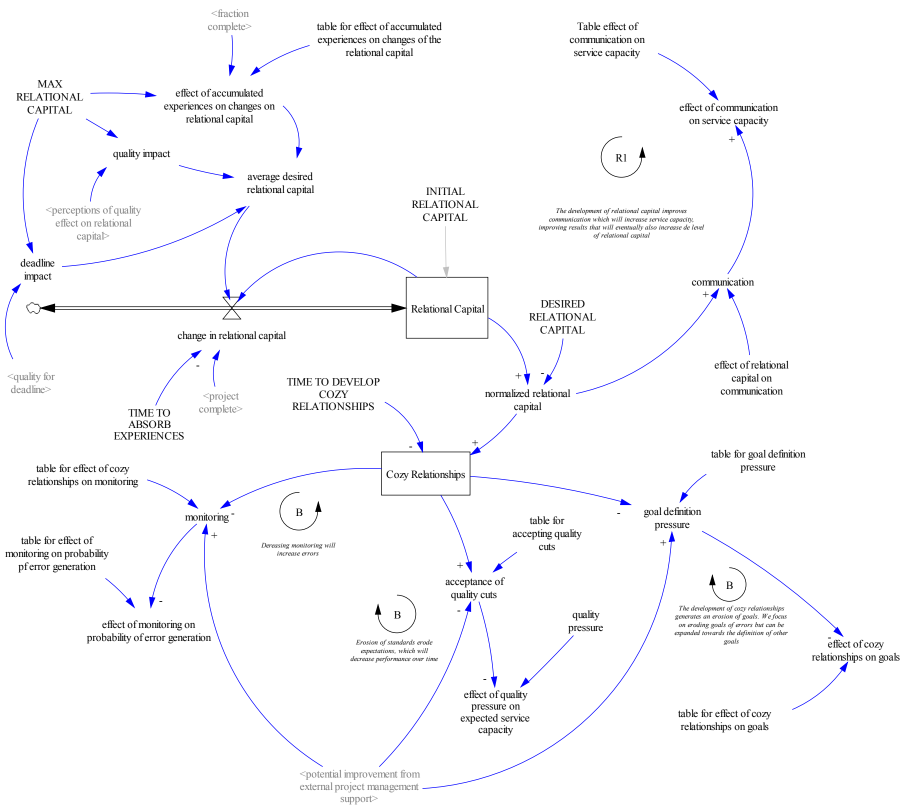


Figure 32 – Relational capital structure

The model includes a Desired Relational Capital that allows organizations to actively manage this important tool. Software development companies are taking the first steps to manage it by trying to standardize the interactions between clients and service provider's teams, defining what is acceptable and desirable for these interactions, or even by not allowing developers to work within the same client for more than a certain period. However, this is a simplification of an entire subsystem that could and should be addressed by future research given its importance. The 'Desired Relational Capital' variable was included to allow for the exploration of an active goal, reflecting the potential for companies to strategically manage their relational capital. Companies can and should establish goals for their desired level of relational capital, based on an understanding of its impact on project outcomes. In recent years, organizations are shifting strategies, from promoting relational capital through unstructured social events (such as dinners, golf meetings, etc, dominant in the past) to implementing controlled management practices. This evolution reflects a growing understanding of the need to balance relationship building with control mechanisms to optimize project outcomes (Villena, Choi and Revilla, 2021).

4.5.3 Other sectors

Our service capacity sector considers both rookies and experienced staff, and is based on Oliva & Sterman (2010) with only one addition: the possibility of hiring experienced staff for the project. As in the previous reference, productivity is measured in "experienced equivalents," accounting for the time senior developers spend training rookies and providing commercial support. Additionally, service capacity is corrected by the time spent in mandatory Agile meetings.

The plan and control sector manages service capacity and deadlines, inspired by previous models (Ford, Lyneis and Taylor, 2007; Jalili and Ford, 2016; Li et al., 2018). It uses the schedule overrun to calculate the service capacity needed to complete the project on time. This allows managers to adjust capacity based on changing needs, using traditional methods like modifying work intensity, overtime, or team size (Li *et al.*, 2018).

The quality sector tackles two aspects. First, it calculates the probability of error generation based on factors like fatigue, experience level, workload, and monitoring, and is inspired by Lyneis and Ford (2007) and Oliva and Sterman (2010). Second, it considers service quality, a concept borrowed by Oliva and Sterman (2010) from Parasuraman et al. (1985), who define it as the gap between client expectations and perceptions. Unlike the original definition, this research applies service quality to factors like service capacity (quality for service capacity), error generation (quality for probability of error generation), work done (quality for work done), and schedule delays (quality deadline). These items are readily available for discussion in all Agile ceremonies (at least in sprint planning, daily meetings and retrospectives) where evaluations should include them.

Models are always a simplification of reality (Sterman 2000) which require assumptions and criteria to decide on what to include or not. The choice to include or exclude variables and effects was based on four major considerations: our focus on single projects, literature support, adherence and relevance to Agile, Hybrid and Company A's processes.

4.5.4 Model validation

The model was tested using Sterman's (2000) approach and based on real data from the sample of projects described earlier in Company A, a Portuguese software development firm. The model's behavior under typical conditions is consistent with previous project management models and the reference modes from the projects in our sample. The use of structures developed and tested in previous published System Dynamics work improves confidence in the structure and behavior of the model presented. The model units are consistent with units used in real projects, and there are no ambiguous conversion variables. The model was also presented to the interviewed project managers to validate all relationships and assumptions. Appendix 5 presents details of the model validation efforts and sensitivity tests, to enable focusing the main text on the practical implications of the model.

In Appendix 5, we present a comprehensive description of a hypothetical project that follows Company A's standard decision rules. Through model simulations, we observe behavior similar to the average values of our five-project sample. Under conditions where the project begins understaffed (35% compared to the sample average of 39%) and with over 50% experienced staff, our model demonstrates a schedule overrun of 61% (compared to the sample average of 58.15%) and a total cost of 425,504€, representing a cost overrun of 14.38% (compared to the sample average of 17.07%). These results successfully replicate the reference modes presented in Section 4.4.2 for Company A's projects and are summarized in Table 15 in Appendix 7.

Lastly, it is essential to highlight the model's capability to reproduce empirical project behavior. Project 2 from the dataset was specifically chosen to evaluate this capacity. The model underwent calibration based on the initial project plan and was further refined to incorporate the nuances of its execution. The comparison presented in Figure 33 between the actual data of Project 2 and the model's simulated output clearly demonstrates the model's accuracy in replicating the project's observed dynamics.

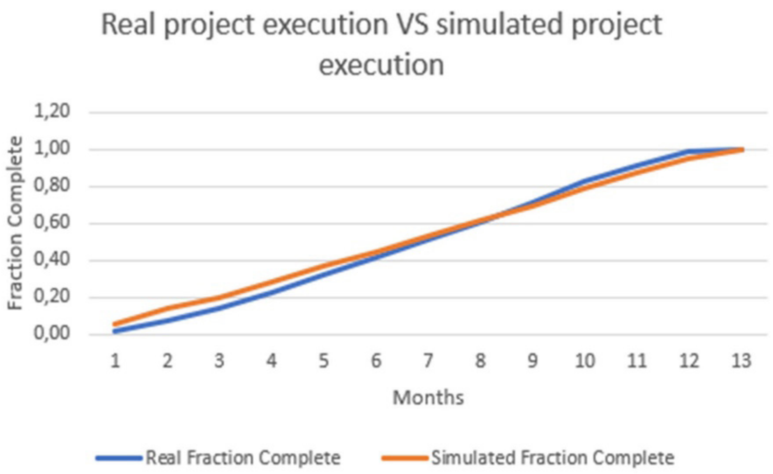


Figure 33 – Simulated behavior versus real data for project schedule

The validation process detailed herein, in conjunction with the comprehensive process validation presented in Appendix 5, which adheres to standard System Dynamics methodologies, provides substantial support for the model's ability to simulate real-world project implementations effectively.

4.6 Results

This section presents the results of our study, which focused on evaluating the dynamics of commonly employed project management policies with strong support from relational capital theory, rather than pursuing an optimization-driven 'best policy' approach. Our intent was to provide practical insights into how these real-world policies perform within the model, thereby testing and challenging prevalent practitioner mental models. While Appendix 5 details the full range of policy results, the discussion in this section concentrates on the most salient combination of policies that produce findings that directly confront and refine conventional assumptions driving project management practices.

To evaluate potential project management policies, we simulated Company A's project with these core parameters: a 9,600-hour workload to be completed within 60 weeks, resulting in a four-person team working 40 hours per week. Aligning with Company A's Agile/Hybrid project estimation practices, we began with client requirements and then estimated development time based on team capacity. For this simulation, we assumed a four-person team of experienced staff, a configuration preferred by Company A's project managers. The project's duration was calculated by dividing the total workload (9,600 hours) by the team's weekly working hours (4 people x 40 hours). Crucially, we also assumed this project involved a new client, unbiased by prior experiences with the service provider and team, setting the initial relational capital at level 3, as defined by Barão and Silva's (2011) model. Scenarios with varying initial relational capital levels are beyond the scope of this study. Our focus is to isolate and examine the impact of relational capital dynamics on a single project initiated from a neutral starting point, a scenario notably absent from existing literature and experimental research. Future studies can build upon these findings to explore the effects of alternative initial relational capital levels.

To evaluate policy combinations, we explored scenarios incorporating both external project management support, a practice increasingly prevalent in software development, hiring, as well as managing the desired relational capital. The approach, where clients or service providers engage external companies or teams for roles such as product owner and scrum master, presents a complex dynamic. Given the mixed perceptions regarding its overall efficiency, we deemed it essential to test this policy and its underlying assumptions. We simulated four distinct scenarios: (1) a standard configuration, as suggested by project managers, involving external project management support without the option to hire additional staff, reflecting the challenges of talent acquisition in the software industry; (2) a variation of the first scenario, but enabling managing the desired relational capital; (3) a variation of the first scenario but with the possibility to add staff; and (3) a scenario building upon the third, incorporating the management of desired relational capital.

The first scenario 'External PM Support - No Hiring,' examined the impact of external project management support, along with its associated costs, without hiring additional internal staff. This resulted in a 6.67% schedule overrun and a 16.17% cost overrun, indicating a viable project configuration. The use of an external project management team implies independent oversight. This team, operating outside the intense collaborative environment of Agile and Hybrid projects, monitors progress, evaluates deliverable quality, and participates in goal setting. Nevertheless, while this independent oversight improves results due to enhanced coordination efforts, it is not enough to mitigate the negative effects of 'cozy relationships' as illustrated in Figures 34,35, and 36.

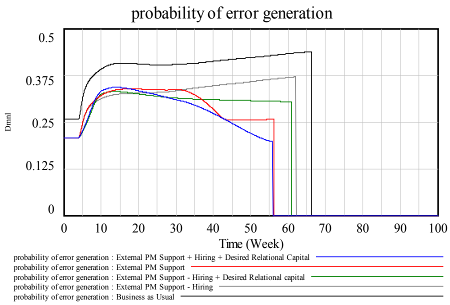


Figure 34 – Probability of error generation for policies using external project management support

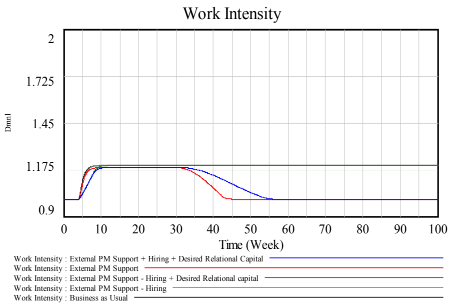


Figure 35 – Work intensity for policies using external project management support

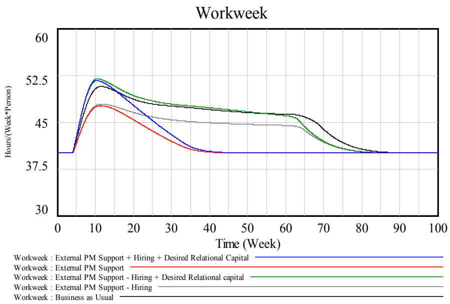


Figure 36 – Workweek for policies using external project management support

The second scenario, 'External PM Support - No Hiring + Desired Relational Capital,' built upon the first by incorporating the progressive increase of the desired relational capital goal. This policy further enhanced project outcomes, yielding a 5% schedule overrun and a 13.77% cost overrun. Notably, it also effectively controlled the development of 'cozy relationships,' suggesting potential for further performance optimization.

The third scenario, ('External PM Support'), we evaluated the impact of integrating external project management support, in combination with the possibility to hire additional staff, under the 50% rookie hiring policy. This approach resulted in a one-week early project completion but incurred a 26.55% cost overrun. Notably, it also led to a consistent increase in relational capital and a reduction in the negative effects of cozy relationships. Despite reaching the maximum team size, the project experienced a subsequent staff reduction by week 35. This reduction was attributed to a significant decrease in error probability, which dampened the rework cycle and limited the total workload. The decline in error probability, particularly concerning project responses, can be explained by reduced work intensity and overtime after the project's midpoint, as shown in Figures 35 and 36.

Finally, the fourth scenario combines the third with incorporating the progressive increase of the desired relational capital goal. The fourth scenario produces better results than the third. Despite both resulting in a one-week early project completion, the fourth scenario has a lower cost overrun. These improvements result from reduced staffing needs in later project stages and lower error rates compared to other scenarios (Figure 34). Notably, the reduced error rates and staffing needs are not attributed to marginal improvements, but to a distinct dynamic resulting from relational capital management. Relational capital management dampened "Cozy Relationships," mitigating the negative effects on monitoring, quality cut acceptance, and goal definition pressure, thereby maintaining standards closer to initial values. This effect may be particularly beneficial for long-term or subsequent projects.

This optimization potential for policies managing relational capital is demonstrated by two key arguments. First, the probability of error generation is significantly lower compared to the other scenarios (Figure 34), leading to a reduced rework cycle and its associated benefits. Second, this policy prevents the erosion of goals and expectations exemplified in Figure 37 (red line), a factor shown in previous System Dynamics studies to significantly impact project outcomes (Abdel-Hamid, 1999; Lyneis and Ford, 2007; Oliva and Sterman, 2001; Oliva and Sterman, 2010). Furthermore, the impact of this policy is likely to be even more pronounced in larger or multi-project environments.

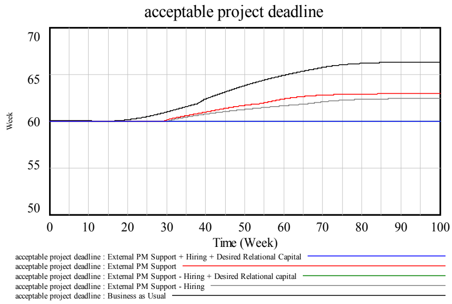


Figure 37 – Erosion of goals example for the different policies using external project management support

Combining the arguments presented in section 4.3.2 with the results just presented, we can now improve our answer to the first research question: How does relational capital impact project results in terms of cost and schedule? We observe a general increase in relational capital over time. While this initially boosts service capacity, it also allows for the emergence of cozy relationships, eroding goals, increasingly accepts quality cuts, and decreases monitoring, amplifying the significant cost and schedule overruns widely discussed in the literature. Our study clearly shows the important impact of cozy relationships on the continuous erosion of probability of error generation, on expectations, and goals, which affect quality assessments, as shown.

Moving on to answering the second research question (How can service providers leverage relational capital for better outcomes in terms of cost and schedule?), our simulations show that we can use the following strategies:

- Invest in experienced staff. Their higher productivity and lower error rates compared to rookies necessitate a well-balanced staffing approach. Understaffing projects can result at least in lower mentoring, and compromised project prioritization.
- Set clear benchmark goals for service capacity, errors, and deadlines as this is crucial to prevent project decline.
- Improve monitoring systems Integrating continuous comparisons between planned and actual values for service capacity, errors, and schedule

enabling early intervention, helps to align stakeholder expectations with project reality, and provide a clearer picture of the project's true state.

- Complement enhanced monitoring systems with policies that prevent the development of "cozy relationships", fostering objectivity and higher levels of control and segregation. These policies can include:
    a. External quality audits: Independent assessments of project quality.
    b. External project management support: Utilizing outside expertise for project planning and control.
- Implement policies to manage the Desired Relational Capital, like process standardization, minimizing non-project-related communication, segregating functions, and establishing quality baselines for deliverables and milestones, is important to mitigate the risks associated with "cozy relationships."

4.7 Discussion and conclusion

Despite advancements in project management methodologies, many software development projects still experience cost overruns. Agile and its Hybrid variations have gained popularity due to their co-creative, iterative, and incremental approach, which emphasizes client involvement throughout the software development process. As discussed in the literature review, client involvement is crucial, providing unique business and organizational knowledge through continuous daily interactions and validation. These interactions foster relational capital, which can have both positive and negative impacts on the strength of the client-developer relationship over time. Despite relational capital's central role in software development, little research focuses on how to effectively manage and capitalize on relational capital from a service provider's perspective in both project management and System Dynamics literature.

Recognizing this research gap, we embarked on an exploration of the significance of client involvement in Agile and Hybrid Agile methodologies from the first moment of working together, without previous biases. This led to our first research question: How does relational capital impact project results in terms of cost and schedule? To address this question, we delved into the literature to identify causal relationships between relational capital and its impacts. We then gathered qualitative insights from project manager interviews and analyzed quantitative data from real-world projects to provide us with the critical reference modes and decision rules. Finally, leveraging System Dynamics, we integrated these findings into a simulation model that provides clear explanations of how and when relational capital shapes the outcomes of Agile projects. Our results corroborate existing literature (e.g., Autry and Golicic, (2010, p. 87)), highlighting the short-term benefits of enhanced relational capital, including improved communication and business knowledge transfer. However, our research also unveils a novel finding: the potential for long-term negative consequences arising from "cozy relationships." These relationships, which take time to develop, can create a situation where relational capital remains high despite deteriorating project results, effectively locking organizations into suboptimal performance.

Further model exploration allowed us to answer the second research question: How can service providers leverage relational capital for better outcomes? Our study shows that projects' results tend to erode if management fails to act. However, the extensive use of simulations enabled us to identify clear strategies to improve results regarding cost and schedule. The simulation results show that any decision involves compromises, some favoring schedule and others cost. Moreover, the use of the simulation model helped us raise new questions to be answered in future research. One example for future research would be to understand the impact of pre-existing levels of relational capital on subsequent projects, which would require examining starting discussions with the level of relational capital other than the neutral but would require the additional consideration of staff turnover that can be important for analyzing extended periods.

4.7.1 Theoretical implications

Our research has challenging theoretical implications. First, it contributes to the literature on project management by enhancing our understanding of how relationship capital develops and accumulates. This establishes a new bridge between marketing and project management literature. Second, it introduces the role of relational capital to the System Dynamics literature applied to project management. Third, it introduces System Dynamics as an excellent method to study the integration of diverse domains of knowledge (Zimmermann and Curran, 2023), in our case project management, and marketing. Building on the previous, our study also strengthens the use of System Dynamics for theory building (Hanneman, 1988; Schwaninger and Grösser, 2008). Fifth, it introduces project management as a new service setting for marketing research, a setting in which new knowledge generated is critical to improve results as it was demonstrated by the present research. Finally, we hope to motivate service researchers to broaden their research by taking a long-term approach using System Dynamics to articulate their theories as proposed by Spohrer and Maglio (2008).

4.7.2 Managerial implications

Our study yielded seven key implications. First, we suggest improved decision-making procedures that help managers to identify unforeseen consequences of their decisions, such as declining standards and goal adjustments based on poor performance. Second, we developed practical guidelines for software development projects. Examples of simple guidelines are maintaining at least a 50% ratio of experienced employees, comparing project progress against plans, allowing for revisions, implementing clear contractual terms and establishing realistic performance benchmarks, and standardizing processes and developing tools to convert tacit knowledge into explicit knowledge.

A third managerial implication concerns the paramount role of relational capital on expectation adjustment and goal setting. Managers can counteract the tendency for downward adjustments by establishing clear, measurable benchmark goals for errors, quality, and project outcomes. To actively manage relational capital, companies need to: (1) understand the definition of relational capital and its influence on projects, which is a primary focus of our research; and (2) identify and implement appropriate levers for managing relational capital (e.g., team rotation, controlled social interactions, matrix structures, control milestones). The latter represents an area for future research, as our current study does not comprehensively address all potential management levers.

The fourth key managerial takeaway is the need to reevaluate team composition. A higher proportion of experienced staff significantly improves project performance in terms of cost and time, corroborating Kunc's (2008) research. To optimize project planning, we recommend revising staffing strategies to avoid underestimating the time allocation of experienced personnel. This proactive approach can mitigate unnecessary pressure and delays. Fifth, we propose expanding the project monitoring system with key performance indicators (KPIs) aligned with our model findings. These KPIs can significantly enhance project control and prompt timely interventions. We also advise managers to consider the introduction of formal service quality measurements involving clients using the scales already developed for that such as SERVQUAL (Parasuraman, Zeithaml and Berry, 1988) and SERVPREV (Cronin Jr and Taylor, 1992). Our proposed additional KPIs include:

- Error tracking:
  - Monitor error count throughout sprints and later testing phases.
  - Compare actual errors to expected error rates.
- Service capacity management:
  - Track "effective agile workforce".
  - Calculate and monitor "expected weekly service capacity" based on average individual productivity and team size.
  - Monitor the gap between expected and actual service capacity to identify deviations and potential delays.

Sixth, our findings have the potential to be applied to projects beyond Agile and Hybrid methodologies due to the fundamental similarity in relational capital development and project control mechanisms across various approaches. Our insights can be extended to other business settings like consulting, construction, and service industries, which share characteristics such as knowledge intensity, intangibility, client dependency, and frequent interactions between service providers and clients. Seventh, the generalizability of our results has the potential to enhance project outcomes across a wide range of endeavors.

4.7.3 Limitations, future research, and concluding remarks

This study is constrained by the availability and limitations of real-world project data. The existing data does not fully capture the scope of our research interests. Traditional corporate systems often focus on accounting aspects, overlooking crucial operational details like overtime or workload intensity. Moreover, the systems used to manage project backlogs were under client control, making access challenging for researchers. Lastly, the pressure to keep project costs under control might lead to staff misreporting their labor hours, potentially affecting the data's accuracy. Additionally, the inclusion of only one Agile project limits the generalizability of our insights. Future research could delve into the real-life differences in project development stemming from the absence of detailed plans inherent in Agile methodologies.

Our research focused on specific policy decisions adopted by Company A, providing valuable insights into relational capital in their context. However, this option is bounded by limited policy exploration. This represents a research opportunity to further connect marketing and social capital researchers with System Dynamics researchers. Future studies could investigate diverse policy combinations under various project scenarios to broaden the generalizability of findings. Some examples are:

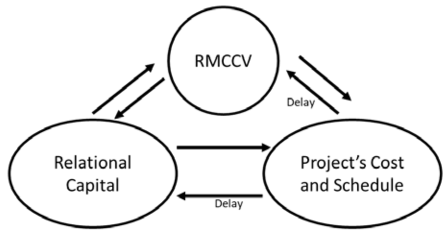
- Inclusion of burnout-induced turnover: While leaving out this factor from our model is justified due to Company A's low turnover rate, future models should consider this factor to explore the broader impact of prolonged overtime and work intensity on staff rotation.
- Limited focus on relational capital effects: Focusing primarily on "cozy relationships" limits the scope. Future research could integrate the diverse positive and negative effects of relational capital for a more comprehensive understanding.
- Underexplored impact of Desired Relational Capital: Further exploration of direct consequences arising from using "Desired Relational Capital" and the development of specific structures to detail how to achieve the goal would broaden the range of strategies available to organizations.

Another limitation arises from the difficulty in measuring quality. Our decision to incorporate non-traditional quality metrics in project management poses challenges. We combined service quality literature (Parasuraman, Zeithaml and Berry, 1985) with System Dynamics principles (Oliva and Sterman, 2010) to introduce quality measurements based on discrepancies between expected and actual outcomes. While this approach offered valuable insights, it also highlighted the need for empirical quality measurements. These measurements are a recognized challenge. We sought longitudinal client feedback on service quality and perceptions, maintaining consistency in both client and team participants. However, practical limitations, including client time constraints, prevented the acquisition of such data. This constraint is consistent with the broader challenges observed in marketing and service quality literature, which often rely on standardized scales and cross-sectional analyses due to similar data acquisition difficulties. Future research should develop long-term approaches to track quality changes over time, a promising area for further exploration.

Another limitation is the service providers' perspective adopted by the study. Although the vast majority of project management literature focuses on the provider's perspective, the one with the formal responsibility to actively manage the project, in Agile and Hybrid approaches roles and responsibilities are blurred. Additional research could minimize this bias and adopt a neutral approach to improving project outcomes in terms of cost, schedule, and quality. Lastly, future research could focus on multi-projects, assessing the impact of starting a project with values either lower or higher than 3 (neutral), reflecting a history of interactions.

5. How does the combination of the relational motive to co-create value and relational capital impact software development projects?

Chapter 5 brings all elements introduced individually by Chapters 2, 3, and 4 together, applying the resulting theoretical framework to software development projects using Hybrid project management methodologies. To capture the inherent complexity of these projects, Chapter 5 details the development of a System Dynamics simulation model and its validation. Chapter 5 offers a robustly grounded simulation tool and provides a definite answer to the first overarching research question - How does the relational motive to co-create value and relational capital impact project results in terms of cost and schedule? This unified theory empowers organizations to leverage relationships for improved project outcomes in terms of cost and schedule.

Causal relationship	
Gaps addressed	Combination from the RMCCV and relational capital; Their combined impact in project results using Hybrid Agile methodologies;
Research questions	• How do the relational motive to co-crate and relational capital impact project results in terms of cost and schedule?
Overarching research questions	• How do the relational motive to co-create value (RMCCV) and relational capital impact project results in terms of cost and schedule? • How can service providers leverage the relational motive to co-crate value and relational capital for better project results in terms of cost and schedule?

Sousa, J., Rouwette, E.J.JA, Bloemer, J.M.M., Jacobson, J., Malczynski, L. (2025). *Relationship dynamics in hybrid software development projects.*

5.1 Abstract

Understanding the interplay of relationships in Hybrid Agile software development projects is crucial for optimizing outcomes in terms of cost and schedule. These methodologies prioritize client involvement, fostering valuable insights and feedback that drive project success. Effectively managing the resulting personal relationships, characterized by the reciprocal interaction between the relational motive to co-create and relational capital, is essential for boosting project performance. However, this area remains under-explored. To address this gap, a literature review was conducted, and a System Dynamics model was developed, rigorously validated using data from four real-world Hybrid Agile projects. Findings demonstrate how and when relational capital and relationship-oriented policies impact project dynamics and outcomes. Moreover, the study reveals the potential for relationships to have both positive and negative long-term effects. This research offers a dynamic understanding of the interplay between the Relational Motive to Co-Create Value and relational capital in software development, providing theoretical and managerial recommendations for enhancing project results. Potential avenues for future research are also identified.

5.2 Introduction

Software projects consistently face overruns, with over two-thirds of projects exceeding their planned budgets regarding time and cost (Kuutila *et al.*, 2020). These overruns, the increasing pace of evolving business requirements, and the demand for greater flexibility paved the way for the emergence of Hybrid methodologies (Reiff and Schlegel, 2022; Křivánková and Remta, 2023) in an attempt to combine the best of the Agile and traditional approaches (Yahya and Maidin, 2023; Reiff and Schlegel, 2022; Cooper and Sommer, 2018). One common hybrid methodology used in software development is the Water-Scrum-Fall, which is the combination of Scrum with the waterfall model (Yahya and Maidin, 2023), using Waterfall for the initial stage of requirement definition and planning, and for the final stage for integration, testing and delivering, while using Agile for the software development stage (Yahya and Maidin, 2023; Reiff and Schlegel, 2022).

The hybrid agile method places clients at the center of the development process because relies on the Scrum process, which requires critical resources from the client and permanent communication and validation over continuous iterations (Yahya and Maidin, 2023). This continuous interaction fosters the accumulation of relational capital, defined as the network of personal relationships individuals develop with others over time (Cummings and Dennis, 2018). These relationships are fundamental for the success of Hybrid software development projects, and highlight the importance of motivating the participants to co-create, exploring the potential of the relational motive to co-create value (hereinafter, RMCCV) defined as "enhancing the social and emotional connection" between teams from the service provider and the client (Neghina *et al.*, 2017, p. 160). The combination of the actions taken to motivate participants to co-create with the result from those actions accumulated by relational capital gives us an overarching perspective on relationships.

Relationships evolve and often have positive and negative consequences (Villena, Revilla and Choi, 2011) with different dominances and effects over time (Autry and Golicic, 2010). Looking at the positive consequences, first, it fosters a deeper understanding of client needs (Noordhoff *et al.*, 2011), leading to more precise service requirements and expectations (Johnsen and Lacoste, 2016). This precision, in turn, demonstrably improves service quality and client satisfaction (Bettencourt *et al.*, 2002; Nordin and Kowalkowski, 2010; Jaakkola and Alexander, 2014). Furthermore, such intense collaboration can cultivate interpersonal social relationships (Bagdoniene and Valkauskiene, 2018) by leveraging the informal contacts that are ingrained in the daily routines of service professionals (Taminiau, Ferguson and Moser, 2016).

Taking a different approach, looking at the negative effects, it's found that relationships produce biased judgments and evaluations, emerging from losing objectivity (Rood *et al.*, 2018; Villena, Choi and Revilla, 2021). Second, the acceptance of bad performance from complacency (Villena, Revilla and Choi, 2011; Autry and Golicic, 2010; Mitręga and Zolkiewski, 2012) and blurred lines between the roles of the service provider and the client (Rood *et al.*, 2018). Third, complacency and blurred lines also contribute to the development of lower expectations and poor goal definition (Johnsen and Lacoste, 2016; Villena, Choi and Revilla, 2021) and a reluctance to challenge or change established relationships (Villena, Choi and Revilla, 2019; Rood et al., 2018). Finally, poor decision-making is exacerbated by redundant knowledge and thinking alignment (Villena, Revilla and Choi, 2011; Anderson and Jap, 2005), excess reciprocity (Anderson and Jap, 2005), and opportunistic self-seeking behavior (Johnsen and Lacoste, 2016; Noordhoff *et al.*, 2011; Mitręga and Zolkiewski, 2012).

Despite the significant implications of these evolving relationships, both positive and negative, research on their impact within these collaborations remains limited (Rood et al., 2018). Moreover, Hybrid methodologies are still process-oriented, failing to capture the combined positive and negative consequences of relational dynamics on project success, leaving it largely unexplored. Additionally, little is known about the real-life implementation of Water-Scrum-Fall (Křivánková and Remta, 2023). These gaps give rise to concern, particularly because of the frequency of interactions and the reliance on client input in modern Hybrid software development. Our research aims to address these knowledge gaps by investigating the interplay between personal relationships and project outcomes within Hybrid software development settings answering the first overarching research question from the present thesis: How does the relational motive to co-create and relational capital impact project results in terms of cost and schedule?

Understanding the reciprocal interaction between the relational motive to co-create and relational capital in software development is crucial for boosting project success, resulting in substantial cost savings, and keeping teams motivated and successful. While, the RMCCV fosters collaboration, with continuous stakeholder engagement, potentially leading to long-term relationships, relational capital facilitates knowledge sharing, strengthens client ties, unlocks access to valuable external resources, and enhances risk management. Thus, the reciprocal interaction between the RMCCV and relational capital increases the potential for enhancing project outcomes and driving long-term success in Hybrid software development projects.

Addressing this chapter's research question necessitates a combined theoretical and empirical approach. The research strategy involves a literature review and the development of a System Dynamics model, rigorously validated against data from four real-world Hybrid Agile projects. This multi-method approach ensures the model accurately captures the critical elements of these complex projects.

Informed by the literature on service quality, relational motive, and relational capital, we develop a System Dynamics model to explore their interconnectedness and impact on Hybrid Agile software projects. The paper commences with a literature review, establishing the foundational concepts. Subsequently, the System Dynamics model is presented, followed by a detailed validation process. Finally, key findings, implications, limitations, and future research directions are discussed.

5.3 Literature review

To address our first overarching research question, Chapter 5 conducts a summary of the literature review conducted throughout the thesis, to enable capturing the impacts of the relational motive to co-create value and relational capital on project results in terms of cost and schedule in Hybrid project management.

5.3.1 The Hybrid methodology to manage projects

Hybrid project management, a methodology combining traditional and Agile approaches (Reiff and Schlegel, 2022; Yahya and Maidin, 2023), has become the norm in today's software development industry (Křivánková and Remta, 2023). Its appeal lies in its ability to leverage the strengths of both worlds, addressing the shortcomings of traditional or Agile methods (Cooper and Sommer, 2018). While a detailed exploration of the hybrid method is provided in Appendix 6, the following brief overview underscores the significance of relationships in hybrid project management.

Hybrid methodologies preserve Agile client-centricity while introducing structural elements that enable long-term planning. Hybrid projects foster a co-creation dynamic where clients actively participate in shaping the project scope, define priorities, and provide invaluable feedback and validation (Cooper and Sommer, 2018). Their ongoing involvement, characterized by daily interactions and continuous feedback, is instrumental in aligning the project with evolving client needs. This intense collaboration not only demands substantial client commitment but also cultivates strong interpersonal relationships between project teams. While this deep engagement is invaluable for product success, it simultaneously introduces new challenges. Motivating team members to embrace a co-creative mindset and building the necessary relational capital to sustain such intense collaboration become critical success factors.

5.3.2 Service quality

Chapter 2 provides the theoretical foundation for the analysis of service quality. Nevertheless, it is important to establish a connection with the importance of relationships in software development projects to fully answer the overarching research questions that address the impact of the RMCCV and relational capital on project results in terms of cost and schedule.

Although service quality has been predominantly examined focusing on the tangible side of quality and measuring it as the number of errors since the seminal work of Abdel-Hamid (1984), this thesis follows the approach from service quality literature, using the definition of service quality by Parasuraman, Zeithaml, and Berry (1985, p. 46): "The quality of a service that a consumer perceives is a function of the gap between expected service and perceived service." Their work highlights the client’s experience in service delivery as a key driver. This is particularly significant for IT services, where extended delivery periods and active client participation characterize interactions that impact service quality (Jaakkola and Alexander, 2014). It becomes clear that relationships clearly affect service quality.

Having established that the drivers of service quality (expectations and perceptions) are influenced by relationships, it is critical to acknowledge its consequences, where service quality is known to influence customer behavior (Zeithaml, Berry and Parasuraman, 1996), expectations (Gronroos, 2007), and client satisfaction (Storbacka, Strandvik and Grönroos, 1994). These effects are bounded by relationships, which play a crucial role in how the accumulated experiences are perceived (Grönroos and Voima, 2013). Overall, a feedback loop is observed where relationships impact expectations and perceptions that will impact service quality, which will further affect the development of relationships.

5.3.3 The relational motive to co-create value

Motivating team members to co-create value is a source of competitive advantage for companies (Neghina *et al.*, 2017; Vargo, Maglio and Akaka, 2008; Bettencourt, Lusch and Vargo, 2014). This is particularly evident in the software development domain, where clients play a pivotal role in service delivery. The interpersonal connections that result from the close collaboration between client and service provider can evolve into bonds of friendship and intimacy, further motivating participants to engage in joint value co-creation processes (Pera, Occhiocupo and Clarke, 2016; Chan, Yim and Lam, 2010). The RMCCV centers on fostering strong social and emotional connections between service providers and clients (Neghina *et al.*, 2017). This perspective highlights the significance of collaborative partnerships in generating mutual value. Consequently, the RMCCV prioritizes the development of enduring, interactive relationships over short-term transactions, emphasizing value co-creation through a history of collaboration.

The success of software development projects using Hybrid methodologies relies on the collaborative environment often leading to the development of a strong relational foundation (Yeniaras, Di Benedetto and Dayan, 2021). As explained in detail earlier in section 1.3.5. this collaborative environment will enable the diffusion of unique business knowledge, a better understanding of client motivations, and the development of interpersonal social relationships. However, a sole focus on understanding the relational motive to co-create value may prove insufficient, as it primarily addresses actions aimed at value co-creation without fully considering the resultant accumulation of relational assets. Thus, a comprehensive investigation into relational capital is warranted to provide a wider understanding of the enduring consequences derived from sustained collaborative efforts. This holistic approach is imperative for fully grasping the intricacies of relationship-driven value creation in software development projects, thereby fostering projects' success.

5.3.4 The relational capital

While developing the ability to motivate teams using the RMCCV is critical, looking at relationships as an asset introduces an additional layer that allows organizations to manage social relationships. Continuous interaction fosters the accumulation of relational capital, defined as the network of personal relationships individuals develop with others over time (Cummings and Dennis, 2018). The accumulation of relational capital is influenced by the actions taken to manage relationships, among them, the actions developed to motivate the team to co-create. It can be concluded that RMCCV strategies affect the interactions (Neghina *et al.*, 2017) that drive the accumulation of relational capital. Moving on to the consequences, relational capital fosters strong relationships within teams (Aisyah, Sukoco and Anshori, 2019), influencing behaviors and expectations (Villena, Revilla and Choi, 2011; Chan, Yim and Lam, 2010), which have positive and negative consequences (Anderson and Jap, 2005; Villena, Choi and Revilla, 2021). While close ties offer advantages, overly familiar connections can create breeding grounds for nepotism, favoritism, and ethical violations (Anderson and Jap, 2005).

5.3.5 The complementarity between the relational motive to co-create and relational capital in a hybrid software development project

By uncovering the reciprocal interaction between these perspectives, a comprehensive framework emerges that captures both the dynamic process of value co-creation efforts and the resulting accumulation of relational assets over time. This approach moves beyond analyzing RMCCV or relational capital in isolation, offering a more holistic and dynamic lens to understand relationship management in projects. Understanding both the driving force (the Relational Motive to Co-Create Value) and the accumulated reservoir (the relational capital) is essential. This integrated understanding unlocks strategies that foster productive partnerships, elevate project success, and lead to deeper insights into the dynamics of collaboration.

Figure 38 summarizes this crucial combination, illustrating the potential for mutual reinforcement. The RMCCV and relational capital are not merely additive; they are interdependent, creating a dynamic interdependence that maximizes their contribution to long-term value creation. This complementarity in their strategic relationship management approaches offers a robust framework for guiding organizations in value co-creation. Specifically, Figure 38 exposes a reinforcing feedback loop at the core of this dynamic:

First, RMCCV strategies directly influence the interactions (Neghina *et al.*, 2017) that drive the changes in, and ultimately the accumulation of, relational capital. These are the actions taken to build the relational asset.

Second, the existing relational capital (the accumulated relational asset) fosters strong relationships within teams (Aisyah, Sukoco and Anshori, 2019). The nature of this relational capital, whether characterized by its positive or negative consequences (Anderson and Jap, 2005; Villena, Choi and Revilla, 2021), then directly influences the willingness and effectiveness of applying future RMCCV strategies. For example, strong, positive relational capital might promote more open and effective co-creation efforts, while negative aspects could hinder them.

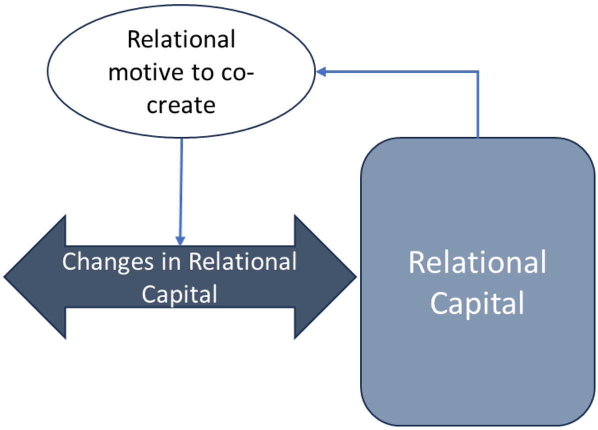


Figure 38 – Relationship between the relational motive and relational capital

Overall, while the RMCCV (as the driving force behind relationship development) focuses on enhancing relationships for value co-creation purposes, relational capital (as the accumulation of this relational resource) provides a framework for understanding the tangible and intangible value of those accumulated relationships, encompassing both their benefits and pitfalls. This dual perspective is fundamental to understanding the full complexity of relationship-driven project success in software development.

Building on the preceding literature review, this thesis proposes a unique theoretical framework that posits a dynamic and self-reinforcing interplay between the RMCCV and relational capital. Within the context of Hybrid software development projects, this interdependent relationship is hypothesized to significantly impact project outcomes in terms of cost and schedule. Crucially, the framework acknowledges that while this relational dynamic can drive positive results through enhanced collaboration and value co-creation, it also carries the potential for negative consequences that can impede project performance. This framework forms the conceptual basis for the System Dynamics model developed in the subsequent section, allowing for the exploration of these complex feedback mechanisms and their long-term effects on project success.

5.4 Methodology

This study employed System Dynamics as the method to integrate the theoretical framework outlined in section 5.2.5. Building upon this theoretical framework, along with qualitative data, decision rules, and project data, a System Dynamics simulation model was developed for simulating project scenarios, evaluating strategies, and identifying performance improvements. System Dynamics emerged as the ideal choice for this research due to its proven track record and ability for building and developing formal theory (Homer, 1996; Schwaninger and Grösser, 2008; Luna-Reyes *et al.*, 2008) and to handle complex problems involving feedback loops, nonlinearities, delays, and accumulation over time (Sterman, 2000; Gao and Zhang, 2022). Moreover, System Dynamics is considered a good approach to study problems that require integration of "diverse knowledge and world views" (Zimmermann and Curran, 2023, p. 336) as is the case for the present research, involving a diverse set of knowledge domains (such as project management, value co-creation, and relational capital) and several stakeholders.

Furthermore, System Dynamics has a long history of project management applications spanning for over five decades. In the context of Agile and Hybrid projects, System Dynamics has been applied to study overall project dynamics (Cao, Ramesh and Abdel-Hamid, 2010; Glaiel, Moulton and Madnick, 2014; Van Oorschot, Sengupta and van Wassenhove, 2009), the transition from traditional to Agile methods (Sarangee *et al.*, 2022), and the potential of hybrid approaches (Imani, Nakano and Anantatmula, 2017). Additional studies have examined team dynamics and productivity (Ching and Mutuc, 2018; Fatema and Sakib, 2018), iteration length effects (van Oorschot, Sengupta and Van Wassenhove, 2018), product development (Rebentisch *et al.*, 2018), and project performance (F. Tripp and Armstrong, 2018).

This research integrates findings from the importance of the RMCCV and relational capital in Hybrid project management, developing a theory that is then tested and validated with real-life project data (Homer, 1996; Schwaninger and Grösser, 2008). The simulation model we developed expands Chapter 4's model that was inspired by existing models of Agile projects (Cao, Ramesh and Abdel-Hamid, 2010; Glaiel, Moulton and Madnick, 2014), adding a Hybrid approach (Imani, Nakano and Anantatmula, 2017), and incorporating new structures that capture the structures behind the RMCCV policies as well as the accumulation of relational capital. The next section presents a detailed description of the model, its validation and parameter estimation strategy, which allowed for testing its robustness and reliability.

5.5 Model Structure

This section presents a formal description of the project management system affected by relationships formulated as a System Dynamics model. The model consists of interconnected mathematical equations, where the causal relationships and conceptual underpinnings are derived from the theoretical framework established in section 5.3 and are further grounded in the detailed literature reviews and prior modeling efforts presented in Chapters 2, 3, and 4. This model results from improving and integrating the models and findings from these previous chapters, thereby introducing a novel approach to understanding the impact of relationships on project outcomes regarding cost and schedule. As with all models (Sterman, 2000), this representation is a simplification of reality. Future iterations may incorporate refinements or alternative approaches to capturing the complexity of project dynamics.

Nevertheless, the current model effectively replicates the key processes identified in this research. Furthermore, it establishes a cohesive framework linking these concepts, thus contributing a novel and fully integrated theory on the significance of relationships in project management success.

This model's critical innovation lies in its unique integration of the RMCCV with the concept of relational capital. As established in Chapter 1 (and further discussed in section 5.3), limitations exist in solely utilizing the RMCCV to capture the impact of project relationships. A System Dynamics perspective offers a valuable lens. By leveraging the action-oriented nature of RMCCV, policies identified in the literature can be modeled as influencing the variables that ultimately alter the accumulation of relational capital. While System Dynamics has traditionally modeled intangible motivations or attributes as accumulating variables (e.g., worker morale or knowledge stocks; see Homer, 1996 for such applications), incorporating relational capital as a distinct stock variable simplifies the modeling approach and aligns more directly with marketing literature focusing on relationships. For instance, relational capital is often conceptualized as an accumulated asset or resource that drives future exchange and value, similar to how it is treated in relationship marketing literature (e.g., Grönroos and Voima, 2013 on value co-creation; Palmatier, Dant, Grewal, and Evans, 2006 on relationship marketing's impact on firm performance).

5.5.1 Boundaries of the model

This model aspires to generate a comprehensive, endogenous theory explaining the influence of relationships on project outcomes in terms of cost, schedule, and quality. Our primary objective is to equip project managers with actionable insights. The model allows managers to intervene by adjusting controllable factors, effectively acting as levers to influence project dynamics. Furthermore, we aim to expand the traditional set of four managerial responses (postpone schedule, expedite work, incur overtime, and hire additional staff) by including a broader range of policies with a specific focus on relationship management. These additional policies will be available to managers within the model. The model's scope is defined by its purpose. Building upon the established model from Chapter 4, the model then extends this framework by incorporating the dynamic impact of the combination between the RMCCV and relational capital development.

Our System Dynamics simulation model follows the same structure presented in Chapter 4, incorporating five sectors (Figure 39), leveraging structures from previously published System Dynamics studies whenever possible. The **software development sector** tracks work completion and defect generation/ discovery. The **quality sector** reflects the impact of management decisions on quality and error probability. These interact with project development rate and quality through service capacity and planning and control. The **service capacity sector** considers the team's ability to deliver tasks, accounting for experience, productivity, and time allocation. The **plan and control sector** reflects ongoing work oversight and management responses to deviations from goals. Finally, the **Relationships sector**, novel to project management System Dynamics models, explains how the combination between the action oriented RMCCV and the resulting accumulation of relational capital impact all previous sectors over time.

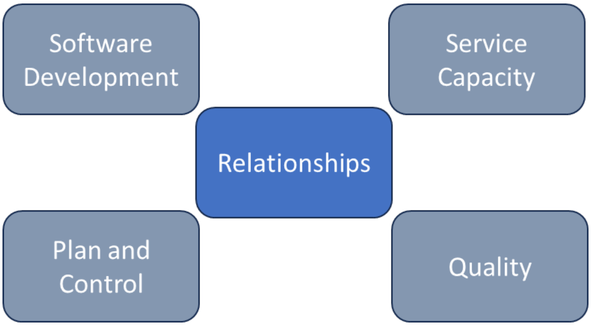


Figure 39 – Sector model

The model incorporates a comprehensive set of behavioral decision rules, informed by project manager interviews conducted for chapter two and three. These rules aim to replicate how project managers make choices in real-world scenarios. To empower project managers, the model includes a wide range of policy options. This allows them to not only explore individual interventions but also experiment with hundreds of potential policy combinations. Table 2 provides a detailed overview of the available managerial decisions within the model framework.

To achieve the model's goals, we strategically streamlined certain aspects and excluded specific features. These decisions were made to maintain a balance between model scope and overall complexity, and can be summarized by:

- Team focus: The model intentionally excludes factors such as the impact of overtime and work intensity on employee burnout, as well as the potential consequences of burnout on staff turnover.These considerations fell outside the primary focus of the model.

- Project completion focus: To comprehensively simulate the range of managerial decision-making consequences, we excluded the possibility of project cancellation.
- Budget restrictions: Our focus on project completion combined with the reality of the projects observed lead to the exclusion of budget limitations, even the ones regarding the team's increase. We followed the real project's assumptions where the need to add resources into a project is usually done through a pool of existing resources.

Table 2 - List of available decisions

#	Variable	Intended Policy
	Plan and control	
1	Scope Increase to be sold	Allows project managers to decide what part of the additional work done in the project can be sold.
2	Additional requirements per sprint	This can be used to limit the amount of additional requirements accepted in the project.
3	Scope decrease	This can be used to decrease the project scope to meet deadlines.
4	Average change in requirements per sprint	Allows to impose a limit to the change of requirements within the project.
5	Percentage of gap to be filled by work intensity	Allows choosing how much of the policy of work intensity can be used.
6	Percentage of gap to be filled by overtime	Allows choosing how much of the policy of overtime can be used.
7	Time to start using policies	Defines when to start using capacity correction policies.
8	Maximum work intensity	Defines a maximum value allowed for work intensity. It can be the result of legal demands but also from the project manager's decision to overload the team.
9	Maximum work week	Defines a maximum value allowed for the number of working hours per week. It can be the result of legal demands but also from the project manager's decision to overload the team.
10	Reduction of work week by hiring	Establishes a goal for reducing overtime when hiring.
11	Reduction of work intensity by hiring	Establishes a goal for reducing work intensity when hiring.
12	Desired change in sprint duration	The decision to change sprint duration. This decision results from monitoring the adequacy of the capacity used and the work planned for each sprint.

Table 2 - Continued

#	Variable	Intended Policy
13	Time to start changing sprint duration	The decision when to start using the policy to change sprint duration.
14	Time to end changing sprint duration	The decision when to end using the policy to change sprint duration.
15	Switch manual sprint capacity	Decision between adjusting sprint capacity at the end of each sprint, or defining specific moments to do it.
16	Sprint capacity change	The decision about how much to change sprint capacity.
17	Time to change sprint capacity	The decision when to start using the policy to change sprint capacity.
18	Time to end change sprint capacity	The decision when to end using the policy to change sprint capacity.
19	Percentage of deadline gap incorporation	A decision agreed with the client to postpone the project schedule and by how much.
Service Capacity		
20	Maximum project workforce	Definition of the maximum number of people allowed to work on the project simultaneously.
21	Desired ratio of rookies	Project decision about the experience mix for new staff.
22	Fraction of time for commercial activity	The decision to manage the amount of time experienced staff can use to participate in commercial activities outside the project's scope.
23	Fraction of time to train rookies	The decision to manage the amount of time experienced uses to train the less experienced members of the project.
Agile ceremonies		
24	Hours spent in daily meetings	The project manager can act on time management.
25	Hours spent in sprint reviews	The project manager can act on time management.
26	Hours spent in sprint planning	The project manager can act on time management.
Specific Policies from Relationships		
27	Hours spent training clients per week	Literature suggests that investing in training the client will improve his motivation to co-create and consequently improve overall productivity.
28	Improvement from monitoring Policy	Both academic literature and insights from project managers underscore the importance of robust monitoring mechanisms. Literature highlights their role in managing the motivation to co-create, while interviews with project managers specifically reveal that improved client monitoring aids in effectively managing expectations and enhancing quality perceptions.
29	Switch to turn on monitoring policy	Decision point to start using the improvement of monitoring.

Table 2 - Continued

#	Variable	Intended Policy
30	Decision to establish account management	Literature suggests that the adoption of matrix organizations within a project enhances monitoring, quality control, and coordination.
31	Increase efficiency from external project management support	Over the last decade, both software development companies and their clients have increasingly adopted external project management support. This trend is primarily driven by the anticipated benefits of enhanced productivity and improved project efficiency.
32	Desired relational capital	Establishing a specific goal for relational capital opens a crucial avenue of research into policies designed to manage its dynamics effectively. This includes standardizing internal processes and, more importantly, implementing structured approaches for daily client interactions. The aim is to cultivate professional relationships that leverage relational capital for mutual benefit, while actively preventing the emergence of 'cozy relationships' or over-dependency that could hinder objectivity and performance.

5.5.2 Software development sector

Building upon the foundation established in Chapter 4 and drawing insights from existing research on Agile development with System Dynamics (Cao, Ramesh and Abdel-Hamid, 2010; Glaiel, Moulton and Madnick, 2014; Rebentisch *et al.*, 2018), we present an expanded model of the software development process (Figure 40). This refined model adopts a similar structure to the one presented in Chapter 4, utilizing stocks (e.g., Project Backlog) to represent work accumulation points and flows (e.g., sprint planning) to depict the movement of work between these points.

The initial project scope feeds into the Project Backlog, which is subsequently decomposed into manageable units for development within sprints. Team capacity and error rates influence the development process during each sprint. Completed tasks are stockpiled in the Test Backlog representing the amount of work that was developed in the different sprints and needs to be tested for final acceptance. However, some tasks may contain errors. These errors are addressed in two ways: either fixed within the current sprint or returned to the Project Backlog for replanning. The sprint concludes when all tasks are completed or the designated time limit expires. In the case of an incomplete sprint due to time constraints, unfinished work is redirected to the

Project Backlog for rescheduling. Work developed during sprints accumulates in the Test Backlog for further testing by a separate team, often from a different company. While error rates are generally lower at this stage, they can still occur. Any errors identified during this testing phase are returned to the Project Backlog for replanning and rework.

Chapter 4 successfully demonstrated the impact of relationships on project outcomes (cost and schedule) and highlighted potential strategies for leveraging this influence. Building upon this foundation, we now propose to further expand the model by integrating a broader range of policy options. This expansion aims to equip project managers with an even more comprehensive set of decision-making tools. To achieve this, additional policies identified in project management literature were incorporated and validated through project manager interviews already presented in Chapter 4.

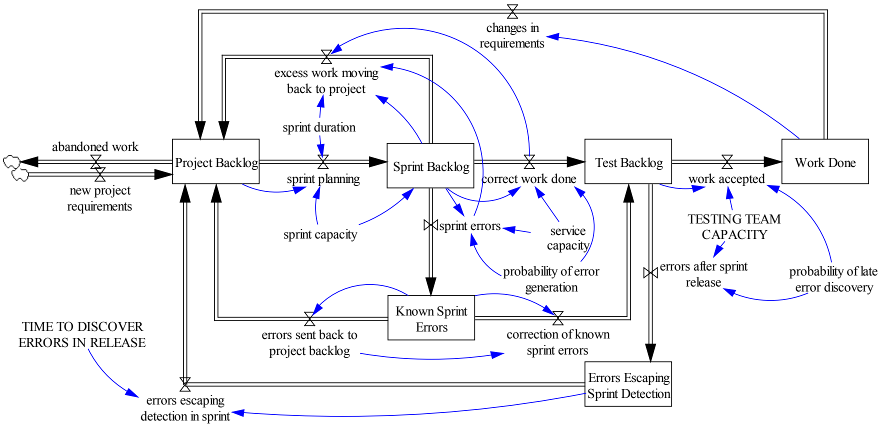


Figure 40 – Software development process

Project managers and System Dynamics literature consistently identify changing requirements as a significant source of project pressure (Li *et al.*, 2018; Lyneis and Ford, 2007). These changes not only necessitate additional work to reflect the new specifications but also render some previously completed work obsolete. Consequently, revisions and retesting become necessary. Agile methodologies, as previously discussed, embrace the concept of adapting to evolving business needs by readily accepting changes in requirements. The modeling approach incorporates certain simplifications. The first assumption involves applying an average value for requirement changes within each sprint cycle. This parameter can also be interpreted as the project's established, or maximum, tolerance for requirement changes during scenario testing. A non-linear function is further incorporated to capture the diminishing acceptance of requirement changes as the project nears its delivery deadline.

In addition to changing requirements, the acceptance of entirely new requirements emerges as another significant pressure point, particularly within hybrid project management methodologies as our interviews with project managers revealed. While Agile approaches readily embrace new project requirements, their introduction in hybrid structures can introduce significant pressure when deadlines are strict. Similar to the approach for changing requirements, we model new requirements as an average value introduced within each sprint cycle. Furthermore, we incorporate a function representing the project's willingness to accept new requirements. This function reflects a higher acceptance rate at the project's outset, gradually diminishing as the delivery deadline approaches.

Finally, the model was expanded to encompass the possibility of scope reduction through abandoned work. Project managers identified this strategy as a viable option when adhering to project schedules necessitates critical prioritization of requirements to ensure the delivery of a functional project, even if certain requirements are ultimately excluded.

5.5.3 Service capacity sector

The model adopts a simplification of the human resource structure used in projects similar to the structures widely used in by System Dynamics to calculate capacity (Oliva and Sterman, 2010; Sterman, 2000; Rahmandad and Hu, 2010) as shown in Figure 41. The project team is divided into two categories: rookies and experienced workers. Given the long-term nature of the projects simulated by the model, it is crucial to consider the concept of "experience chains." This concept captures the experience gained by rookies as the project progresses. Interviews conducted for Chapters 2 and 4 indicate that rookies typically require four to five years to become fully experienced in software development. Therefore, within a one-year project, a rookie's experience level will demonstrably increase. Furthermore, as rookies gain experience, the time commitment required from experienced employees to oversee their work naturally diminishes over the project lifecycle. Capturing these dynamics is essential for long-term project simulations due to their significant impact on project development.

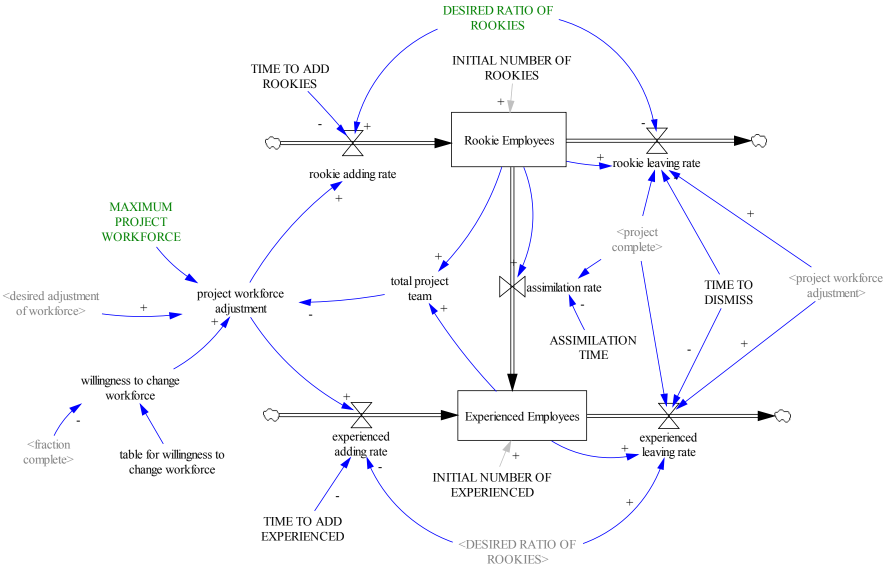


Figure 41 – Workforce structure

Staffing modifications within the project are governed by two key decisions:

- **Maximum allowable workforce**: This parameter reflects the service provider's or project manager's established limit on the total number of team members assigned to a single project. Agile literature emphasizes the challenges of managing and maintaining flexibility in large teams (cite sources here). Based on the project analyses conducted in Chapter 4, we set this value to ten team members, reflecting the limit observed by project managers.
- **Willingness to change workforce**: This variable captures project manager preferences regarding staff changes. Generally, adjustments are more readily accepted during the project's early stages. However, as deadlines approach and schedule pressure intensifies, the willingness to integrate new team members diminishes due to time constraints. This becomes particularly relevant as project milestones near.

Figure 42 introduces project productivity expressed in terms of "experienced equivalent employees." This reflects the assumption that experienced employees represent the standard unit of productivity. Rookie employees, on the other hand, contribute a percentage of the output generated by an experienced worker.

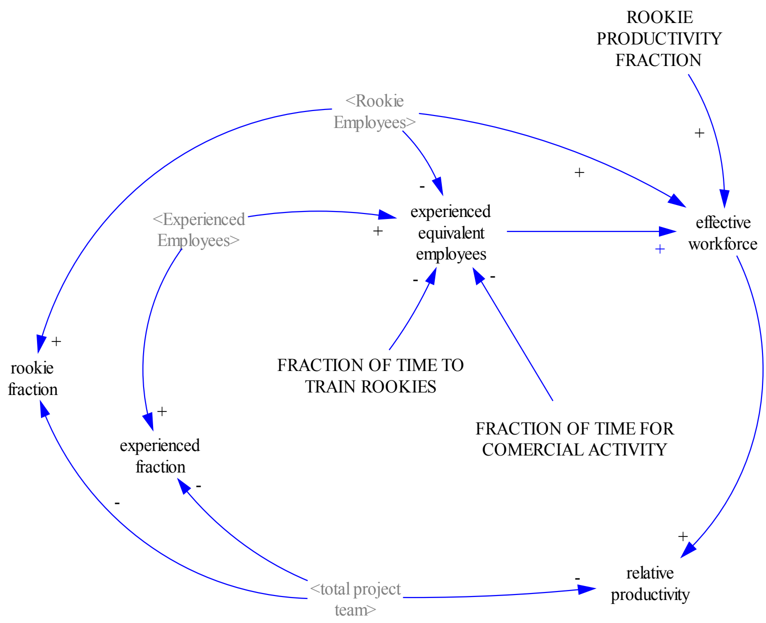


Figure 42 – Effective workforce

Experienced employees play a crucial role in project development. They not only contribute directly but also dedicate time to training rookies. Furthermore, in knowledge-intensive service environments, experienced employees are frequently involved in crafting new commercial proposals, including designing technical solutions and estimating effort required. These additional responsibilities inevitably limit the time they can dedicate solely to active project development. To capture this dynamic, the model introduces a new variable: "experienced employee equivalents." This variable represents the effective time available from experienced employees for project development activities. The "effective workforce" reflects the total number of experienced employee equivalents available for the project. This value is calculated by considering both rookies and their relative productivity, as detailed in the following equation:

$$Effective\ Workforce = Experienced\ Equivalent\ Employees + (Rookie\ Employees * Rookie\ Productivity\ Fraction)$$

To determine the service capacity available for project development, we must further refine the "effective workforce" by accounting for time dedicated to mandatory Agile ceremonies. As discussed in the introduction and Chapter 4, Hybrid methodologies necessitate regular meetings. The most common ceremonies observed in the projects studied in Chapter 4 were incorporated:

- Daily stand-up meetings (15 minutes per day)
- Sprint review meetings (2 hours per sprint)
- Sprint planning meetings (4 hours per sprint)

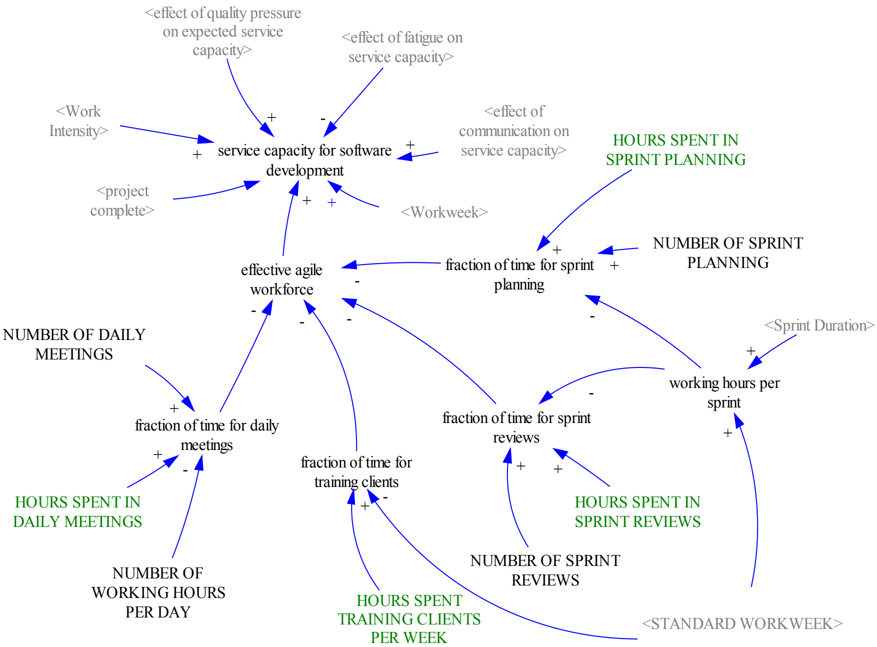


Figure 43 – Service capacity

Figure 43 illustrates the intricate structure used to calculate the "effective agile workforce" dedicated to project development, measured in "persons." This value serves as the driver for the software development service capacity, which is ultimately converted into "hours per week" by considering the standard employee workweek. Finally, service capacity for software development is also influenced by the cumulative impact of project manager decisions, as shown in the next equation:

$$\begin{aligned}
&\mathit{Service\ Capacity\ for\ Software\ Development} \\
&\qquad = \mathit{Effective\ Agile\ Workforce} * \mathit{Workweek} * \mathit{Work\ Intensity} \\
&\qquad * \mathit{effect\ of\ fatigue\ on\ service\ capacity} \\
&\qquad * \mathit{effect\ of\ communication\ on\ service\ capacity} \\
&\qquad * \mathit{effect\ of\ quality\ pressure\ on\ expected\ service\ capacity} * (1 \\
&\qquad - \mathit{project\ complete})
\end{aligned}$$

5.5.4 Service quality sector

The service quality sector addresses two core aspects: the probability of error generation and a multi-dimensional framework for service quality measurements. First, as Figure 44 illustrates, this sector captures the likelihood of errors arising during development. Several influences contribute to this probability, including fatigue, experience level, workload, and monitoring effectiveness. This approach is inspired by the work of Lyneis and Ford (2007) and Oliva and Sterman (2010). System Dynamics research has extensively explored this well-established concept of error generation. The rework cycle reflects the reality that service providers inevitably introduce errors during development. These errors require time for detection and subsequent correction, leading to additional workload. The pressure to adhere to deadlines often compels teams to work longer hours to compensate for the rework, consequently increasing fatigue and ultimately raising the probability of further errors. This dynamic creates a potentially escalating feedback loop.

The second and fundamentally novel aspect of service quality in this model represents a significant extension to existing System Dynamics models of project management. While building upon Oliva and Sterman's (2010), adaptation of the service quality definition by Parasuraman et al. (1985) to capture the gap between client expectations and perceptions, this model extends the concept beyond solely client perception. It encompasses a broader range of quantifiable factors: Service Capacity Alignment Quality, Error Probability Alignment Quality, Work Progress Alignment Quality, Cost Alignment Quality, and Deadline Adherence Quality. An "adjustment time" is incorporated to reflect Sterman's (2000) observation that perceptions change gradually. The inclusion of these diverse measurement variables stems from two key findings:

- The need for improved service quality measurement and monitoring systems, as identified in our research interviews.

- The potential managerial implications highlighted in the relevant literature.

These measurements are designed to be readily obtainable using existing company tools and should be routinely incorporated into project management reports, providing actionable insights for stakeholders.

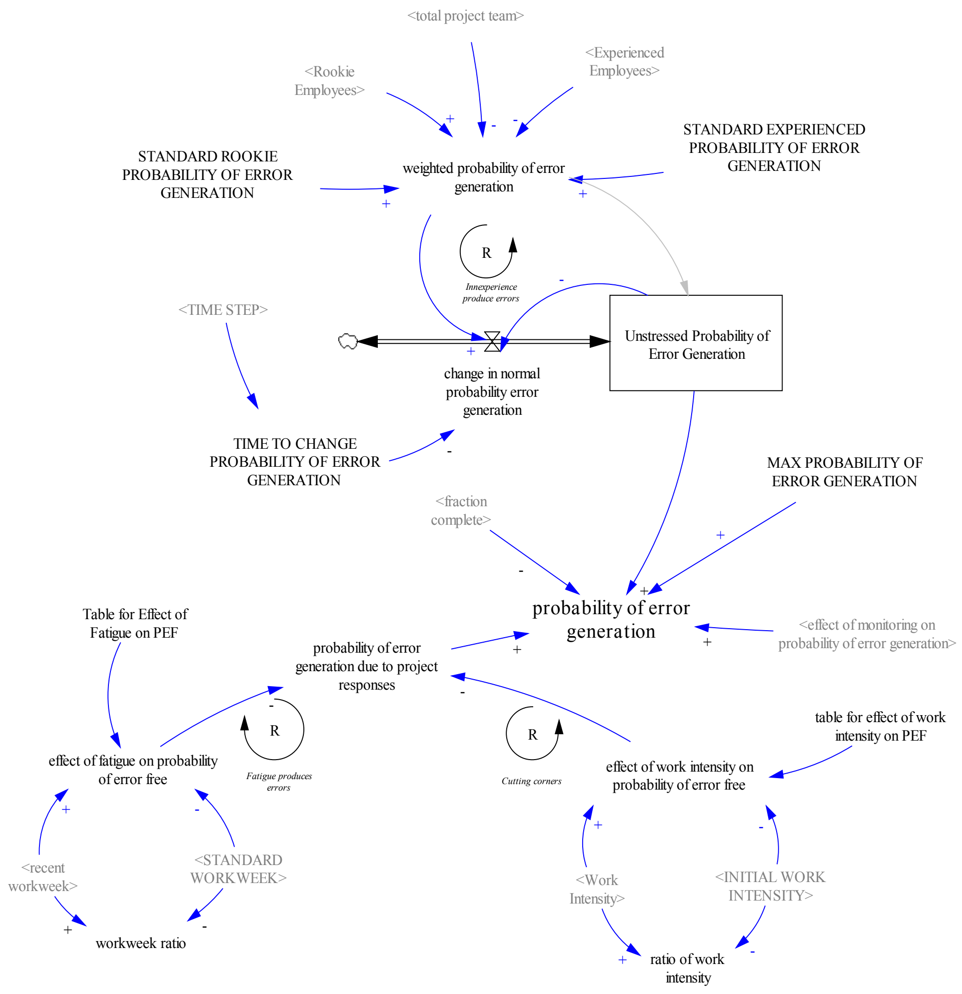


Figure 44 – Probability of error generation

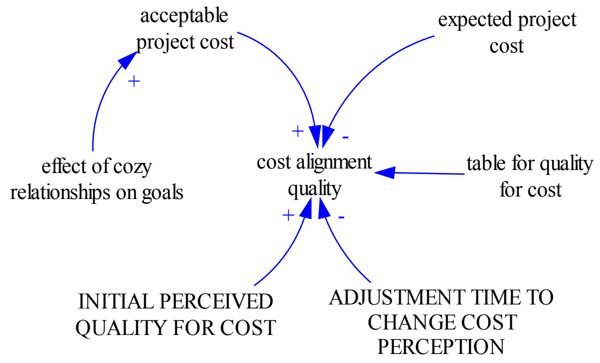


Figure 45 – Cost alignment quality

5

As illustrated in Figure 45, this sector of the model captures the concept of Cost Alignment Quality. This metric reflects the degree to which project execution costs align with initial expectations. While Chapters 2, 3, and 4 explore the influence of literature on this concept, the model incorporates an additional factor: the potential impact of relationship development on project costs. Drawing upon evidence from the literature, the model introduces the possibility that overly cozy relationships can lead to a relaxed focus on strict cost adherence. This, in turn, can contribute to cost overruns relative to initial expectations, representing a negative consequence of specific relational dynamics.

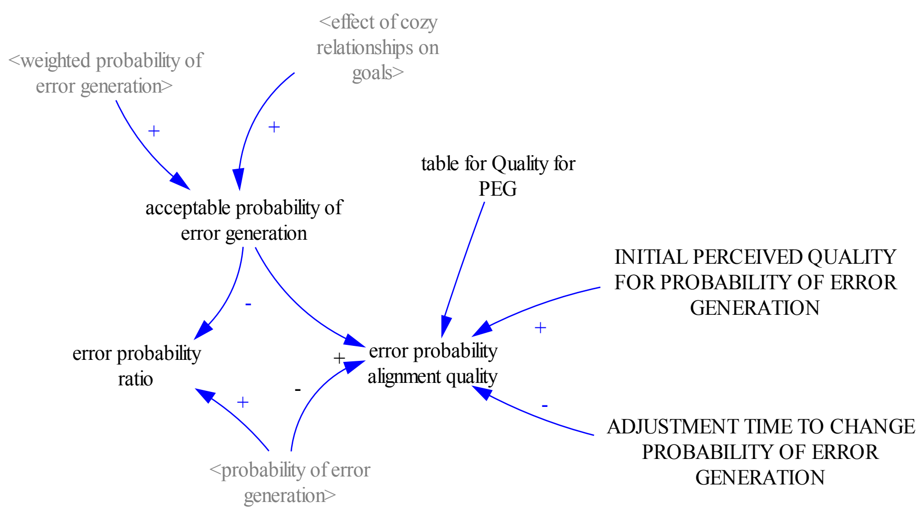


Figure 46 – Error probability alignment quality

The Error Probability Alignment Quality (Figure 46) adopts a similar logic to the Cost Alignment Quality measure. It reflects the degree to which the observed probability of errors aligns with the initially accepted error probability, considering the potential influence of relationship development over time. Building upon Oliva and Sterman's (2010) approach and formulation, a nonlinear function has been developed to assess this quality dimension. This function is informed by the extensive interviews conducted throughout the research project.

Figure 47 depicts the Service Capacity Alignment Quality measure. Similar to the previous quality dimensions, this metric assesses the degree to which the project's current service capacity aligns with expectations. Expected service capacity is established based on the initial plan and is influenced during the project by the effect of cozy relationships.

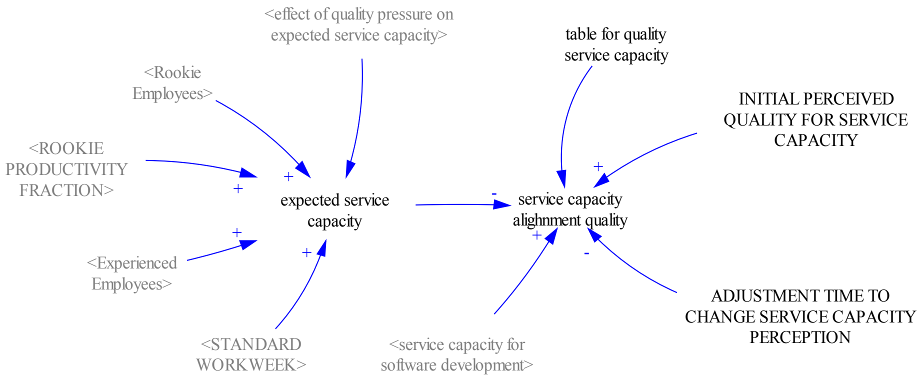


Figure 47 – Service capacity alignment quality

Figure 48 illustrates the model's measure of Work Progress Alignment Quality. This metric captures the degree to which the actual progress of the project aligns with the originally planned work schedule, taking into account the potential influence of relationship development. The concept of Work Progress Alignment Quality emphasizes its importance as a key performance indicator that warrants continuous monitoring and evaluation throughout the project lifecycle.

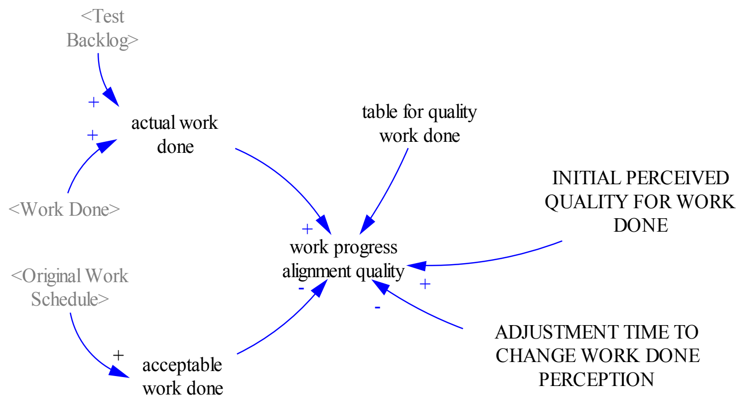


Figure 48 – Work done alignment quality

Figure 49 depicts the model's approach to measuring Deadline Adherence Quality. This metric assesses the degree to which the project is likely to adhere to its initial deadline. The model calculates a revised deadline based on the remaining workload, the effect of relationships, and the available service capacity. The greater the discrepancy between the initial and revised deadlines, the lower the deadline adherence quality.

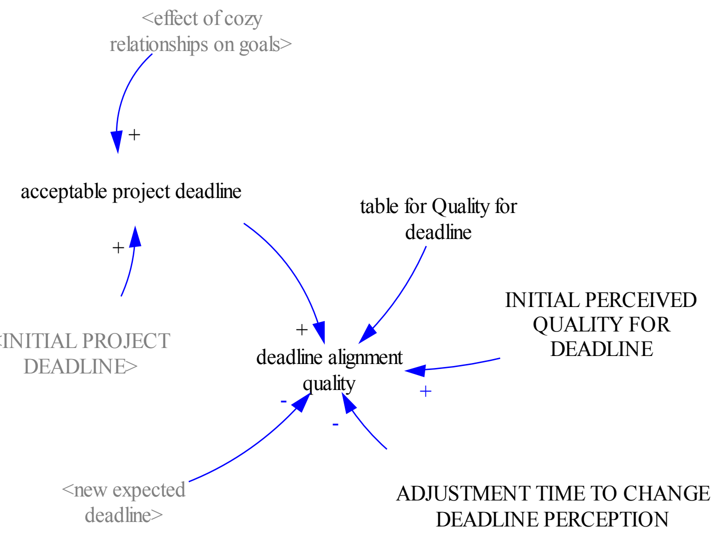


Figure 49 – Deadline alignment quality

These quality measurements serve a vital purpose for both clients and service providers.

- Client Benefits: Clients gain valuable insights into project progress and potential risks associated with cost, schedule, error rates, and service capacity. This information empowers them to make informed decisions, while facilitating the joint decision-making process.
- Service Provider Benefits: By proactively monitoring these quality dimensions, service providers can identify and address potential issues early in the project lifecycle. This enables them to take corrective actions, improve project execution, and ultimately enhance client satisfaction.
- Managing Expectations: Effective quality measurement fosters realistic project expectations for both clients and service providers. By transparently communicating these measurements, all stakeholders can maintain a clear understanding of project progress and potential challenges.
- Relational Capital: The ability to consistently deliver high-quality projects strengthens trust and reinforces positive relationships between clients and service providers. This accumulated "relational capital" fosters long-term collaboration and business success if managed appropriately.

5.5.5 Relationships sector

5.5.5.1 The relational motive to co-create value

Building upon the theoretical foundations established in Chapters 2 and 3, a set of RMCCV policies was compiled to enhance social and emotional connections, as advocated by Neghina at al. (2017). The model integrates key project management practices that foster effective team collaboration and manage stakeholder expectations. These practices include scope adjustments, control responses, and targeted investments in efficiency and capacity. These strategies are designed to optimize resource allocation, improve project planning and execution, and strengthen relationships between project stakeholders. Appendix 9 provides a comprehensive overview of these policies and their alignment with the RMCCV's objectives of fostering collaboration and maximizing co-creative motivation.

5.5.5.1.1 Policies to adjust scope

A primary challenge faced by project managers is the frequent need to modify project requirements during development. Interviews with experienced professionals confirmed that such changes significantly contribute to project overruns. Implementing strategies to actively manage the acceptance of requirement changes can be instrumental in mitigating these risks. By effectively managing expectations and workload, organizations can enhance project outcomes. However, the successful application of these strategies depends on the service provider's approach and the nature of existing client relationships. Figure 50 illustrates the model's approach to managing requirement changes. The model considers an average probability of changing requirements based on the project manager's best estimation. A nonlinear probability function is proposed that reflects the increasing difficulty of accommodating changes as projects progress. This function can serve as a policy tool for establishing baseline guidelines. Adopting Sterman's (2000) perspective, it is recognized that requirement changes can add to the project backlog and render previous work obsolete, thereby impacting project timelines and resources.

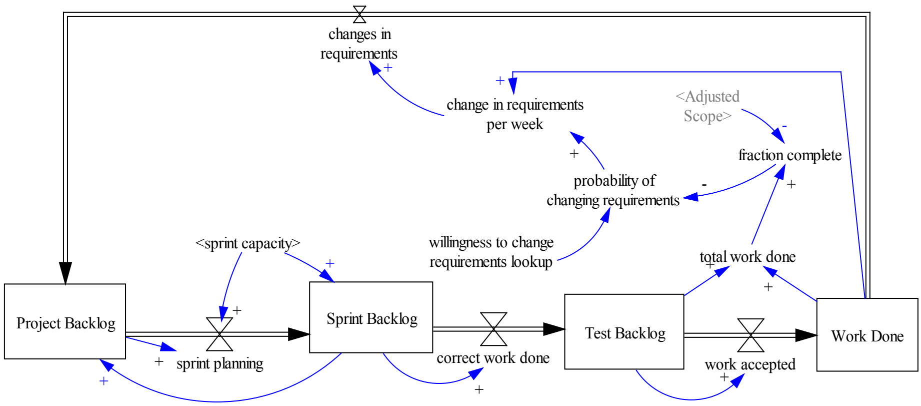


Figure 50 – Change in requirements structure

Another challenge faced by project managers is the ongoing pressure to incorporate new requirements illustrated in Figure 51. Large-scale projects, spanning extended periods, are inherently difficult to plan in detail at the outset, often leading to the discovery of additional requirements as the software solution evolves. This phenomenon, widely acknowledged in both our interviews and existing literature (Sterman, 2000; Lyneis and Ford, 2007; Li *et al.*, 2018), serves as a major source of project pressure. Project managers can strategically employ this policy to influence the project's perception and the accumulation of relational capital. A higher level of accumulated capital can increase the project team's willingness to accept new requirements. To explore the various scenarios that may arise, the model incorporates a non-linear function that dynamically adjusts the team's receptiveness to new requirements throughout the project's lifecycle.

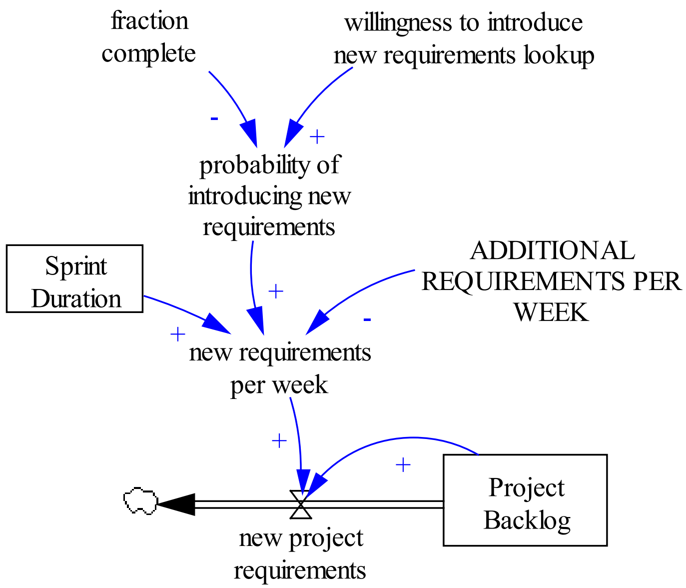


Figure 51 – New requirements structure

While less common, decreasing project scope is another strategic option worth considering, especially in the face of schedule overruns and escalating costs. Research interviews with project managers revealed that this approach is considered to meet deadline constraints. Strong, collaborative relationships can facilitate mutual acceptance of scope adjustments, with both clients and service providers potentially more open to reducing scope to a manageable level. As depicted in Figure 52, the model incorporates the influence of cozy relationships on project goals, which can impact the extent of potential scope adjustments. Although less frequently employed, this policy merits careful consideration within the RMCCV framework, as it can significantly affect project outcomes and the accumulation of relational capital.

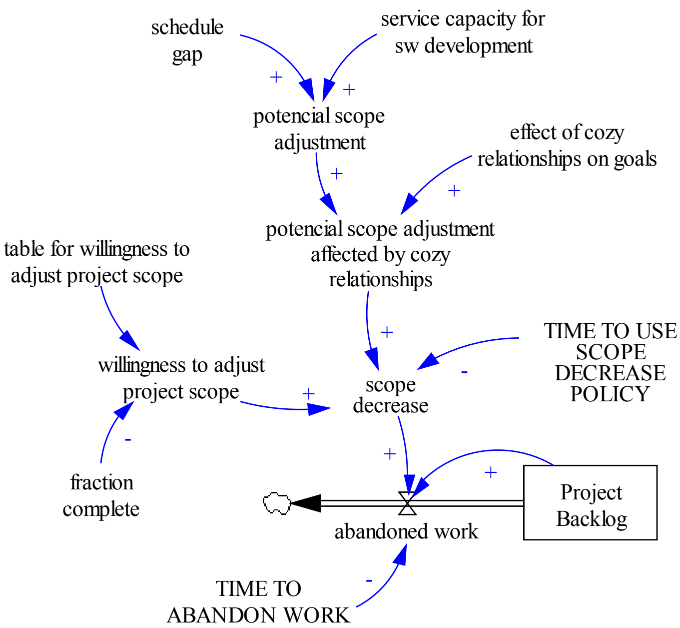


Figure 52 – Scope decrease structure

5.5.5.1.2 Control responses

Project managers frequently grapple with the decision to adjust project deadlines. While this tactic is often avoided in the early stages, delaying the disclosure of problems can lead to significant consequences. Clients may be caught off guard by unexpected schedule overruns, making it difficult to anticipate and mitigate the resulting challenges. The ability to strategically manage project schedules is a valuable tool within the RMCCV framework, as it allows for improved stakeholder expectations and a more authentic project experience. By avoiding false assumptions, project managers can make informed decisions throughout the project's lifecycle. This policy is further explored and explained in section 5.5.6, where we delve into the planning and control aspect of our model and incorporate the active management of project schedules.

A second RMCCV policy project managers frequently cite is the need to adjust sprint durations (Policy: Change sprint duration) throughout the project lifecycle in response to evolving project conditions. This approach helps to avoid situations where the team lacks tasks during a sprint or necessitates significant replanning due to extended durations. Figure 53 illustrates the model's structure for managing sprint duration changes. Project managers have the flexibility to determine the magnitude and timing of these adjustments, improving expectations management and also the accumulation of capital.

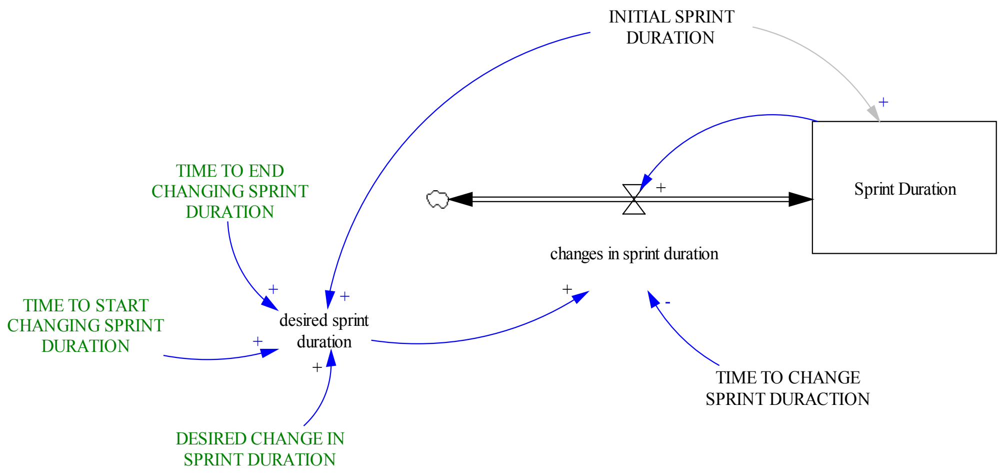


Figure 53 – Process of sprint duration adjustment

Project managers also address capacity variations by modifying sprint capacity (Policy: Change sprint capacity) illustrated in Figure 54. This can be necessary due to factors like increasing team productivity through knowledge transfer, changes in capacity due to hiring, or unforeseen errors in initial planning. The model offers project managers two approaches for managing sprint capacity:

- Manual Adjustments: This option allows project managers to consciously control adjustments to sprint capacity based on actual project conditions. Adjustments are made intermittently as needed.
- Automatic Adjustments: This option uses continuous project monitoring to inform automatic adjustments to sprint capacity.

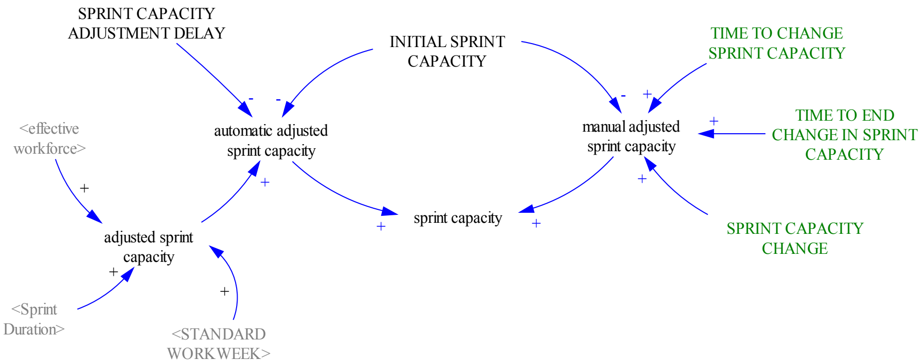


Figure 54 – Process of sprint capacity adjustment

The use of these options require close attention form the project management and emphasizes the importance of the Agile ceremonies.

5.5.5.1.3 Efficiency responses

Figure 55 depicts the available options for improving efficiency, as described by both project managers and the literature. The selection of the two following policies is justified by their consistent referral in both sources:

- External Project Management Support: This encompasses acquiring expertise through external project managers, scrum masters, or consultants. Their specialized knowledge can significantly improve project efficiency and coordination, but also increases project costs.
- Matrixed Teams and Client Collaboration: Matrix structures integrate additional team members, such as business development or internal project management personnel, into project activities (e.g., Agile ceremonies). This fosters increased client interaction and leverages diverse perspectives, although it can dilute individual responsibilities.

As depicted in Figure 56, a final strategy for optimizing efficiency and capacity is to invest in training the client's team. Co-creation literature supports this approach, suggesting that equipping the client's staff with a deep understanding of the project's intricacies and constraints will enhance their ability to communicate vital business information and requirements. This, in turn, will streamline collaboration and lead to an overall increase in service capacity. However, it is important to note that training the client's team requires a significant time commitment, which may temporarily decrease service capacity. Ultimately, the decision to invest in training must be weighed carefully, considering both the potential benefits and the short-term trade-offs.

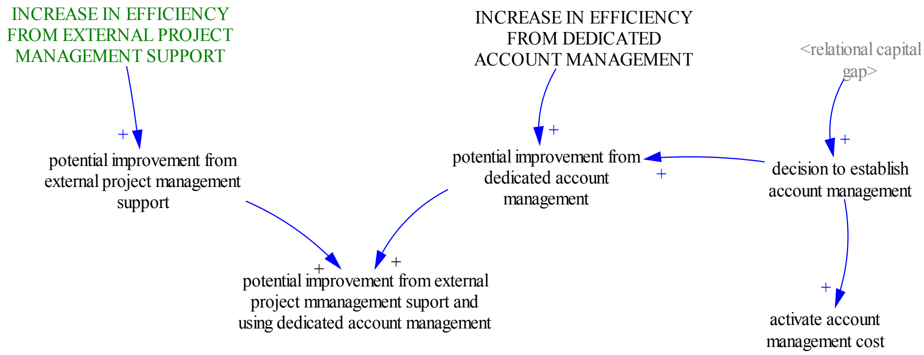


Figure 55 – Using external support to improve project management and adopting a matrix organization

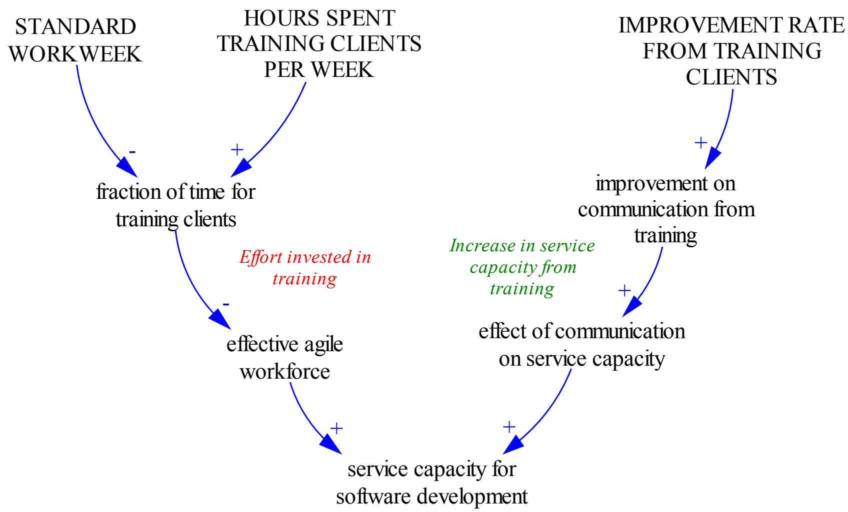


Figure 56 – Training client's resources structure

5.5.5.2 *Relational capital*

The relational capital structure depicted in Figure 57 builds on the structure developed in Chapter 4, and captures the causes and consequences of changes in relational capital. The model considers the full effects of "relational capital" on project outcomes, accounting for both its positive and negative influences. This structure is complemented by the additional new RMCCV strategies introduced.

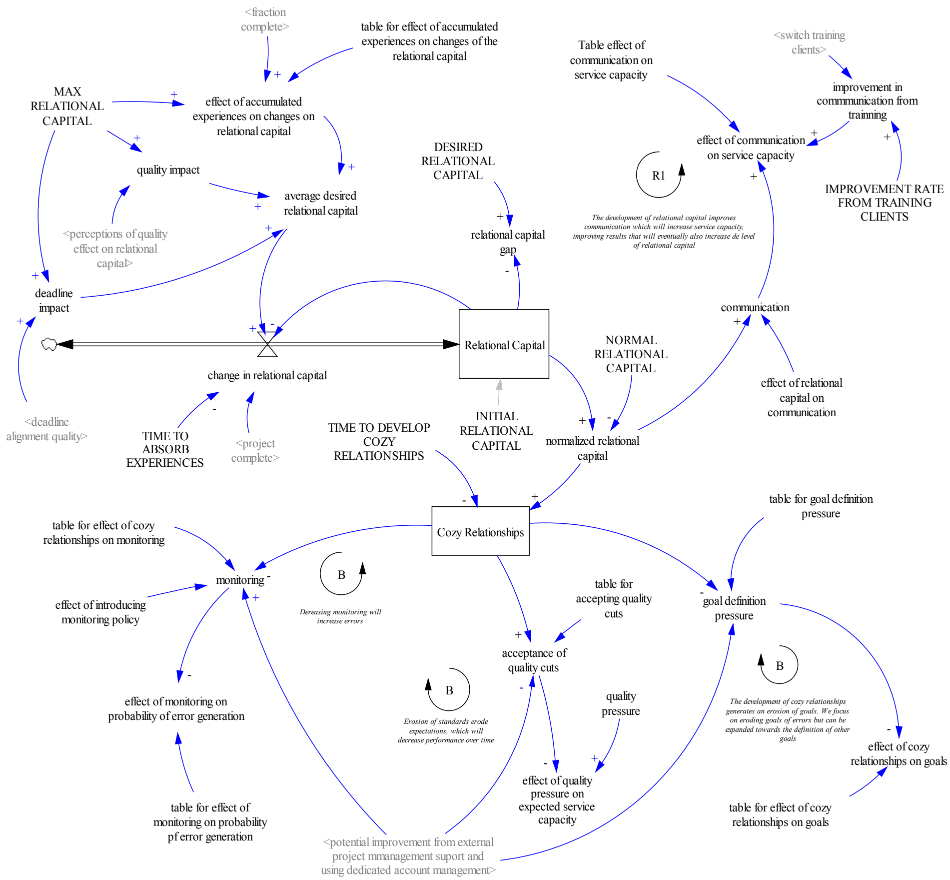


Figure 57 – Relationship sector

As projects progress, relational capital develops through interactions and experience. These interactions and consequently the way experiences are perceived, are affected by the RMCCV policies aiming at developing an healthy accumulation of relational capital, avoiding the negative consequences already mentioned in sections 5.3.3. and 5.3.4. The model captures how enhanced communication and knowledge sharing can lead to an increase in service capacity. Conversely, the negative consequences result from cozy relationships, which include reduced monitoring, lower standards and goals, and impacting quality perceptions, ultimately affecting project performance. The model continuously adjusts the relational capital value based on performance indicators, ensuring responsiveness to changing dynamics as depicted in Figure 58.

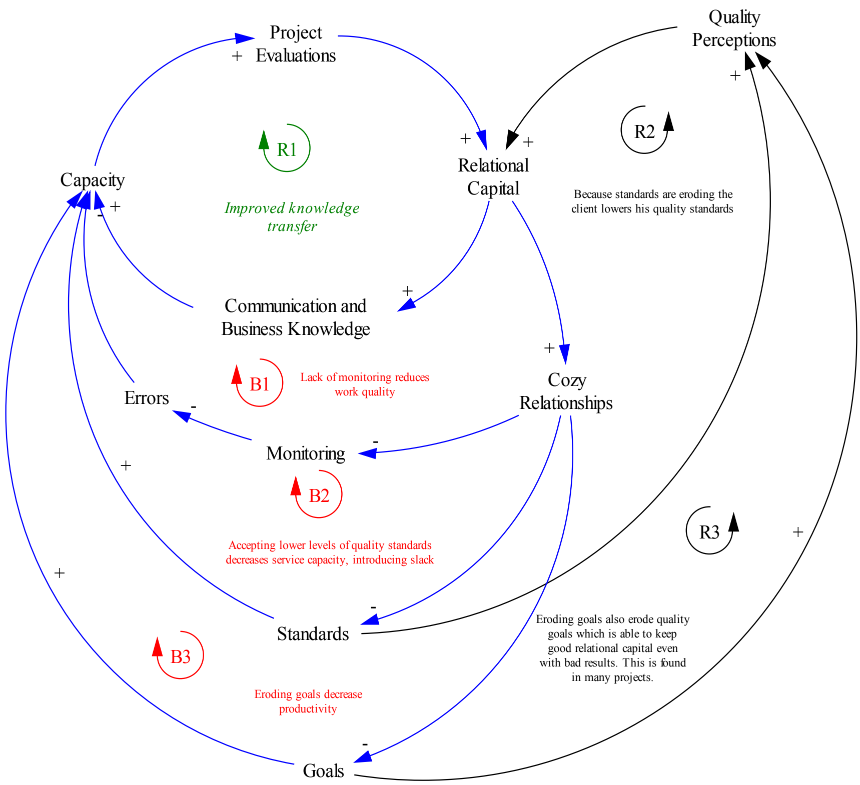


Figure 58 – Consequences from relationships

5.5.6 Planning and Controlling Sector

The plan and control sector manages deadlines and project responses, inspired by previous models (Ford, Lyneis and Taylor, 2007; Jalili and Ford, 2016; Li et al., 2018). This sector utilizes project deadlines to determine the service capacity required for timely project completion. This information allows managers to make informed decisions regarding project execution, using traditional responses like postponing schedule modifying work intensity, overtime, or team size (Li *et al.*, 2018) summarized by Figure 59.

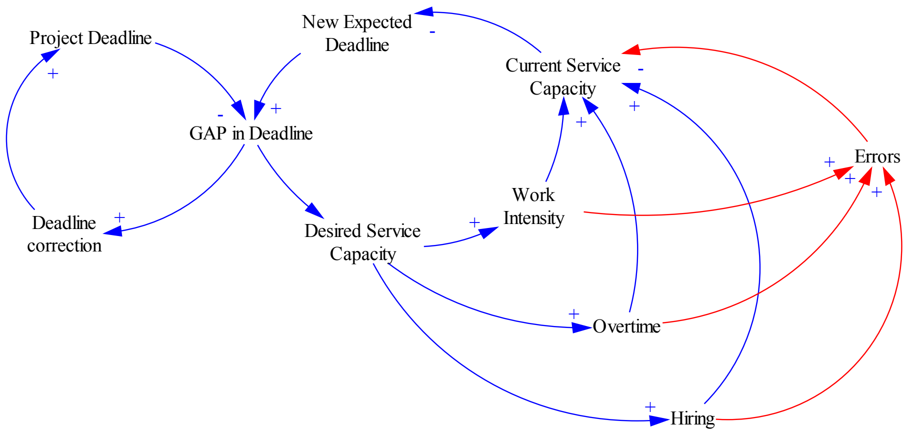


Figure 59 – Traditional project responses

5.5.6.1 Project deadline

Managing project deadlines is a critical activity during the development of a project. When deadlines slip, project managers must extend the project or increase capacity (team size, overtime). Both options have drawbacks. Extending deadlines can strain client relationships and lead to lower deadline adherence quality. Increasing capacity through work intensity, overtime, or hiring can lead to short-term productivity gains but also higher error rates due to fatigue and inexperience. Figure 59 emphasizes the interconnectedness of the model's sectors. Decisions in the Planning and Control Sector impact service capacity and quality, which in turn influence future planning and control decisions.

The deadline structure depicted in Figure 60, captures the evolving project deadline. The initial deadline is set during the proposal phase between the service provider and client. Left unaddressed, deadlines automatically adjust upon reaching the original due date, extending weekly until project completion. Project managers, however, have the option to proactively manage deadlines through client negotiations. This can occur when efficient project control identifies potential overruns. The model incorporates the concept of "percentage of deadline gap incorporation," a variable that reflects the portion of the schedule extension agreed upon by both parties.

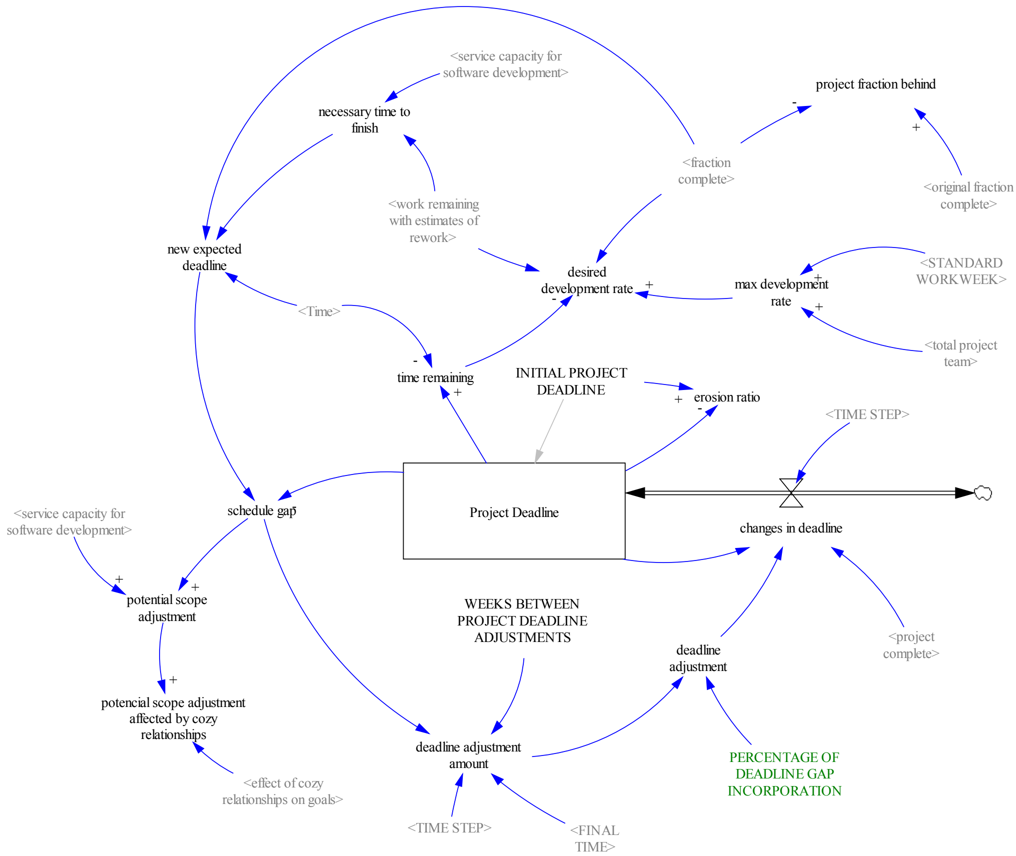


Figure 60 – Project deadline structure

The project deadline plays a crucial role in determining the desired development rate, which represents the number of weekly work hours required to adhere to the current deadline. The equation calculates this rate as the minimum value between two factors:

1. Maximum Development Rate: This reflects the total available capacity, calculated by multiplying the number of team members by their standard weekly work hours.
2. Work Remaining vs. Time Remaining: This factor is obtained by dividing the estimated remaining workload by the remaining time until the deadline.

A critical assumption within this formulation is that project managers must incorporate rework estimates into their workload calculations. System Dynamics literature emphasizes that neglecting a rework strategy is a significant project management failing, and our model development reinforces this notion. Inaccurate rework estimations lead to severe underestimations of required capacity.

$$Desired\ development\ rate = MIN(\max\ development\ rate, work\ remaining\ with\ estimates\ of\ rework / time\ remaining)$$

5.5.6.2 Traditional capacity responses

After calculating the desired development rate or desired service capacity, the project manager often relies on three options: (1) work intensity – which involves methods such as cutting breaks, working faster, and cutting corners; (2) work overtime – to increase the number of daily working hours; and 3) hiring additional staff for the project.

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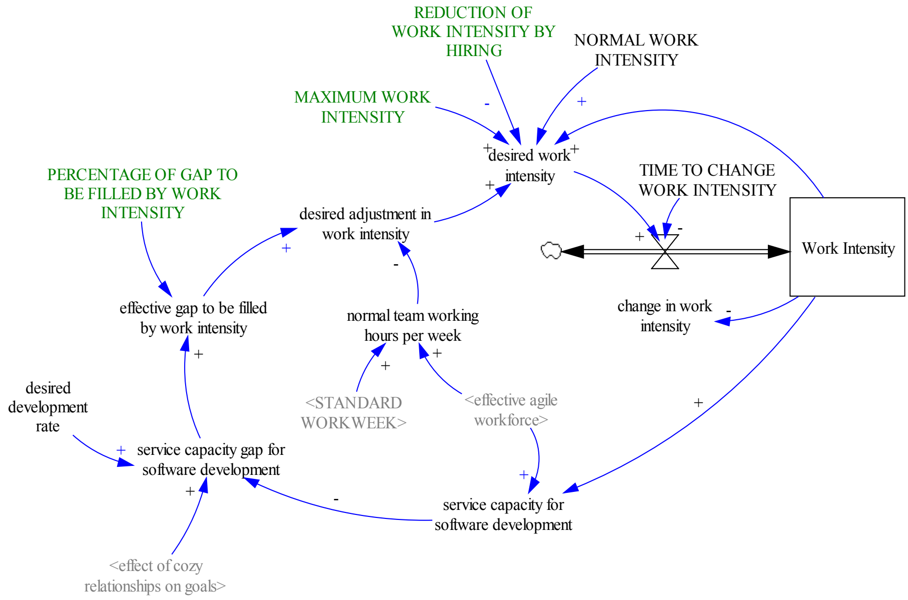

Figure 61 - Increasing capacity through work intensity

Figure 61 details how project managers leverage work intensity to address capacity gaps. By comparing desired and actual development rates, they determine the intensity level and duration needed to close the gap. However, this approach is a double-edged sword. While it initially boosts capacity, it can also increase errors due to fatigue and compromised quality (as discussed in Oliva & Sterman (2010)). This creates a reinforcing feedback loop (Figure 59): higher intensity leads to errors, requiring rework, which necessitates further intensity. The model considers a maximum allowable work intensity based on project manager estimates, company policy, or legal limitations. Additionally, "reduction of work intensity by hiring" reflects the expectation that hiring new staff alleviates the need for high intensity. Finally, the model considers the effect of cozy relationships in eroding standards by correcting the gap between desired and current capacity, explaining that when cozy relationships arise, the gap between the two is perceived as smaller.

Figure 62 depicts the model's approach to overtime, the second common response used by project managers to address capacity gaps. Project managers have the flexibility to determine the portion of the remaining capacity gap they wish to address through overtime. The model prioritizes work intensity adjustments (previously discussed) before calculating the overtime requirement. This reflects the preference for work intensity observed in our project manager interviews.

$$\begin{aligned} &\textit{Desired adjustment in workweek} \\ &\qquad = \textit{effective gap to be filled by overtime} \div (\textit{effective agile workforce} \\ &\qquad * \textit{Work Intensity}) \end{aligned}$$

The model calculates a desired workweek per person, considering potential reductions if hiring is planned (similar to work intensity). This desired workweek is then compared to the actual workweek to determine necessary adjustments. Increasing the workweek boosts service capacity but, like work intensity and overtime, can lead to errors due to fatigue (refer to quality sector). This creates a reinforcing feedback loop: longer workweeks lead to errors, requiring more work, potentially necessitating even longer workweeks (Figure 59). Similarly to work intensity, the gap between desired and current capacity is affected by cozy relationships, which lower the perceived gap.

Figure 63 depicts the model's response of staff adjustments. Project managers can determine the portion of the capacity gap they aim to address through hiring. This calculation considers the desired development rate and the impact of new hires on service capacity (see Section 5.5.3). While hiring boosts capacity in the long term, it's less effective for short-term fluctuations due to onboarding times. Additionally, like work intensity and overtime, hiring alters team composition, potentially affecting error rates (see quality sector section 5.5.4.). This decision creates a complex dynamic within the model. Once again, the gap between desired and current capacity is affected by cozy relationships, which lower the perceived gap.

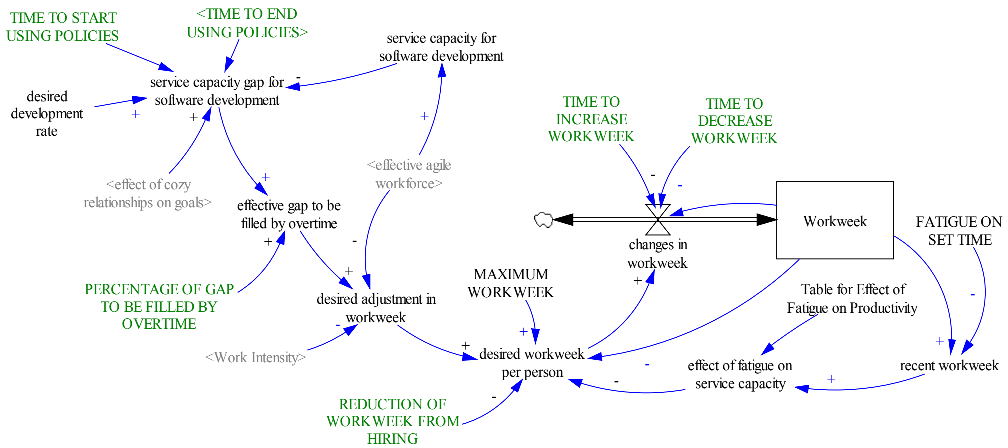

Figure 62 – Increasing capacity through overtime

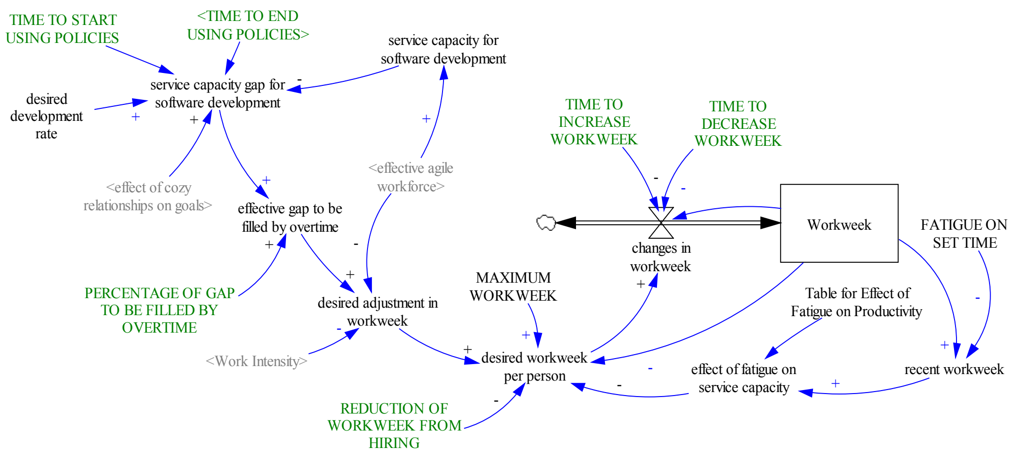

Figure 63 – Increasing capacity through hiring

5.5.6.3 Cost

The model incorporates a structure that tracks all project costs throughout the development lifecycle (Figure 64). This includes not only staff costs but also expenses associated with project manager decisions such as external support (e.g., project managers, scrum masters, consultants), monitoring teams, and account management teams. The model continuously generates updated cost estimates, providing valuable insights for informed managerial decisions and fostering realistic client expectations regarding project budget and quality.

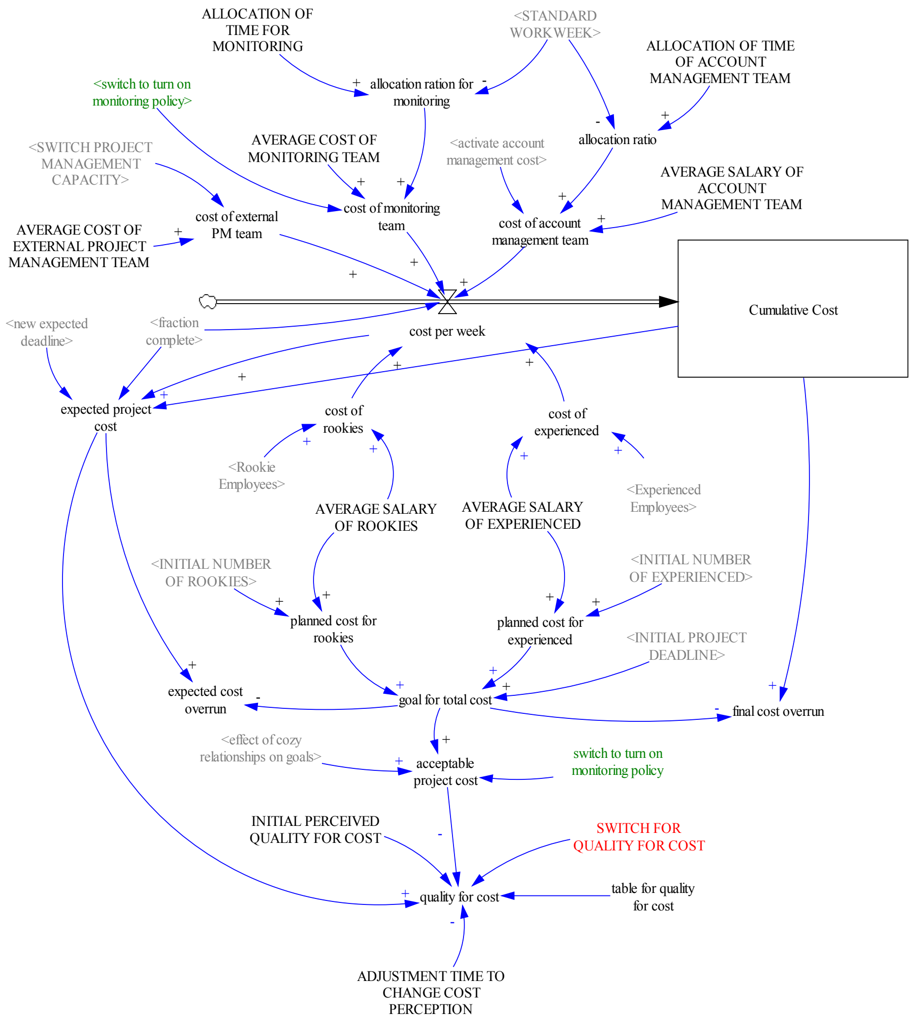

Figure 64 – Structure to track and plan costs

5.5.6.4 Total Scope

A critical metric tracked by the model is the total project work, encompassing:

- Initial estimates
- Rework due to errors
- Adjustments for new and changed requirements

This comprehensive measure transcends individual projects, fostering insights into project complexity. It informs future project planning, policy selection, and client communication regarding budget and quality. The model additionally incorporates the "scope increase to be sold" variable. This allows service providers to track work exceeding the initial scope due to factors beyond error correction or requirement adjustments. This structure can adapt to a service provider's specific definition of new work. Notably, project manager interviews revealed that some companies consider client-driven changes to approved work as part of the "scope increase to be sold" category.

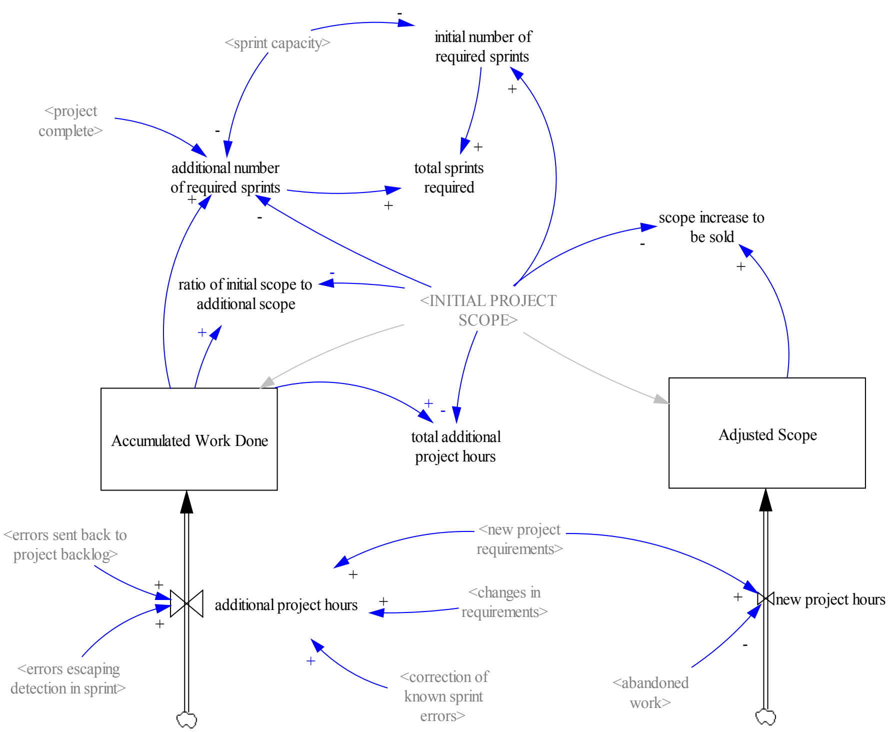

Figure 65 – Project scope tracker

5.6 Validation of the model

Model calibration, the process of aligning simulated results with real-world observations, was achieved through a two-pronged approach. Initially, parameters established in the relevant literature were leveraged. Subsequently, specific project data from the studied company was incorporated. For decision-making variables lacking explicit quantitative data, estimations were judiciously made based on insights from interviews and the broader literature, serving as indicative parameter values. While acknowledging that "validation and verification of models is impossible" (Sterman, 2000, p. 846), confidence in this model's theoretical foundation and practical applicability was built through a rigorous, multi-faceted approach consistent with System Dynamics best practices (Schwaninger and Grösser, 2008; Homer, 1996; Oliva, 1996). This validation process focused on establishing:

Structural validity: The model's conceptualization, encompassing insights from the Dark Side of Relationships (DSR), Value Co-creation (VCC) literature, project management, and service quality, is firmly rooted in established System Dynamics research. The model's relationships and assumptions were presented to and validated by project managers to ensure alignment with real-world practices. Furthermore, the integration of structures developed and tested in previous published System Dynamics work bolsters confidence in the model's underlying mechanisms.

Parameter validity: While many parameters are literature-derived or based on company data, critical decision-making variables rely on carefully estimated indicative values, refined through literature review and qualitative data from Chapter 4.

Behavioral reproduction validity: Following Sterman's (2000) recommended approach, the model was rigorously tested using real project data from Company A, a Portuguese software development firm (described in Chapter 4). The model successfully replicates the reference modes observed in the analyzed projects; for instance, its behavior under typical understaffed conditions for Company A's financial market projects accurately mirrored Section 4.4.2's reference modes, exhibiting a 61% schedule overrun (compared to an average of 58.15%) and a 14.38% cost increase (compared to an average of 17.07%). Moreover, the model's ability to replicate real-world behavior was further demonstrated by simulating the four individual Hybrid Agile projects detailed in Appendix 8, showing strong alignment with observed outcomes. The model's use of units directly comparable to those in real projects further enhances its realism.

Policy sensitivity and behavior Under Extreme Conditions: To confirm that each policy change produced expected effects and to verify the internal consistency of the model's structures, 17 additional simulations were run. A summary of these validation simulations is presented in Table 3. This systematic testing, which involved isolating individual policy impacts before exploring combined effects, confirmed that each structure behaved as expected based on literature, data, and interview insights. For example, the 'No errors' simulation confirmed ideal conditions by showing minimal overruns (0.93% schedule, 1.05% cost), while the 'Introducing errors (Base Case)' accurately reflected an immediate delay from the rework cycle, demonstrating 10.32% schedule and 10.74% cost overruns even with adequate initial staffing. Individual policy tests (e.g., Dialogue, Training, Hiring) further confirmed their expected directional impacts on project overruns, as detailed in Table 3.

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Table 3 - Validation simulations

Simulations	**Schedule**		**Cost**	
	Weeks	**% Overrun**	**Total Cost**	**% Overrun**
Initial Plan	60		€ 372.000,00	
No errors	60,56	0,93%	€ 375.897,00	1,05%
Introducing errors (Base Case)	**66,19**	**10,32%**	**€ 411.939,00**	**10,74%**
Adjusting Sprint capacity automatically	70,69	17,82%	€ 440.836,00	18,50%
Adjusting Sprint capacity manually	71,69	19,48%	€ 447.266,00	20,23%
Quality On	70,69	17,82%	€ 440.836,00	18,50%
Dialogue	62,25	3,75%	€ 386.700,00	3,95%
Hiring with automatic sprint capacity adjustment	61,12	1,87%	€ 426.254,00	14,58%
Cozy Relationships without quality evaluations	62,31	3,85%	€ 447.504,00	20,30%
Erosion of goals	65,59	9,32%	€ 407.930,00	9,66%
Training	63,69	6,15%	€ 395.909,00	6,43%

5.7 Results

This research employed a simulation model to investigate the interplay between the RMCCV, relational capital, and project outcomes in a software development context. The model incorporated a Hybrid-Agile development process, calculated service capacity and schedule requirements, and assessed the impact of the resulting project dynamics on cost and schedule. A distinctive feature of the model was its inclusion of relationship dynamics between clients and service providers, which significantly influenced project outcomes. The simulation model presented here extends previous simulation models capturing the most common features in a software development project and the combination of the RMCCV and relational capital, establishing the first model of its kind.

To validate the model, a series of simulations were conducted using a fictional project based on the business rules of Company A (from Chapter 4). The base case analysis demonstrated that individual policies produced results consistent with expectations from both literature and project manager experiences. Numerous simulations were conducted, a variety of policy options were tested, and 16 representative runs were selected to highlight common policy combinations. The initial simulation replicated the project as initially planned, while subsequent runs incorporated different policy options and simulated real-world scenarios, including errors, project responses, and client involvement. These simulations confirmed the model's coherence and provided plausible outcomes. By comparing the simulation results to real-life project data, the model's accuracy and its ability to replicate different project conditions accurately were validated.

The validation efforts are instrumental in addressing the research question from this Chapter: How do relational motives and relational capital impact project outcomes? The model identifies the dominance of the positive effects from relationships over the short-term of the project as proposed by the vast majority of value co-creation literature, where relationships promote better communication and knowledge transfer, improving service capacity. However, the model revealed that while relationships initially have positive effects, their long-term impact can be detrimental. The accumulation of relational capital can lead to cozy relationships, characterized by decreased monitoring, reduced goal-setting, and increased acceptance of quality cuts. In the model, if countermeasures are not adopted, these effects start showing from week five onwards, establishing the foundations for an unnoticed continuous process of eroding project results, leading to schedule and cost overruns. Furthermore, results show that without other countermeasures, the effectiveness of adding capacity is limited still producing schedule overruns (3,85%) and significant cost overruns (20,30%) showing poor cost performance. This result is coherent with experiences reported by project managers and by literature (Autry and Golicic, 2010).

Despite the challenges posed by cozy relationships, the model demonstrated that RMCCV policies can effectively mitigate these negative effects and improve project outcomes. By implementing strategies such as capacity development, control measures, and scope changes, project managers can significantly enhance project performance.

The analysis revealed that capacity development policies, such as training and improved communication, are particularly effective in improving service capacity and mitigating schedule and cost overruns. Investing in training, for example, can reduce both schedule and cost overruns to around 6% while providing a substantial increase in service capacity, comparable to hiring new staff, which suffers from the associated productivity and training costs. Moreover, training the client's staff can delay the emergence of negative effects from cozy relationships, postponing their impact from week 5 to week 10.

Policies focusing on controlling such as establishing quality evaluations, are also very efficient, especially when adding staff is allowed. When quality measures are in place, the effect of cozy relationships is significantly smaller and increases much later, only after week 20. This allows the positive effects to occur while limiting the emergence of cozy relationships, improving both cost and schedule overruns. Considered in isolation, the control responses, adjusting the sprint duration and capacity, and postponing the schedule are less effective than the previous options, while changing scope is a viable option only when adding staff is possible.

This research confirmed the thesis that the RMCCV and relational capital significantly influence project outcomes. The model demonstrated that while relationships can initially improve performance, their long-term impact can be negative unless effectively managed. This study revealed that the negative effects of relationships can outweigh the positive ones, leading to suboptimal performance. However, RMCCV policies can help counter these negative trends and improve project outcomes by controlling the accumulation of relational capital.

5.8 Discussion and conclusion

Hybrid project management methodologies are increasingly used, hoping that the combination of the benefits of plan-driven with Agile methodologies results in significant improvements in project outcomes. They still rely on their co-creative, iterative, and incremental approach, placing the client at the center of the software development process. The intense participation in the project promotes continuous daily interactions and validation, fostering the accumulation of relational capital, which can have both positive and negative impacts on the strength of the client-developer relationship over time. The permanent interactions between the team members and the accumulation of relational capital uncover the importance and potential of motivating the clients to co-create value. Despite motivating the client to co-create and the accumulation of relational capital having a central role in software development, little research focuses on explaining how the combination of both impacts project outcomes.

Recognizing this research gap, we built on previous steps of this research to establishing a framework that combines the RMCCV and relational capital in Hybrid Agile methodologies. This research provides the answer to one research question, which is also the first overarching research question of this dissertation: How do the RMCCV and relational capital impact project results in terms of cost and schedule? To address this question, a deep dive into the literature was necessary to identify causal relationships between the RMCCV, relational capital, and their impacts, leading to a framework relating the RMCCV policies with the accumulation process of relational capital. Subsequently, it was added a complete set of project characteristics and the combination between the RMCCV and relational capital to a project management simulation model previously developed in Chapter 4, enabling a comprehensive understanding of the software development activity. The present research focused especially on the validation of the simulation model, providing the necessary confidence to answer the research question.

The findings reinforce the results presented in Chapter 4, corroborating existing literature that identifies both positive and negative effects of relationships, leading to complex dynamics with unexpected long-term consequences. While enhanced relational capital, characterized by improved communication and knowledge transfer, initially dominates, its accumulation can foster cozy relationships. These relationships, in turn, can trigger a negative spiral characterized by decreased monitoring, reduced quality standards, and lowered goals. Such negative effects are often exacerbated by blurred lines between service providers and customers (Pillai et al., 2017), loss of objectivity, knowledge redundancy, increased dependency (Johnsen and Lacoste, 2016), and complacency (Villena, Choi and Revilla, 2021). If not actively managed, the accumulation of relational capital can ultimately lead to a decline in project performance, as the negative effects gradually outweigh the positive ones over time.

Despite the challenges posed by cozy relationships, this research demonstrates that strategically implementing RMCCV policies can effectively mitigate these negative effects. By motivating participants to co-create value, project managers can significantly influence the accumulation of relational capital and postpone the erosion of project results. The analysis reveals that capacity development policies, such as training and improved communication, are particularly effective in enhancing service capacity and mitigating schedule and cost overruns. Additionally, control measures, such as establishing quality evaluations, can also be highly beneficial, especially when combined with increased staffing. While adjusting sprint duration, capacity, or postponing schedules can be less effective when considered in isolation, changing project scope may be a viable option if additional resources are available. By strategically implementing RMCCV policies, project managers can navigate the complexities of relationships and achieve improved project outcomes.

5.8.1 Theoretical implications

This research offers significant theoretical implications for the fields of project management, marketing, and System Dynamics.

First, it exposes the reciprocal interaction of RMCCV and relational capital in project management. This study contributes substantively to project management literature by deeply exploring and elucidating the complex, dynamic interplay between the RMCCV and relational capital, and their subsequent impact on project outcomes. This provides a crucial interdisciplinary bridge, as argued in Chapters 3 and 4, connecting traditional project management concerns with the evolving insights from marketing on value co-creation and relationship dynamics.

Second, it establishes a novel and comprehensive relationships framework for service contexts. This research uniquely establishes a "relationships framework" that rigorously integrates RMCCV and relational capital within a service delivery context, particularly for complex software development projects. This framework offers an unprecedented, dynamic, and holistic perspective on the profound influence of client-provider relationships on service outcomes. It addresses a critical gap in existing literature by explicitly conceptualizing how relational motivations lead to the accumulation of relational capital, and how this capital, in turn, dynamically influences the entire service lifecycle, a comprehensive linkage never before successfully attempted in this manner.

Third, it integrates a relationship-centric framework into System Dynamics project management modeling. This developed framework represents a novel contribution to the field of System Dynamics as applied to project management. It provides a strategic and robust dynamic modeling approach to rigorously incorporate RMCCV-oriented policies and systematically evaluate their complex, cascading impact on relational capital accumulation and, consequently, on project performance over time. This extends the application of System Dynamics to a previously underexplored area of relational influences in project settings.

Fourth, it advances the understanding of relational capital's dual nature and dynamic evolution. This study makes a significant theoretical contribution by demonstrating the nuanced and often contradictory dual nature of relational capital in project settings. Contrary to simplistic assumptions of solely positive effects, the model explicitly reveals how the long-term accumulation of relational capital can paradoxically lead to detrimental "cozy relationships" characterized by decreased monitoring, reduced goal-setting, and compromised quality standards. This offers a more nuanced and realistic theoretical understanding of relationship evolution, its dynamic onset of negative impacts (e.g., from week five onwards), and its profound influence on project performance.

Fifth, it reinforces the suitability of System Dynamics for interdisciplinary knowledge Integration. This study powerfully reinforces the suitability of System Dynamics as an invaluable methodological tool for integrating diverse knowledge domains, as highlighted by Zimmermann and Curran (2023). It demonstrates how System Dynamics can effectively synthesize insights from traditionally separate fields such as project management, value co-creation, and social capital theory into a coherent, dynamic whole that reveals complex feedback loops.

Sixth, it strengthens System Dynamics as a tool for theory building. Beyond merely integrating existing knowledge, this research strengthens the use of System Dynamics specifically for theory building (Hanneman, 1988; Schwaninger and Grösser, 2008). By explicitly modeling the causal feedback loops and dynamic behaviors observed in client-provider relationships and their influence on project outcomes, the study provides a robust, testable theoretical structure for understanding complex relational phenomena that unfold over time.

Seventh, it positions project management as a novel service setting for marketing research. This research distinctly positions project management as a compelling and novel service setting for marketing research. By highlighting the critical role of relational dynamics and the need for new knowledge to improve results in this complex service context, it opens rich avenues for marketing scholars to explore value co-creation and relationship management in a traditionally operational domain.

The eighth and final implication is that it encourages the expansion of the research scope and time horizon in service research. Drawing from the insights gained through System Dynamics modeling, this research encourages service researchers to expand their research scope and time horizon. It advocates for integrating various knowledge fields and adopting a long-term, dynamic perspective through System Dynamics, as passionately advocated by Spohrer and Maglio (2008), to fully capture the evolving nature of service relationships and their outcomes in complex environments.

5.8.2 Managerial implications

This study yields several crucial managerial implications, providing actionable insights for project managers operating in hybrid project management environments.

First, it provides a clear understanding of relationship impact dynamics. This research provides a definitive answer to the study's research question, offering project managers a clear understanding of how and, critically, when relationships influence project outcomes. Specifically, it shows the dual nature of relational capital, demonstrating its initial positive effects but also revealing the precise onset and mechanisms through which it can lead to detrimental "cozy relationships" and project erosion if unmanaged.

Second, it empowers proactive relationship management strategies. The study establishes a crucial connection between leveraging the RMCCV to motivate team members for collaborative value creation and the subsequent accumulation of relational capital. This empowers managers to proactively employ a variety of RMCCV-oriented strategies to enhance project results through effective relationship management, moving beyond reactive problem-solving. Furthermore, the study provides invaluable insights into the relative effectiveness of each of these policies (e.g., capacity development, control measures, scope changes, traditional responses), allowing for more informed and strategic decision-making that considers both relational outcomes and underlying motivations.

Third, it supports strategic resource allocation and capacity management. The model's findings offer nuanced guidance on strategic resource allocation and capacity management. It reveals the short-term benefits and long-term pitfalls of relying solely on methods like work intensity and overtime, highlighting their potential to increase errors and fatigue. Crucially, it demonstrates that simply adding capacity without addressing relational dynamics is insufficient to prevent schedule and cost overruns, urging managers to adopt a more holistic view of resource management.

Fourth, it supports the development of decision heuristics and practical guidelines. The simulation model, by illuminating the underlying causal structure of project challenges, facilitates the development of practical decision heuristics and operational guidelines. Examples of such guidelines include:

- Scheduling weekly training sessions with clients' staff to enhance understanding and delay the onset of negative cozy relationship effects.
- Involving the business development team in project oversight to maintain objectivity.
- Implementing a robust quality control team to significantly mitigate the detrimental impacts of cozy relationships.
- Establishing a standardized reporting system to objectively assess project progress and counter complacency.

Fifth, it enhances project monitoring by proposing new key performance indicators (KPIs). Building upon the insights from Chapter 4, expanding the monitoring system with key performance indicators (KPIs) directly aligned with the model's findings is crucial for enhancing project results. These KPIs can significantly improve project control and enable timely interventions:

- Project Progress: Monitor project progress rigorously against the original plan to detect deviations early.

- Quality Adherence: Maintain strict oversight of incidents and tickets that arise during the project lifecycle. This KPI helps gauge the effectiveness of policies such as implementing quality controls and utilizing matrix structures.
- Effective Service Capacity: Track the "effective agile workforce" and compare it to project progress to objectively evaluate the efficacy of policies like training clients' staff and adding external support.
- Scope Management: Continuously monitor changes and additional requirements, assess the acceptance of changes and additional requirements, and identify potential opportunities for scope reduction to prevent uncontrolled project creep.

Sixth, it emphasizes proactive countermeasures to “cozy relationships” erosion. The research provides specific, actionable guidance on the timing of interventions. Given that the model identified the emergence of cozy relationship effects from week five onwards, managers are advised to implement countermeasures (e.g., client training, quality evaluations) proactively within the early phases of a project to postpone and mitigate the erosion of project results. This shifts the focus from reactive problem-solving to preventative relationship management.

Finally, it broadens the applicability to knowledge-intensive business services (KIBS). The findings have the potential for broader application to projects beyond the software service setting, particularly within KIBS, where the influence of relationships is similarly significant. Examples include all KIBS characterized by high knowledge intensity, intangibility, significant customer dependency, and frequent interactions between service providers and clients. This extends the practical relevance of the model's insights across a wider range of service industries.

5.8.3 Limitations and future research

This study, while offering significant contributions, operates within certain limitations that delineate its scope and suggest promising avenues for future research.

The first limitation of the study it is its explanatory focus. The primary research question adopted an explanatory focus, aiming to elucidate how and when relational phenomena influence project outcomes. This deliberate decision prioritized the development of a highly accurate and descriptive theoretical framework and simulation model, ensuring rigor and building trust within academic and professional audiences. Consequently, while the study provides valuable insights into effective strategies, it primarily aimed at understanding causal mechanisms rather than providing an exhaustive optimization of policies. Future research is encouraged to leverage the high confidence in the model's abilities to explore other RMCCV-oriented policies, analyze their combinations, and systematically search for optimal policy portfolios to maximize project performance.

The constraints of real-world project data cause a second limitation for this study. The model's expansion built upon previous studies using the same dataset, inherently inheriting common limitations associated with the availability and quality of real-world project data. The existing data did not fully encompass the comprehensive scope of this research's interests, as corporate systems often prioritize accounting and financial aspects, frequently overlooking critical quality and human factors. Furthermore, operational systems are often under client control, hindering direct researcher access. Finally, the pressure to maintain existing project KPIs may lead to reporting biases, potentially compromising data accuracy, as noted by Ford and Sterman (2003b). Future research could delve deeper into the under-reporting phenomenon and critically assess its pervasive impact on future project performance.

The challenges in measuring and tracking quality present a third challenge for this study and for project management. While this study innovatively integrated service quality literature (Parasuraman, Zeithaml and Berry, 1985) with System Dynamics principles (Oliva and Sterman, 2010) to define quality based on the discrepancy between expected and actual outcomes, empirical quality measurement is unfortunately not a common practice in many organizations. Future research should critically focus on developing and implementing robust, long-term approaches to systematically track quality changes over time, presenting a promising avenue for further empirical and methodological exploration.

The fourth limitation arises from not providing direct empirical measurements for the motivation component inherent in RMCCV, despite the unique "relationships framework" presented in this study being comprehensive in its dynamic modeling of relational capital accumulation and RMCCV-driven policies. This was a conscious decision to maintain the research's clarity and manageability, as directly measuring subtle motivational states within complex project environments presents significant empirical challenges.

Instead, the focus was placed on observable and managerially controllable policies (actions) that are theorized to stem from or foster RMCCV. However, this innovative approach opens several exciting research avenues. On the one hand, future studies could focus on the empirical measurement of both the RMCCV (motivation) and relational capital, incorporating additional policies suggested by value co-creation literature. On the other hand, future System Dynamics studies could expand the model to conceptualize and use RMCCV as a dynamic stock, where its level could explicitly influence the feasibility or effectiveness of specific RMCCV-oriented policies, thereby addressing the underlying motivational aspects more directly.

The fifth challenge is connected with the generalizability of the quantitative findings. While the model's qualitative behaviors and proposed mechanisms are broadly applicable, the specific quantitative findings derived from the simulation (e.g., the precise timing of "cozy relationship" onset at week five, or specific percentage overruns) are tied to the empirical context of Company A, a Portuguese software development firm. These findings provide valuable insights for similar organizational settings, but future research should conduct further empirical validation and calibration of the model in diverse organizational contexts and industries (e.g., different company sizes, cultural contexts, or project types) to assess the generalizability of these specific quantitative thresholds.

The complexity of policy implementation in real-world settings pose a sixth challenge. The model provides insights into the effectiveness of various policies under simulated conditions, but it does not explicitly account for the multifaceted complexities, costs, or potential organizational challenges associated with implementing these policies in real-world settings. These challenges can include organizational inertia, resistance to change, the actual financial/resource costs of training programs, or the difficulty in effectively forming and integrating new quality control teams. Future research could extend the model to incorporate the dynamics of policy adoption, organizational resistance, and the economic feasibility of organizational transformations necessary to implement RMCCV-driven strategies.

The novel findings from the present research open up additional, equally important research avenues that go beyond simply "fixing" a limitation. These avenues naturally emerge from the insights the model provides, from which some present exceptionally interesting future research.

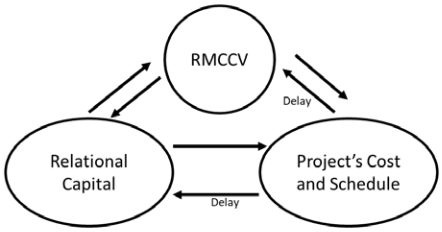
One of these examples is the broader application of this research. Despite the limitations in specific quantitative generalizability, the findings possess significant potential for broader application to projects beyond the software service setting, particularly within Knowledge-Intensive Business Services (KIBS). The model's insights are highly relevant for KIBS characterized by similar dynamics of knowledge intensity, intangibility, significant customer dependency, and frequent interactions between service providers and clients. Future research could empirically test and adapt the model within these analogous service contexts to validate and refine its applicability.

Another example is the in-depth exploration of "cozy relationships" mechanisms across contexts. The model's identification of the dual nature of relational capital, particularly the emergence of detrimental "cozy relationships" and their specific mechanisms (decreased monitoring, reduced quality, lowered goals), is a significant novel finding. Future research could conduct deeper qualitative and quantitative studies to empirically investigate how these "cozy relationships" manifest and evolve in different organizational cultures, industries (beyond IT/software), or project types (e.g., highly innovative R&D projects vs. more routine service delivery). This would validate and enrich the model's behavioral hypotheses.

Finally, studying the impact of different contractual arrangements and governance structures is also promising. Future research could investigate how different contractual arrangements (e.g., fixed-price, time & materials, incentive-based contracts, Agile contracts) or formal governance structures (e.g., dedicated steering committees, formalized review gates) influence the accumulation and effects of relational capital and the efficacy of RMCCV policies. Can certain contract types be designed to mitigate the risks of "cozy relationships"?

6. Relationship-based strategies to improve software development projects

While Chapter 5 focused on explaining how the RMCCV and relational capital impact project results, answering this thesis' first overarching research question, Chapter 6 tests policies and different combinations identified through interviews with project managers and the wider literature. This analysis extends to explore the synergistic effects of combining these policies, ultimately aiming to provide concrete strategies for improving project outcomes in terms of costs, schedule, and quality, answering the thesis's second overarching research question. Chapter 6 embodies the thesis's dedication to actionable knowledge, presenting novel strategies, and identifying pathways for more detailed policy exploration in future work. While the most impactful policies and combinations are prioritized in Chapter 6, Appendixes 8 and 9 offer a comprehensive listing of all explored policies, including those with less significant effects on the core discussion.

Causal relationship	
Gaps addressed	Combination of the RMCCV and relational capital; Their combined impact in project results using Hybrid Agile methodologies;
Research questions	• Which strategies can be used to leverage the relational motive to co-crate and relational capital for better project results in terms of cost and schedule?
Overarching research questions	• How do the relational motive to co-create value (RMCCV) and relational capital impact project results in terms of cost and schedule? • How can service providers leverage the relational motive to co-crate value and relational capital for better project results in terms of cost and schedule?

Sousa, J., Rouwette, E.J.JA, Bloemer, J.M.M., Jacobson, J., Malczynski, L. (2025). *Relationship based strategies to improve software development projects.*

6.1 Abstract

Client-centric hybrid project management methodologies offer a unique advantage for improving project outcomes: attending to relationships. The collaborative nature of software development project teams fosters personal relationships, emphasizing the importance of motivating team members and cultivating relational capital to drive project success. Despite this recognition, research on strategies leveraging the relational motive to co-create and relational capital to enhance project outcomes is limited. This study addresses this gap by conducting an in-depth investigation of relationship-oriented policies identified in the literature, validated by experienced project managers, and tested in a System Dynamics simulation model. The findings underscore the critical role of staffing policies in the effectiveness of various relationship-oriented policies. Additionally, the study demonstrates that a combination of policies aimed at increasing capacity, fostering relational capital, and controlling overly close relationships is more efficient than individual policies, resulting in reduced cost and schedule overruns. For instance, pairing staffing adjustments with improved feedback systems and external project management support resulted in a marked reduction in cost and schedule overruns. This study explores the synergies between the policies, suggesting a set of actionable policies and insights for enhancing software development project results, and identifies potential avenues for future research to expand the repertoire of accessible policies for improving project outcomes.

6.2 Introduction

While hybrid project management methodologies were initially lauded for their potential to enhance software development outcomes (Reiff and Schlegel, 2022; Křivánková and Remta, 2023), their actual performance has been mixed (Kuutila *et al.*, 2020; Patel, 2021). A factor often overlooked is the critical role of customer involvement, where the permanent interactions within project teams (Yahya and Maidin, 2023) foster the emergence of personal relationships. These relationships highlight the importance of motivating the teams to co-create and manage relational capital to drive project success, as demonstrated in Chapter 5. Nevertheless, this still begs the question of how to leverage relationships to optimize project results.

Building upon the findings from Chapter 5, this chapter extends the research, aiming to address the following research question: How can service providers leverage the relational motive to co-create value (RMCCV) and relational capital for better project results in terms of cost and schedule? To comprehensively answer this research question, This study expanded upon the existing model and findings, exploring relevant literature to identify potential policies and their combinations and conducting in-depth interviews with project managers. This expansion directly informs this investigation into several key areas, including: (1) The efficacy of isolated strategies**:** Can project overruns be solved using strategies for staffing, RMCCV, relational capital, or scheduling independently? (2) The power of combined approaches: How do combinations of these policies impact project outcomes? and (3) Addressing dynamic project environments**:** How can companies effectively deal with changing requirements, a common reality in software development projects?

After identifying the policies and their combinations, these were tested with the established model developed in Chapter 5. The conscious choice to test specific strategies and their combinations in an incremental way rather than optimizing the model provides significant methodological advantages. First, this approach enhances understanding of the underlying structural relationships driving project behavior. For example, testing staffing policies in isolation allows for observation of how increased capacity directly affects service capacity and the resulting dynamics affecting the project's performance, revealing the specific causal pathways that might be obscured in an optimized solution where multiple variables change simultaneously. Second, our exploratory approach enables the discovery of unexpected policy interactions and previously unconsidered interventions. Optimization approaches require researchers to predefine which variables to optimize and their permissible ranges, potentially constraining the discovery space to anticipated solutions. In contrast, our incremental testing approach allows for emergent insights, such as identifying when certain policy combinations produce counterintuitive results or when policies effective in isolation become ineffective when combined.

This methodological choice aligns with System Dynamics principles of learning about system structure through experimentation (Crielaard *et al.*, 2024; Rouwette, 2022). To test the policy results, a business-as-usual scenario that reflects the normal conditions in Company A's projects was established and a second more challenging scenario. The second scenario entails the acceptance of changes and new requirements to represent a pervasive common scenario projects face. Then isolated policies were tested, that allowed us to answer the sub-research questions, and only then explored the policy combinations to answer the main research question.

This Chapter outlines the sources of inspiration for policy selection (literature and interviews), describes the literature review, and explains how System Dynamics methodology was specifically applied to conceptualize these policies (e.g., leveraging goal-setting mechanisms to drive system changes) and implement their corresponding business rules within the model for this study. The paper then presents the policy testing and results, and discusses the theoretical and managerial implications. Finally, limitations are acknowledged and avenues for future research are proposed.

6.3 Methodology

The study employed a multi-method approach to identify and test policies that can be used to improve project outcomes in terms of costs and schedule. This study relied on the literature review and the interviews with experienced practitioners from Chapter 4, which provided qualitative data on project management processes, decision-making, and software development dynamics. Building upon the theoretical framework, qualitative data, and decision rules, we used the System Dynamics simulation model developed and validated in Chapter 5 to test the individual policies and their combinations inspired by the interviews and literature review.

6.3.1 Literature review

Chapter 5 lays the theoretical foundation for the model used to test various project management policies. Rather than seeking optimal policy combinations, this study focused on evaluating practical policies commonly used by practitioners and referenced in the literature. This approach aims to increase insight into the effectiveness of these policies in real-world project contexts and improves the learning experiences that result from the model experimentation. Through literature review and interviews with project managers, this study identified a set of policies that address key areas such as relationship management, capacity management, change management, and feedback and monitoring. These policies draw on insights from diverse fields including project management, System Dynamics, value co-creation, social capital, and relationship management from a marketing perspective.

From this literature review, a clearer understanding emerges of how problems arise in projects and the critical role of the probability of error generation. Errors are a recognized source of project issues that significantly influence policy effectiveness (Oliva and Sterman, 2010; Jalili and Ford, 2016; Li *et al.*, 2018; Lyneis and Ford, 2007; Rahmandad and Hu, 2010; Rebentisch *et al.*, 2018). These errors occur during project activities, leading to rework and increased effort, which in turn necessitates service capacity adjustments. Such adjustments can significantly affect the probability of error generation themselves (Oliva and Sterman, 2010; Sterman, 2000). Effective capacity management, involving the balancing of resource allocation, team experience, and addressing capacity gaps through strategies like hiring, overtime, or adjusting work intensity (Li *et al.*, 2018), is crucial for keeping the probability of error generation as low as possible. Project management literature broadly argues that effective capacity management strategies lead to improved project performance. This leads us to our first hypothesis:

- Hypothesis 1: Effective capacity management strategies, including appropriate staffing and workload balancing, can lead to improved project performance (e.g., lower costs, faster completion)

This hypothesis directly addresses our first sub-research question, allowing us to test common beliefs about whether staffing alone or scheduling alone are sufficient to solve common project overruns. However, our broader exploration reveals that these operational challenges are not isolated. Besides reacting to the project's execution results, capacity management strategies are closely tied, and even bounded, by planning and controlling activities, which play a vital role in project success.

While Project managers often slightly increase estimated task times to account for uncertainties, acknowledging a persistent trend to underestimate the total scope of the project (Austin, 2001; Abdel-Hamid and Madnick, 1991), this static approach often proves ineffective. This highlights the critical need to evolve towards continuous adjustment, a principle central to Agile methodologies (Sarangee *et al.*, 2022; Repenning, Kieffer and Repenning, 2017; Yahya and Maidin, 2023; Glaiel, Moulton and Madnick, 2014). Furthermore, the literature identifies the additional role of feedback and monitoring as an enabler. First, enhanced feedback and monitoring enable more efficient use of policies like schedule changes (Sarangee *et al.*, 2022; Repenning, Kieffer and Repenning, 2017; Yahya and Maidin, 2023; Glaiel, Moulton and Madnick, 2014). Second, improved control contributes to better capacity management as demonstrated in Chapters 4 and 5. This leads to our second Hypothesis:

- Hypothesis 2: Regular feedback and monitoring can identify and address issues early, leading to better project outcomes and efficient relationships.

While effective planning, continuous adjustment, and robust feedback and monitoring mechanisms are undeniably crucial for managing project uncertainties, capacity, and schedule (as discussed above), their ultimate efficacy is profoundly shaped by the underlying relational dynamics among project stakeholders. It is within this context that effective relationship management emerges as pivotal for identifying and implementing innovative policy solutions that significantly enhance project outcomes. Research indicates that successful relationship management is critical for project success across various industries.

In this research context, relationship management encompasses two key aspects, both crucial for project success. Firstly, it acts as a safeguard against the development of detrimental "cozy relationships", where a lack of critical scrutiny, compromised standards, or insufficient adherence to project goals can undermine overall quality and objectives. Effective relationship management fosters an environment that encourages the acceptance of monitoring instruments, adherence to quality standards, and the pursuit of challenging project goals (Anantatmula, 2010; Sarangee *et al.*, 2022; Patel, 2021; Franck *et al.*, 2017). Feedback mechanisms, in particular, are instrumental in this process, not only for rigorous project control but also, crucially, for effectively managing expectations. By providing project teams with continuous access to development data and milestones, regular quality assessments necessitate ongoing adjustments of expectations, resulting in a more realistic understanding of project outcomes.

On the other hand, relationship management also actively improves the entire project system through proactive engagement. For instance, investing in client knowledge development can significantly enhance value co-creation (Neghina *et al.*, 2015), which directly improves project results (Fatema and Sakib, 2018; Swart, Bond-Barnard and Chugh, 2022; Křivánková and Remta, 2023). Similarly, integrating account managers into project teams (Grönroos, 2011; Autry and Golicic, 2010; Johnsen and Lacoste, 2016) can lead to increased capacity and improved quality control. Other individual policies considered, such as providing external project management support (Anantatmula, 2010;

Meng and Boyd, 2017) and establishing a goal for the level of relational capital (Abdel-Hamid, 1999; Meng and Boyd, 2017; Neghina *et al.*, 2015; Villena, Choi and Revilla, 2021), aim to enhance coordination, prevent the pitfalls of cozy relationships, and ultimately maintain adequate levels of this vital capital. Based on these multifaceted benefits, we propose the following hypothesis:

- Hypothesis 3: Projects that prioritize relationship management, such as investing in client training, integrating account managers, or using benchmark goals, will achieve better outcomes in terms of cost and schedule.

Finally, no comprehensive reflection on project management is complete without addressing change management and the critical ability to manage project scope. This is consistently cited by practitioners as one of the most paramount factors for project success. Effective scope management, the ability to judiciously reduce scope when necessary or adeptly adapt to new requirements, presents a significant challenge for project managers, as widely acknowledged in the literature (Lyneis and Ford, 2007; Godlewski, Lee and Cooper, 2012; Glaiel, Moulton and Madnick, 2014; Rebentisch *et al.*, 2018).

While traditional project management approaches often rely heavily on robust monitoring and feedback mechanisms, as highlighted by numerous System Dynamics studies (e.g., (Cao, Ramesh and Abdel-Hamid, 2010; Yahya and Maidin, 2023)), the poor results reported by specialized media suggest that these mechanisms alone are often insufficient to fully address the complexities of scope management. This is primarily because established relationships within and between project teams can profoundly influence their responses to project decisions and the overall management of change. In conclusion, successful project outcomes are contingent upon proactive scope management, a process intricately intertwined with effective monitoring and feedback mechanisms and, crucially, significantly impacted by the accumulated relational capital within the project ecosystem. This leads us to our fourth hypothesis:

- Hypothesis 4: Good feedback and monitoring practices, combined with strong relationships, can facilitate effective change management by fostering open communication and collaboration, thereby enabling efficient access to a wider range of beneficial policies.

To empirically investigate effective strategies for leveraging the RMCCV and relational capital to enhance project outcomes, a System Dynamics model was developed. The approach began by establishing a baseline 'business-as-usual' scenario reflecting Company A's typical project management practices, as detailed in our model specification in Chapter 4. Then it was systematically evaluated the impact of individual staffing, relational motive, and scheduling policies in isolation, addressing a key sub-research question about the sufficiency of isolated interventions. This initial analysis provided a robust foundation for subsequent testing of comprehensive policy combinations. These combinations were strategically designed to identify effective strategies for leveraging the RMCCV and relational capital, ultimately achieving improved project outcomes in terms of cost, schedule, and quality. This detailed simulation approach was further grounded and refined by qualitative insights gleaned from interviews with experienced project managers, enabling us to comprehensively address the core research question: How can service providers leverage the RMCCV and relational capital for better project results in terms of cost and schedule?

6.3.2 Interviews

To answer the research question through an inductive lens, a partnership was established with Company A, a renowned Portuguese software development company with diverse clients across various industries and over two hundred employees. While searching for project managers exceeding three years of Agile/Hybrid practice and managing projects longer than six months, 11 project managers were interviewed (ten male, one woman, averaging 6.5 years of Agile/Hybrid experience) with diverse industry backgrounds.

Semi-structured interviews were conducted (Appendix 4) from mid-April to mid-May 2023, lasting one to one-and-half hours each, to gain in-depth insights from project managers on the software development process and preferred strategies. A 32-question questionnaire provided structure while allowing flexibility for project managers' perspectives. Divided into three sections, the questionnaire captured project managers' experience and project characteristics (framing section), their application of methodologies (methodology section), and team-customer relationships and their evolution (relationship section). This structured yet flexible approach allowed us to capture their experiences, decision-making, and mental models.

To analyze the interview data, the study employed a content analysis approach, following the guidelines of Miles and Huberman (1994). This involved a systematic process of data reduction, data display, and data drawing conclusions. Specifically, the process followed the approach:

1. Data reduction: Initially, the transcripts were read multiple times to familiarize ourselves with the data and identify preliminary themes. Then, the interview transcripts were systematically coded across multiple rounds using Excel, iteratively identifying key themes and categories emerging from the data.
2. Data display: The coded data was organized into matrices and charts to visually represent the findings. This facilitated pattern recognition and identification of relationships between themes and categories, particularly concerning the interplay of traditional project management aspects and relational dynamics.
3. Data drawing conclusions: We interpreted the patterns and themes identified in the data to draw conclusions directly relevant to our research questions and the design of policies for the System Dynamics model.

By systematically coding and analyzing the interview transcripts, it was possible to identify both corroborating findings from the literature and novel insights directly from practice, which will be discussed in detail in the following section.

6.3.3 System Dynamics

System Dynamics emerged as the ideal choice for our research due to several factors. From the methodological perspective, System Dynamics is a well-suited methodology for tackling complex systems characterized by feedback loops, nonlinearities, delays, and stock-and-flow relationships (Sterman, 2000; Gao and Zhang, 2022). Its strength lies in its ability to integrate diverse knowledge domains (Zimmermann and Curran, 2023) and stakeholder perspectives (De Gooyert et al., 2017), making it particularly apt for our research, which draws upon project management, value co-creation, relational capital, and System Dynamics theories. By combining qualitative and quantitative approaches, System Dynamics enables the development of formal theories and the exploration of complex causal relationships (Homer, 1996; Rouwette, 2022). Moreover, System Dynamics's simulation capabilities allow for policy experimentation, facilitating the identification of effective strategies and avoiding costly trial-and-error approaches (Crielaard et al., 2024). The policy experimentation is particularly valuable in our context, where the involvement of diverse stakeholders, including management teams, project managers, development teams, and users, necessitates a holistic understanding of the structures that support the software development system and their interconnections.

From a project management perspective, System Dynamics has been extensively employed in software development project management since the late seventies. In the context of Agile projects, System Dynamics has been applied to study overall project dynamics (Cao, Ramesh and Abdel-Hamid, 2010; Glaiel, Moulton and Madnick, 2014; Van Oorschot, Sengupta and van Wassenhove, 2009), the transition from traditional to Agile methods (Sarangee *et al.*, 2022), and the potential of hybrid approaches (Imani, Nakano and Anantatmula, 2017). Additional studies have examined team dynamics and productivity (Ching and Mutuc, 2018; Fatema and Sakib, 2018), iteration length effects (van Oorschot, Sengupta and Van Wassenhove, 2018), product development (Rebentisch *et al.*, 2018), and project performance (F. Tripp and Armstrong, 2018).

From a relationships management perspective, several characteristics justify the use of System Dynamics as a method to support the testing of the theory presented in Chapter 5, explaining how the RMCCV and relational capital affect project outcomes. Software development takes place in a complex and dynamic environment (Spohrer and Maglio, 2008; Jaakkola and Alexander, 2014) and requires a multidisciplinary approach (Meng and Boyd, 2017), evolving over time, as do relationships, where the existence of delays and the nonlinear nature of relationship development have important roles. Taken together, these characteristics make System Dynamics a suitable method to produce a comprehensive explanation (Sterman, 2000). The model was developed upon existing models of Agile projects (Cao, Ramesh and Abdel-Hamid, 2010; Glaiel, Moulton and Madnick, 2014), adding a Hybrid approach (Imani, Nakano and Anantatmula, 2017), and incorporating new structures that capture RMCCV policies and the impact of relational capital accumulation and specific variables from the interviews. The next section presents a detailed analysis of the policies designed to improve projects results. The model that supports the policy analysis was already presented in detail in Chapter 5 as well as its validation and parameter estimation strategy.

6.4 Results

6.4.1 Results from the interviews

This section presents the findings of the in-depth interviews with project managers, focusing on the policies they recognize, actively employ, or tend to neglect in practice. The qualitative content analysis reveals three primary categories of policy adoption, reflecting underlying patterns in project management approaches and challenges: (1) widely used policies, (2) policies used less frequently, and (3) policies that are rarely used.

As expected the policies widely used by project managers primarily encompass traditional, reactive responses to project pressures: changing schedules, work intensity, overtime, and hiring. Over 90% of project managers try to include slack time in planning although it is not always possible due to competition. A similar proportion of project managers adjust sprint capacity permanently while adhering to maximum workforce rules and seeking a desired mix of experience. Understaffing is also prevalent due to growth pressures within Company A. Finally, project managers try to keep a tight control with additional requirements attempting to charge additional fees and negotiate schedule extensions. These findings highlight a strong reliance on conventional resource and schedule management tactics, often in response to immediate operational demands.

Less frequently used policies include account management involvement despite being recognized as important for client relationships and project alignment. External project management support is increasingly used, primarily at the client's initiative. Other policies like adjusting sprint duration and staff rotation are less used due to potential planning issues. Finally, project managers often attempt to negotiate scope reductions but have limited success, suggesting challenges in managing stakeholder expectations and priorities. These patterns indicate a gap between recognized importance and actual implementation, particularly for policies requiring upfront investment or strong inter-organizational collaboration.

In stark contrast to the widely used reactive methods, a distinct set of policies was rarely implemented by project managers despite their potential for proactive and preventative impact. This category includes investment in client training, a measure broadly recognized as valuable for enhancing client knowledge and fostering value co-creation by aligning expectations, sidelined due to perceived time constraints and a prevalent short-term focus within project teams. It also includes the proactive improvement of formal feedback mechanisms and a strategic increase in direct monitoring of project progress and quality from the client's perspective. While there is an evident focus on internal project control within the service provider's team, crucial and structured feedback sessions designed to identify and address deviations early are rare. Finally, a significant and pervasive omission is the widespread lack of formalized quality indicators. Project managers predominantly rely on perceived cost and schedule overruns as their primary performance metrics. These metrics are influenced by an inherent optimism bias that delays necessary corrective actions, an effect well-documented in the dark side of relationships (DSR) literature (Villena, Choi and Revilla, 2021).

The interview findings collectively highlight project managers' prevailing preferences for reactive, traditional responses, driven by immediate operational pressures. While there is an emerging, albeit limited, recognition of the value of more proactive and strategic approaches, particularly those involving client relationships and external support, their consistent implementation remains a challenge. These observed patterns in policy adoption, from prevalent traditional methods to underutilized relational strategies, directly inform the design and testing of policies within our System Dynamics model. Specifically, they provide the empirical basis for the 'business-as-usual' scenario and justify the selection of specific staffing, relationship management, and scope control policies for detailed simulation and analysis, allowing a deep investigation about their individual and combined impacts on overall project outcomes and address our study's research question regarding effective strategies for leveraging RMCCV and relational capital.

6.4.2 Results: Policy analysis

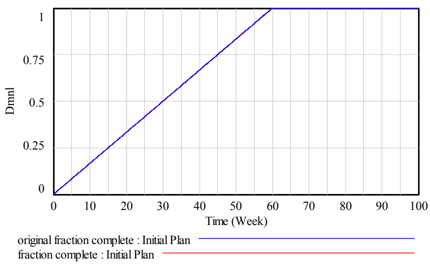
Building on the insights from the literature review and interviews, which underscore the critical role of relationships as a powerful leverage point for improving project outcomes, this study developed a System Dynamics simulation model. This model uniquely integrates common processes and strategies from traditional project management and System Dynamics with an innovative relationship layer. This relational component is a major innovation of this thesis, allowing the exploration of dynamics not typically captured by conventional models.

After rigorous validation of the model's effectiveness (as detailed in Chapter 5), this study gained the confidence necessary to explore a wide range of policy scenarios within a hypothetical project setting. Our analysis began by defining the initial conditions for an imaginary project, presented in Table 4, and its expected behavior according to the project plan, depicted in Figure 66. To establish a baseline for comparison, two initial scenarios were developed: a 'business-as-usual' scenario mirroring Company A's typical project performance in the financial market, including observed overruns; and a second scenario that builds on the first by incorporating changes and new requirements, reflecting the most common project dynamics identified by project managers.

A layered approach was developed to systematically investigate the impact of different policies. Initially, the effects of individual policies were analyzed, such as staffing, scheduling, and relationship management, in isolation. This phase addressed the sub-research questions, providing important insights into the potential benefits of each policy. Subsequently, the study explored the combined effects of multiple policies, progressively increasing the complexity of the scenarios. By testing a total of 40 policy combinations, it was possible to identify effective strategies for leveraging the RMCCV oriented policies and relational capital to optimize project outcomes, answering our main research question. Appendix 9 provides a detailed analysis of all 40 combinations, allowing the following discussion to focus on the most interesting and impactful policies and their combinations.

Table 4 - Initial plan's conditions

Initial Plan			
Hours planned			9600
Team Planned (in experienced equivalent employees)			4
Number of Sprints			30
Project Deadline (Weeks)			60
Cost	€/Week	N. Resources	Total Cost
Experienced	€ 1.000,00	5	€ 300.000,00
Rookies	€ 600,00	2	€ 72.000,00
Total			**€ 372.000,00**



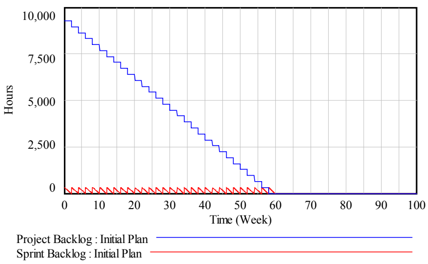


Figure 66 – Initial Plan's project development

Before delving into the simulated policy analyses, it is essential to contextualize the findings by examining the real-world project performance that underpins our 'business-as-usual' scenarios. Figure 67 illustrates the reference modes for schedule results derived from the Company A projects detailed in Chapter 4. This reveals a notable trend: three out of four hybrid projects experienced significant delays. Further complementing this, Table 5 presents a comprehensive overview of actual cost and schedule overruns across all projects, confirming the concerning statistics initially highlighted in Chapter 1.

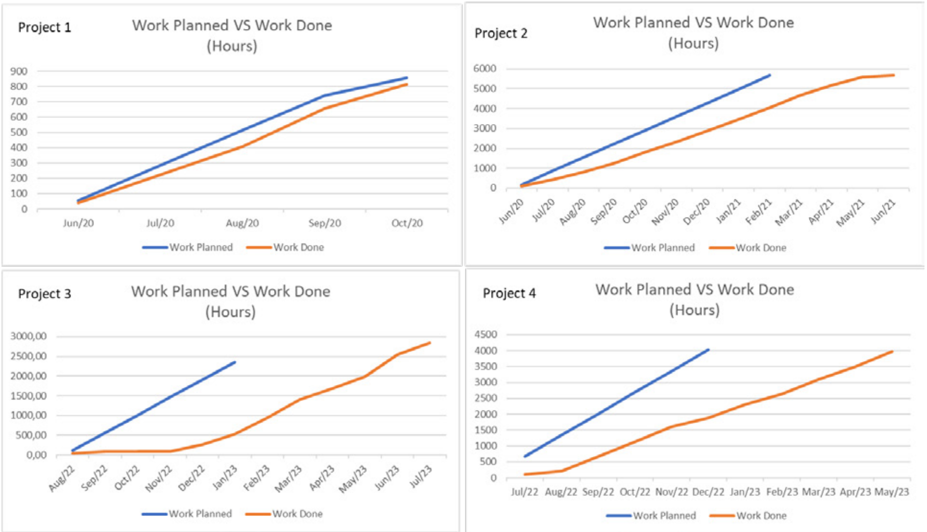


Figure 67 – Reference modes for schedule in Company A's hybrid projects

Table 5 reveals an average cost overrun of 17% and a substantial schedule overrun of 58%. These figures, alongside other qualitative data from these projects, strongly suggest a higher organizational tolerance or focus on managing costs over schedules. However, this observation is nuanced: unlike some industries, many professional service firms, such as Company A, do not directly factor overtime costs into project budgets. This means that extending working hours may not necessarily translate into higher reported project expenses. Additionally, professionals might be incentivized to register their working time on other projects when a particular project faces severe cost overruns, further skewing cost visibility. These real-world dynamics were critical in shaping the parameters and behavior of our baseline simulation scenarios.

Table 5 - Cost and schedule analysis for company A's projects

Project	Type	Cost			
		Plan	Real	Diference	%
1	Hybrid	€ 23.778,88	€ 25.536,72	€ 1.757,84	7,39%
2	Hybrid	€ 136.353,45	€ 141.726,35	€ 5.372,90	3,94%
3	Hybrid	€ 56.212,98	€ 62.741,33	€ 6.528,35	11,61%
4	Hybrid	€ 109.782,00	€ 159.560,00	€ 49.778,00	45,34%
	Average for cost	€ 81.531,83	€ 97.391,10	€ 15.859,27	17,07%
Project		Schedule (weeks)			
		Plan	Real	Diference	%
1	Hybrid	15	17	2	13,33%
2	Hybrid	33	48	15	45,45%
3	Hybrid	21	40	19	90,48%
4	Hybrid	24	44	20	83,33%
	Average for schedule	23	37	14	58,15%

Exploring the Base Cases – Business as Usual (Company A's project realities)

6

Our analysis of policy impacts begins with an in-depth exploration of base case scenarios, reflecting Company A's typical project performance in the finance sector. These scenarios integrate common project management practices, providing a crucial benchmark for evaluating subsequent policy interventions. The initial base case leverages Company A's standard operational policies, which include targeting 50% experienced team members and implementing a permanent adjustment to sprint capacity. Additionally, this base case incorporates the two most preferred responses by project managers to project imbalances: adjusting work intensity and utilizing overtime.

Figure 68 depicts the simulated outcomes under these business-as-usual policies. The project exhibits a schedule overrun of 58.85% (35.31 weeks), almost perfectly replicating the 58.15% average overrun observed in our real-world data (Table 5). Conversely, the simulated cost overrun of 10.53% ($39,174) falls below the real-world average of 17%. It's crucial to note, however, that the real-world cost overrun average may be skewed by a single outlier project from our dataset, which presented four times the cost overrun of the next highest project. Despite operating at peak intensity and incurring significant overtime, the existing team consistently falls short of the desired service capacity in this base case, which in turn elevates the risk of errors. Interestingly, the limited use of formal measurement tools in this scenario allows relational capital to rebound after an initial decline, even surpassing pre-project levels. This aligns with project manager observations (discussed in the interview results) and company data, suggesting that stronger relationships can mitigate the negative impact of deteriorating project outcomes. Furthermore, these findings resonate with Company A's broader business context, where clients continue to engage the company despite facing substantial project overruns, perhaps indicative of high relational capital buffering performance issues.

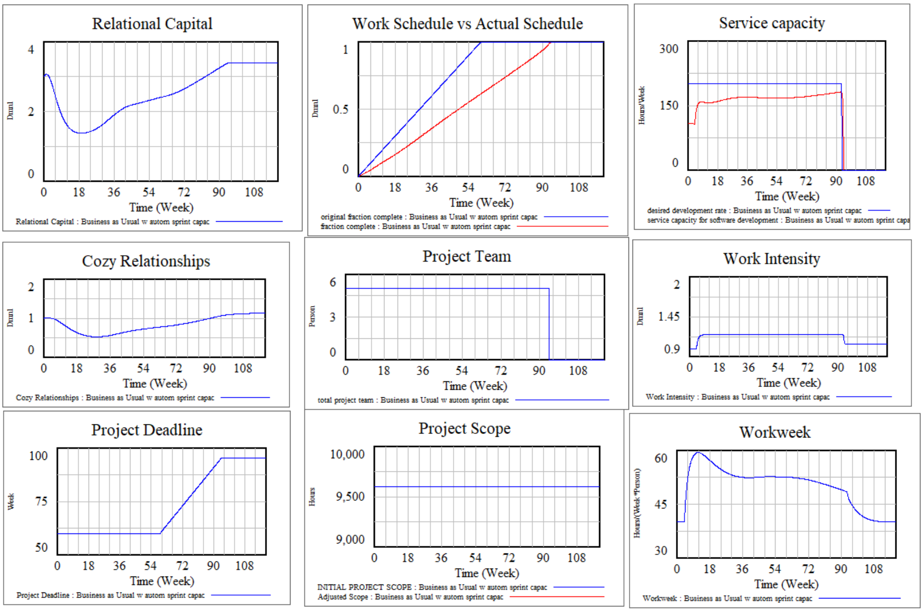


Figure 68 – Summary of the Business as Usual scenario

To further reflect real-world complexities, the impact of scope creep, a common cause of project overruns, was simulated by introducing additional work hours for changes and new requirements. By allocating 32 hours for changes and 64 hours for new requirements per sprint, the project's total workload increased from 9,600 to 11,129 hours. As a direct result, the project duration extended to 113 weeks, representing a significant 89.48% schedule overrun. Project cost also escalated to $494,111, resulting in a 32.83% cost overrun, aligning with the real-world observations discussed in Chapter 1. The negative impact of scope creep on project performance was further exacerbated by a sharp decline in relational capital. The introduction of changes and new requirements strained relationships between project stakeholders, leading to a significant decrease in collaboration. Although some recovery was observed towards the end of the project, the initial erosion of shared goals and expectations had a lasting impact on overall project outcomes.

With these baseline models established (representing projects both with and without the complexities of changes and new requirements), the research can now proceed to simulate the impact of various policy interventions. The analysis will begin by examining the individual effects of policies related to staffing, scheduling, and relationship management, thereby isolating the impact of each and directly addressing our sub-research questions. A detailed analysis of all tested policies and combinations can be found in this chapter and Appendix 9.

6.4.2.1 Policy 1 – Staffing

Staffing strategies are widely recognized as a critical factor influencing project success and a primary lever for project managers in traditional settings. As work intensity and overtime are already incorporated into our model as automatic responses to increased workload, this section focuses on exploring various staffing strategies, including the number of staff and their experience levels. This analysis aims to isolate the impact of staffing interventions, contributing to our understanding of whether traditional policies alone can effectively address project challenges.

Before delving into specific staffing policies, it is important to recall the **business-as-usual (BAU) base case scenario**, which reflects Company A's typical project performance with inherent overruns. As presented in the previous section, this BAU scenario exhibits a significant schedule overrun of 58.85% and a cost overrun of 10.53%. All staffing policies analyzed in this section are measured against this baseline, and their key results are summarized in Table 6.

Table 6 - Summary of staffing policies' results

Policy #	Simulation	Schedule		Cost	
		Weeks	**% Overrun**	**Total Cost**	**% Overrun**
Base Case	**Business as Usual With Automatic Adjustments**	**95,31**	**58,85%**	**€ 411.174**	**10,53%**
Policy 1.1	Staffing: No understaffing	66,31	10,52%	€ 412.741	10,95%
Policy 1.2	Staffing: Hiring 50% Rookies	65,37	8,95%	€ 491.297	32,07%
Policy 1.3	Staffing: Hiring 80% Rookies	73,56	22,60%	€ 540.718	45,35%
Policy 1.4	Staffing: Hiring 20% Rookies	62,06	3,43%	€ 443.013	19,09%

Our initial simulation, Policy 1.1 ('No understaffing'), explores a scenario where the project commences with appropriate staffing levels as per the original plan, rather than the common practice of initial understaffing. This approach requires careful initial staffing planning, particularly considering the time senior employees must allocate to training new hires and non-project tasks. The results from starting the project according to the plan are encouraging when compared to the BAU, significantly reducing the schedule overrun to only 10.52% and leading to a manageable cost overrun of 10.95%. These modest overruns are primarily attributed to the persistent rework cycle, which is typically not fully accounted for during initial planning. Interestingly, despite these overruns, relational capital thrives throughout the project in this scenario, nearly reaching its peak by completion. This behavior of relational capital, coupled with the relative shortness of the overruns, suggests that the standard monitoring tools in place may experience rising complacency under these less stressful conditions.

The second set of scenarios tests the staffing strategy against Company A's most common practice – starting the project understaffed. From extensive simulation, it became clear that with severe initial understaffing, policies that fail to correct the service capacity gap remain largely inefficient. While hiring appears as a straightforward solution to address service capacity imbalances, it presents significant challenges. Integrating new team members necessitates additional training and mentoring, impacting service capacity in the short term. Furthermore, staff availability constraints can lead to lengthy delays between the decision to hire and actual onboarding. To explore the hiring strategy further, three distinct scenarios were tested:

- Policy 1.2 (Company A's financial market rule): This scenario reflects Company A's existing policy in the financial sector, aiming for a 50% rookie ratio in new hires.
- Policy 1.3 (Company A's general industry mental model): This scenario tests Company A's usual approach in other industries, targeting a higher rookie ratio of 80%.
- Policy 1.4 (Improve the experience level): This scenario investigates an alternative approach, based on Kunc's (2008) research, aiming for a lower rookie ratio of only 20%.

In scenarios with initial understaffing (Policies 1.2, 1.3, 1.4), severe pressure to meet deadlines forces work intensity to remain high, and overtime is heavily utilized throughout the project. As these internal solutions are often insufficient to correct the overrun, hiring becomes necessary. Testing Policy 1.2 (hiring 50% rookie employees) led to a significant reduction in schedule overrun (from the BAU's 58.85% to 8.95%), but resulted in a substantial increase in cost overrun (from 10.53% to 32.07%). To mitigate these cost implications, Policy 1.3 was explored, which increased the proportion of rookie employees to 80%, a prevalent business model in IT companies according to the interviews with project managers. Counterintuitively, this policy worsened both schedule and cost performance, leading to a 22.60% schedule overrun and a 45.35% cost overrun, demonstrating the detrimental impact of excessive inexperienced staff.

To optimize the staffing mix, Policy 1.4 (depicted in Figure 69) was tested, which reduced the proportion of rookie employees to 20%, as argued by most project managers interviewed. This strategy yielded the most favourable results among the three tested hiring approaches, achieving a minimal 3.43% schedule overrun and a 19.09% cost overrun. This superior performance can be attributed to several factors. Firstly, investing in experienced staff increased accumulated relational capital, fostering efficient collaboration and knowledge sharing. Secondly, reduced reliance on overtime minimized error rates and improved overall project efficiency. Finally, lower training requirements for experienced staff increased their allocation to development tasks, requiring less overall labour and shortened overall project duration.

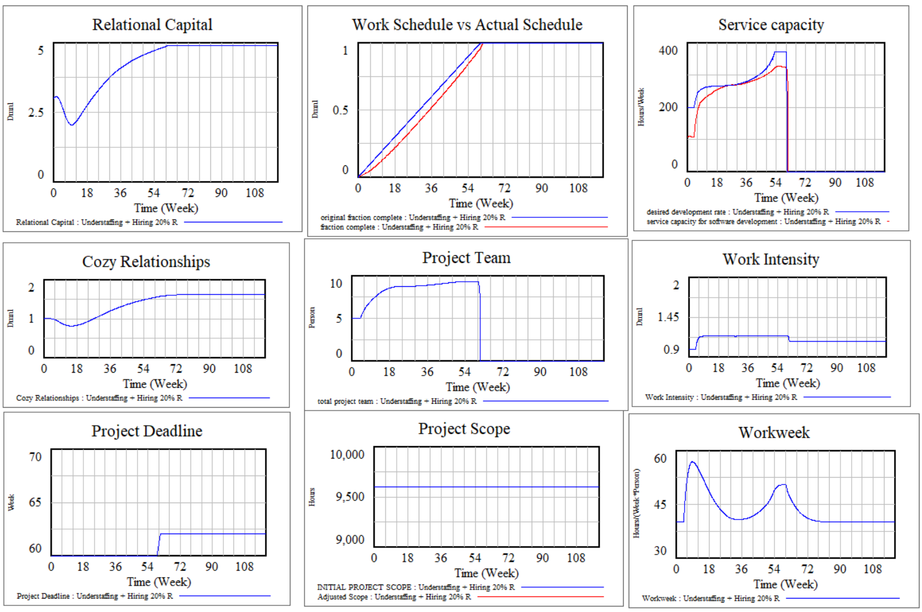


Figure 69 – BAU with hiring 20% of rookies

Overall, the simulation results from the isolated staffing policies provide nuanced insights regarding Hypothesis 1, which posited that staffing strategies alone could comprehensively resolve project overruns. While Policy 1.4, emphasizing the hiring of a larger proportion of experienced employees (specifically a 20% rookie ratio), demonstrated remarkable success in mitigating schedule overruns (a significant reduction from 58.85% in the BAU to a minimal 3.43%), it concurrently led to an increase in cost overrun (from 10.53% to 19.09%). This outcome suggests that even the most effective isolated staffing strategy yields mixed results, achieving substantial improvements in one critical dimension (schedule) at the expense of another (cost). Therefore, while staffing adjustments are powerful levers for improving project performance, their individual application appears insufficient to fully eliminate all forms of overruns or achieve simultaneous optimization across all project dimensions. This finding underscores the complex interplay of project dynamics and highlights the necessity of exploring synergistic effects from combined policies, which will be explored later.

6.4.2.2 Policy 2 – Business-as-usual with adjusting schedules

The next policy tested involved postponing schedules. As expected, this strategy alone did not significantly improve the project's performance, as illustrated in Figure 70. The project still experienced a similar schedule overrun (around 58%) and cost overrun (10.53%). While postponing schedules can potentially reduce team pressure and the likelihood of errors, in the context of our baseline scenario, the substantial gap between required and actual service capacity maintained a high level of pressure on the team, negating the potential benefits of schedule postponement. The results do not confirm Hypothesis 1 regarding the effectiveness of the individual application of schedule strategies because overruns remain unchanged.

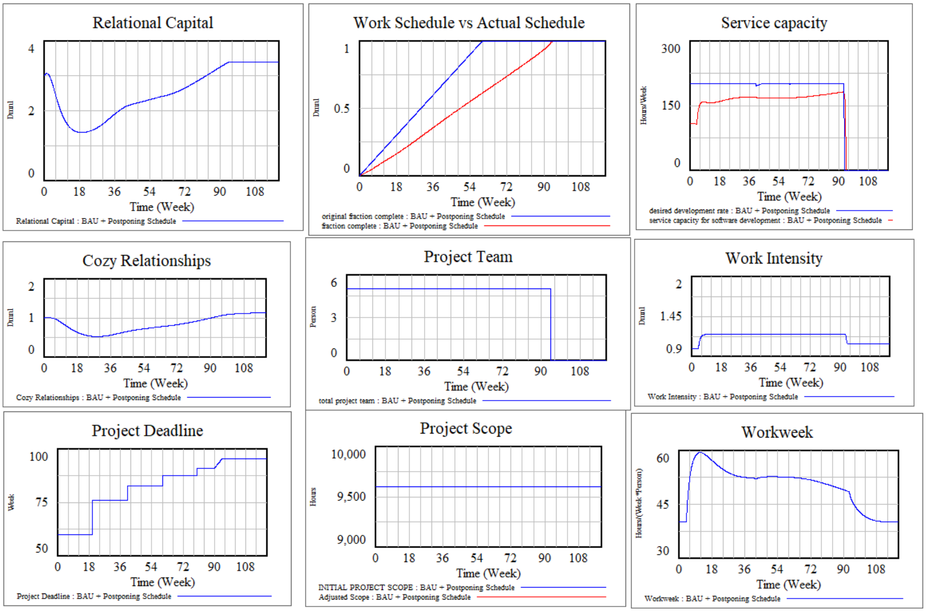


Figure 70 – BAU with postponing schedule

6.4.2.3 Policy 3 – Relational motive to co-create value strategies

While the previous analysis demonstrated that staffing and scheduling strategies cannot fully address the root causes of project challenges, this study now turns its attention to relational motive-based policies. These policies, rooted in fostering strong relationships and collaboration, offer a promising avenue for improving project performance. To assess the individual impact of these policies, the conducted simulations, isolated each policy to understand its standalone effects. The results of these individual relational policy simulations are comprehensively depicted in Table 7.

Table 7 - Summary of relational oriented policies' results

Policy #	Simulation	Schedule		Cost	
		Weeks	**% Overrun**	**Total Cost**	**% Overrun**
Base Case	**Business as Usual With Automatic Adjustments**	**95,31**	**58,85%**	**€ 411.174**	**10,53%**
Policy 3.1	Improving feedback mechanisms	91,06	51,77%	€ 392.107	5,41%
Policy 3.2	Training	92,12	53,53%	€ 396.869	6,69%
Policy 3.3	Account Management	93,75	56,25%	€ 407.837	9,63%
Policy 3.4	External PM capacity	85,94	43,23%	€ 411.673	10,66%
Policy 3.5	Increase Monitoring	92,5	54,17%	€ 403.129	8,37%

6.4.2.3.1 Policy 3.1 – Business-as-usual and improving feedback mechanisms

Enhancing feedback mechanisms emerges as a key recommendation, supported by both project managers and academic literature (Komulainen, 2014). While Company A currently monitors deadlines and work completion, this policy proposes enhancing feedback mechanisms by comparing values for error probability, service capacity, and cost, with their expected value. These measures are feasible for Company A, as systems for them are common in software development. This introduces three additional quality control measures, directly impacting customer perceptions and, consequently, the accumulation of relational capital, using the Parasuraman et al. (1985) approach to measure quality gaps (the difference between expected and perceived quality) for these five items.

Policy 3.1 isolates the impact of these enhanced feedback mechanisms within the context of initial understaffing (depicted in Figure 68). The results show encouraging improvements compared to the baseline scenario: schedule overruns decrease from 58.85% to 51.77%, and cost overruns drop from 10.53% to 5.41%. This positive shift is primarily attributable to stricter monitoring, which reduces the probability of error generation (red line in Figure 71), leading to less rework and a reduced overall workload. Interestingly, compared to the base case, relational capital and the potential for 'cozy relationships' remain lower in this scenario. This outcome is explained by the inclusion of expanded metrics fostering clearer expectations and more realistic perceptions of performance, derived from a broader range of data points.

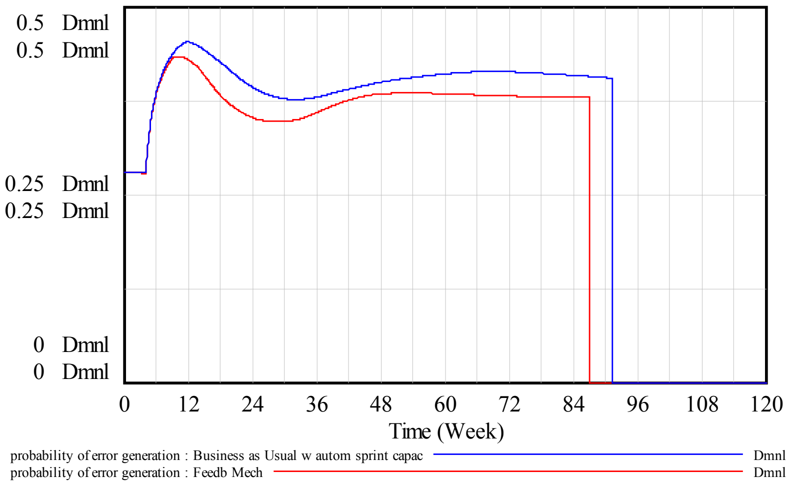


Figure 71 – Probability of error generation for Business as Usual VS Improving feedback mechanisms

6.4.2.3.2 Policy 3.2 – Business-as-usual and training the client's team

Policy 3.2 investigates the challenges and potential of investing in training and development, aligning with the RMCCV research emphasis on co-creation and customer resource development (Karpen, Bove and Lukas, 2012). Literature suggests that improving customer knowledge (Komulainen, 2014) and service provider collaboration skills (Lusch, Vargo and O'brien, 2007) can significantly impact results by fostering individual and collective learning (Pillai *et al.*, 2017). The model incorporates the positive effect of training on service capacity but also acknowledges the time investment required from the team (at least 2 hours per week). While Policy 3.2 improves outcomes, with schedule overruns reduced to from 58,85% in the business-as-usual scenario to 53,53%, and cost overruns cut from 10,53% to 6,69%%, the trade-off in team time warrants further consideration due to its potential.

6.4.2.3.3 Policy 3.3 – Business-as-Usual with account management

Policy 3.3 simulates account management, a prevalent practice in IT and consulting sectors that leverages matrix structures. This policy primarily aims to achieve two objectives: firstly, to increase the number of decision-makers and reduce over-reliance on specific resources (as discussed in earlier chapters), thereby expanding access to critical project information. Secondly, it fosters alternative problem escalation channels and facilitates solutions from diverse perspectives. For this simulation, we conservatively estimated the account management team requires 2 hours per week, acknowledging this may be insufficient for larger projects.

When implemented in isolation, account management yielded limited improvements in overall project outcomes, proving considerably less effective than Policy 3.1 (improving feedback mechanisms), as shown in Table 7. This aligns with expectations, as the chronic service capacity deficit persisted, necessitating sustained high work intensity and overtime. These enduring pressures likely contributed to increased errors and lower scores across the five evaluated quality items, consequently leading to low levels of relational capital.

6.4.2.3.4 Policy 3.4 – Business-as-usual with external project management support

Policy 3.4 investigates a common practice in software development projects and is recognized in the literature (Anantatmula, 2010; Meng and Boyd, 2017). The policy involves hiring external project management support, leveraging Company A's experience in both providing and receiving additional project management support. These external resources act as independent and unbiased team members, bolstering coordination and planning capabilities while remaining immune to internal pressures and existing relationships.

Policy 3.4, leveraging external project management support, demonstrates encouraging results in schedule overrun, reducing it to 43,23%, while almost maintaining the same cost overruns (10,66%). Relational capital also fails to fully recover to its baseline level. Positively, this policy generates the fewest errors among the relational motive-tested approaches, likely contributing to the lowest accumulated workload. While promising, the policy's effectiveness seems contingent on larger teams with adequate service capacity.

6.4.2.3.5 Policy 3.5 – Business-as-usual with increasing monitoring

Policy 3.5 focuses on enhancing project monitoring through the implementation of formal processes. This aligns with the literature emphasizing the importance of control (Payne, Storbacka and Frow, 2008) and customer experiences (Vargo and Lusch, 2016), which are fundamental to value perception (Komulainen, 2014). By establishing clear benchmarks and regular monitoring, this policy aims to prevent the erosion of project goals, while preventing complacency and inefficiency.

Despite these efforts, Policy 3.5 yielded suboptimal results, with a 54.17% schedule overrun and an 8.37% cost overrun. This suggests that, while monitoring and control are essential, they may not be sufficient to address the complex challenges inherent in project management. A more holistic approach, incorporating elements of collaboration, knowledge sharing, and relationship building, is likely to yield better outcomes.

6.4.2.3.6 Summary of Policy 3 – Relational motive to co-create value strategies

The individual simulations of relational motive-based policies, as comprehensively depicted in Table 7, demonstrate their capacity to mitigate project overruns to some extent. Schedule overruns were reduced, ranging from 43.23% to 56.35%, and cost overruns from 5.41% to 10.66%.

These findings partially confirm Hypothesis 1, which posited that testing Relational Motive to Co-Create Value (RMCCV)-oriented policies in isolation would improve results. While some policies, like Policy 3.4 (External PM support), showed significant improvements in schedule, and Policy 3.1 (Improving feedback mechanisms) in cost, the overall impact of any single relational policy proved insufficient to fully overcome the project overruns observed in the business-as-usual scenario. A key insight from this analysis is that, when implemented in isolation, relational motive policies tend to prioritize cost control over schedule adherence. This pattern continues the inherent bias observed in the business-as-usual approach, where managing costs often takes precedence, despite substantial schedule overruns.

Ultimately, while each of these isolated relational policies offers valuable contributions by addressing specific facets of project performance or relationship dynamics, their individual impact remains limited. This underscores the complexity of managing projects where multiple interacting factors contribute to overruns, suggesting the need for a more comprehensive and integrated approach, which we explore in the next section through the analysis of policy combinations.

6.4.2.4 Policies 4 - Combining two policies

The fourth group of policies explores the synergistic effects of combining two previously tested strategies. As per our simplification strategy, a detailed analysis of each specific two-policy combination is provided in Appendix 9. Table 8 below summarizes the key results of these combinations.

Table 8 - Summary of the results from combining two policies

Policy #	Simulation	Schedule		Cost	
		Weeks	**% Overrun**	**Total Cost**	**% Overrun**
Base Case	**Business as Usual With Automatic Adjustments**	**95,31**	**58,85%**	**€ 411.174**	**10,53%**
Policy 4.1	No understaffing with Improving feedback Mechanisms	65,5	9,17%	€ 407.529	9,55%
Policy 4.2	BAU + Improved feedback mechanisms + Postpone Schedule	91,08	51,80%	€ 392.107	5,41%
Policy 4.3	BAU + Hiring 50% rookies + Improving Feedback Mechanisms	64,25	7,08%	€ 482.149	29,61%
Policy 4.4	BAU + Hiring 80% Rookies + Improving Feedback Mechanisms	73,56	22,60%	€ 541.077	45,45%
Policy 4.5	BAU + Hiring 20% Rookies + Improving Feedback Mechanisms	61,25	2,08%	€ 439.631	18,18%
Policy 4.6	Improving feedback Mechanisms with Training	89,25	48,75%	€ 383.988	3,22%

Policy #	Simulation	Schedule		Cost	
		Weeks	% Overrun	Total Cost	% Overrun
Policy 4.7	Improving feedback mechanisms and Account Management	89,69	49,48%	€ 390.225	4,90%
Policy 4.8	Improving feedback mechanisms and Increase monitoring	89,56	49,27%	€ 389.819	4,79%
Policy 4.9	Improving feedback mechanisms and External Project Management Capacity	85,31	42,18%	€ 408.568	9,83%

The results of these combined policies are encouraging, demonstrating more significant improvements over the performance of individual policies. As observed, combinations that prioritized increasing service capacity (e.g., Policy 4.1, 4.3, 4.5) effectively reduced schedule overruns, though sometimes at the cost of higher cost overruns. More broadly, the findings confirm Hypothesis 2, indicating that improving feedback mechanisms (a key component in many of these combinations) and monitoring serve as crucial enablers. This is particularly evident for RMCCV-oriented policy combinations, where significant reductions in cost overruns (approaching 50% in some cases) were observed, confirming Hypothesis 3.

Given the comparative ease of implementing improved feedback mechanisms, as businesses typically possess the necessary systems and processes, the initial focus was on combining this with other policies. However, the observed benefits of these two-policy combinations, while significant, prompted us to explore more complex policy configurations. To ensure a practical and implementable approach, all subsequent combinations involving three or more policies will include the enhancement of feedback mechanisms as a foundational element.

6.4.2.5 Policy 5 – Combinations of three or more policies

Motivated by the promising results observed from combining two policies, testing more complex policy configurations was mandatory. The focus remained on combinations that are both practical to implement and recognizable by project managers. A total of 11 different combinations were tested, comprehensively detailed further in Appendix 9.

Although project outcomes are always a compromise between cost and schedule, the findings reveal a clear pattern: policy combinations that integrate strategies for increasing capacity with those for controlling deliver superior results compared to relying solely on policies focused on increasing capacity or only on control. Moreover, a general trend emerged showing that combining a greater number of policies tends to yield superior overall results.

Table 9 illustrates this progression, demonstrating how schedule and cost overruns progressively decrease as additional policies are combined. This culminates in highly effective combinations, such as the strategic integration of actively increasing staff alongside co-creation policies (training and external project management support) and controlling measures designed to prevent 'cozy relationships' (improving feedback mechanisms and increasing monitoring).

Table 9 - Improvement of results with policy combinations

Policy #	Simulation	Schedule		Cost	
		Weeks	**% Overrun**	**Total Cost**	**% Overrun**
Base Case	**Business as Usual With Automatic Adjustments**	**95,31**	**58,85%**	**€ 411.174**	**10,53%**
Policy 1.2	Staffing: Hiring 50% Rookies	65,37	8,95%	€ 491.297	32,07%
Policy 4.3	BAU + Hiring 50% rookies + Improving Feedback Mechanisms	64,25	7,08%	€ 482.149	29,61%
Policy 5.10	BAU + Hiring 50% + Improving Feedback Mechanisms + Inc Mon + PM Support	61,12	1,87%	€ 475.960	27,95%
Policy 5.11	BAU + Hiring 50% + Improving Feedback Mechanisms + Training+ Inc Mon + PM Support	60,6	1,00%	€ 458.746	23,32%

These results strongly confirm Hypothesis 4, which states that the synergistic application of good feedback and monitoring practices alongside strong relationships and effective change management can substantially improve project outcomes.

Beyond this general trend, the analysis revealed a consistent pattern: combinations integrating adequate staffing (e.g., 'no understaffing' or 'hiring 20% rookies') with improved feedback mechanisms and additional project management support consistently yielded superior results compared to other relational motive-oriented policy configurations. For instance, the best combination of three policies identified was Policy 5.4: no understaffing with increased feedback mechanisms and external project management support, achieving remarkable performance with only 2.70% schedule overrun and 11.03% cost overrun (see Appendix 9). This finding further validates the efficacy of such integrated approaches, which are widely utilized in successful software development projects.

6.4.2.6 Policy 6 - Combination of policies to overcome changes and new requirements

Encouraged by the positive outcomes of the combination of policies, this study assessed their combined effectiveness against a major source of project overruns identified by project managers in our interviews: changes and additions to requirements. Agile environments, known for embracing evolving requirements, present unique challenges in this regard. Changes in requirements are highly disruptive and together with new requirements result in an increase of the total work to do that often is not recognized by the client, forcing the project to be completed within the same schedule and cost.

Table 10 - Results from the combination of policies to changes and new requirements

Policy #	Simulations	Schedule		Cost	
		Weeks	**% Overrun**	**Total Cost**	**% Overrun**
Base Case	Business as Usual With Automatic Adjustments	95,31	58,85%	€ 411.174	10,53%
	BAU + new and changes in requirements	113,69	89,48%	€ 494.111	32,83%
Policy 6.1	Req+No understaffing+ Improving feedback mechanisms + Mon+PM support	65,75	9,58%	€ 444.779	19,56%
Policy 6.2	Req+No understaffing+ Improving feedback mechanisms +Training+Mon+PM support	64,44	7,40%	€ 435.641	17,11%
Policy 6.3	Requirements + BAU + Hiring 50% + Improving feedback mechanisms + Inc Mon + PM Support	64,31	7,18%	€ 508.922	36,81%
Policy 6.4	Req+BAU+Hiring50% + Improving feedback mechanisms + Training + Mon + PM Support	64,06	6,77%	€ 502.085	34,97%
Policy 6.5	Req+BAU+Hiring20%+ Improving feedback mechanisms + Inc Mon + PM Support	61,62	2,70%	€ 458.735	23,32%
Policy 6.6	Req+BAU+Hiring20%+Improving feedback mechanisms + Training + Mon + PM Support	61,81	3,02%	€ 446.195	19,94%

The results show that policies 6.2, 6.5, and 6.6 depicted in Table 10 provide the best combination of results, highlighting the importance of having a higher level of experience in project teams. Although experienced employees are more expensive than rookies, the difference in productivity and quality makes them produce better results for cost and schedule. Policy 6.2, with no understaffing, improvement of feedback mechanisms, training, increasing monitoring, and additional project management support achieves an astonishing 7,40% schedule overrun, and 17,11% cost overrun against 89,48% schedule and 32,83% cost overruns from the base case with requirements, while keeping the same team during the full project completion. Notably, while policies involving 20% rookie hires achieve even lower schedule overruns (e.g., Policy 6.5 and 6.6), these scenarios consistently result in higher cost overruns compared to combinations starting without initial understaffing (Policies 6.1 and 6.2). Crucially, the integrated implementation of improved feedback mechanisms and increased monitoring within these policies significantly enhances the ability to accurately track scope increases. This capability, in turn, facilitates the negotiation of additional revenues for extra work, thereby potentially mitigating cost overruns to below 15%.

6.5 Discussion and conclusion

Hybrid project management methodologies are increasingly prevalent, yet their actual performance still presents significant opportunities for improvement (Kuutila *et al.*, 2020; Patel, 2021). Chapter 5 provided a novel, important explanation on how RMCCV oriented policies and the accumulation of relational capital impact project outcomes in terms of cost and schedule, confirming the critical role of managing the permanent interactions within project teams (Yahya and Maidin, 2023). However, an additional step is required to help researchers and managers identify which strategies are available to leverage relationships to improve project outcomes.

Addressing this research gap, this dissertation sought to answer its main overarching question: How can service providers leverage the relational motive to co-create value (RMCCV) and relational capital for better project results in terms of cost and schedule? To answer this, this study synthesized insights from comprehensive literature reviews and qualitative interviews with experienced project managers, which informed the development of a diverse set of policies for simulation. This process also led to a critical sub-research questions: (1) Can project overruns be solved using strategies for staffing, RMCCV, relational capital, or scheduling independently? (2) How do combinations of these policies impact project outcomes? and (3) How can companies effectively deal with changing requirements? Through systematic simulation of 40 distinct policy combinations, their effectiveness was accessed addressing both research and sub-research questions.

The selection of project management policies inevitably involves navigating a complex dilemma: balancing cost and schedule. The simulations consistently demonstrate that optimal strategies depend heavily on several factors, including a project's initial staffing levels, the organization's historical experiences, and the established mental models that guide decision-making, particularly concerning cost-schedule trade-offs. Furthermore, relational capital, actively fostered through project experience and interactions, plays a crucial role. The layered testing approach systematically moved from individual policies to combinations of two, and then to increasingly complex multi-policy integrations.

Testing individual policies addressed the first sub-research question, revealing that no single strategy (staffing, schedule, or RMCCV-oriented policies) is sufficient to fully resolve project overruns. For instance, while optimized staffing significantly cut schedule overruns, it concurrently increased cost overruns. Schedule policies proved largely ineffective in correcting common overrun scenarios, and isolated RMCCV-oriented policies, while beneficial, only partially reduced overruns. Further analysis, answering the second sub-research question, demonstrated that combining policies holds greater potential. The most efficient combinations paired capacity development with robust control mechanisms, yielding improvements in both cost and schedule. Finally, addressing the third sub-research question, results indicate that managing changing requirements necessitates complex policy combinations. These include adequate staffing (either by avoiding initial understaffing or prioritizing experienced hires) concurrently with policies fostering continuous relational capital growth while actively mitigating the risks of overly close relationships. Policies like 6.2, 6.5, and 6.6 exemplify these effective strategies, which integrate highly experienced teams, enhanced feedback mechanisms, increased monitoring and benchmarking, improved client team training, and external project management support.

The present research highlights that adequate staffing serves as a critical prerequisite for maximizing the impact of relationship-oriented policies. The most effective strategies involve building upon robust staffing by combining policies that foster continuous relational capital growth with those designed to control the development of "cozy relationships". This efficacy stems from control policies enhancing monitoring, goal setting, and objective oversight, thereby mitigating risks such as blurred lines between service providers and customers (Pillai et al., 2017), loss of objectivity, knowledge redundancy, increased dependency (Johnsen and Lacoste, 2016), and complacency (Villena, Choi and Revilla, 2021).

This research unequivocally answers the main research question: starting projects with sufficient capacity yields positive results, which are substantially enhanced by combining collaboration-fostering policies with robust control mechanisms. Policies such as 5.4, 5.5, and 5.6 exemplify this efficacy, aligning with existing literature (Villena, Choi and Revilla, 2021). Significantly, for projects initiated in an understaffed state, augmenting capacity with more experienced personnel demonstrably amplifies the effectiveness of RMCCV-oriented policy combinations. This finding not only corroborates prior research (Kunc, 2008; Glaiel, Moulton and Madnick, 2014) but also challenges conventional management practices that often prioritize cost-cutting through the employment of less experienced staff. By strategically implementing RMCCV policies and actively managing relational capital accumulation, project managers are better equipped to navigate relationship complexities and achieve superior project outcomes.

6.5.1 Theoretical implications

This study offers several significant theoretical contributions, advancing understanding across project management, marketing, and System Dynamics, while also introducing a novel methodological approach.

Firstly, our research introduces a novel methodological approach that integrates insights from diverse fields, including project management, marketing, and System Dynamics. The utilization of System Dynamics as the primary methodology proves crucial, enabling the dynamic simulation and analysis of complex, long-term effects and feedback loops within the project ecosystem. This interdisciplinary framework not only facilitates unequivocal answers to our research and sub-research questions but also serves as a compelling call for a new direction in theory development, one that advocates for the deliberate combination of disciplinary knowledge to address multifaceted problems, rather than maintaining isolated perspectives. The layered approach used in testing policies further underscores the theoretical importance of synthesizing different knowledge areas into integrated policies, demonstrating how understanding their long-term, synergistic effects is pivotal for achieving significant project improvements.

Secondly, the study makes substantial contributions to the project management literature. While existing research acknowledges the importance of factors like trust (Swart, Bond-Barnard and Chugh, 2022), expectations (Sarangee *et al.*, 2022; Yahya and Maidin, 2023), and the role of project managers (Meng and Boyd, 2017), it often overlooks the intricate dynamics of relational capital within project teams and with clients and practices to motivate clients to co-create value. This study expands the scope of project management research by:

- Validating hypothesis 4 and highlighting the critical role of relational capital dynamics**:** The research findings unequivocally confirm Hypothesis 4, demonstrating that robust feedback mechanisms, effective monitoring practices, and strong relational capital are critical for effective requirements management and ultimately, improved project outcomes. This extends existing understanding by showcasing relational capital's multifaceted impact, encompassing both its benefits and potential drawbacks, such as the detrimental effects of "cozy relationships" identified in marketing literature (Anderson and Jap, 2005; Villena, Choi and Revilla, 2021).
- Identifying staffing as a prerequisite for relational policy effectiveness: The study theoretically demonstrates that adequate project staffing is not merely an operational choice but a critical theoretical precondition that significantly amplifies the positive impact of RMCCV-oriented and relational capital policies. This challenges a simplistic view of policy application and suggests a hierarchical model for project intervention effectiveness.
- Proposing a theory of synergistic policy integration for complex challenges: By demonstrating that combinations of policies (particularly those balancing capacity enhancement with control mechanisms) are superior to isolated solutions in addressing the schedule-cost dilemma, this research advances a theoretical argument for a more holistic approach to project management policy design. This underscores that complex, dynamic problems require integrated, multi-lever solutions.
- Introducing a novel framework for managing relational capital: The study proposes a new approach to managing feedback and monitoring within projects, incorporating specific mechanisms to mitigate the risks associated with overly close relationships while fostering co-creation.
- Expanding the theoretical range of available policies: By acknowledging the importance of motivating clients to co-create (Neghina *et al.*, 2017),

this study introduces a broader set of policy options that opens the field to further exploration of policies centered on the RMCCV.

Thirdly, this research contributes significantly to the marketing literature by:

- Extending the application of "dark side of relationships" and "motives to co-create" research: It introduces software development projects as a novel and highly relevant context for investigating the importance of relationships and motivations. This rich empirical setting, characterized by intense client participation (Bardhan *et al.*, 2010) resulting in a co-creation process (Vargo and Lusch, 2004) allows for a deeper theoretical exploration of how client knowledge (Noordhoff et al., 2011) and influence (Johnsen and Lacoste, 2016) affect service quality within a collaborative project framework (Yeniaras, Di Benedetto and Dayan, 2021).
- Demonstrating the utility of System Dynamics for longitudinal studies of relational capital: This study presents System Dynamics as the most appropriate method to study the development of phenomena over time, reinforcing Spohrer and Maglio's (2008) call for more dynamic perspectives in service science and marketing.

Finally, this study advances the field of System Dynamics by:

- Developing novel structures: It introduces innovative structures to capture the dynamic evolution of relational capital within project contexts and to model the decision rules for implementing RMCCV-oriented policies.
- Extending existing models: It builds upon Oliva and Sterman's (2010) approach to measuring quality by incorporating client perceptions and expectations, expanding the scope and quantity of quality indicators, and improving the monitoring capacity of the next generation of project management models.

6.5.2 Managerial implications

This study offers several critical and actionable managerial implications for organizations aiming to significantly enhance project success and mitigate common overruns in knowledge-intensive service industries:

1. Strategic workforce planning and capacity investment:

Organizations must fundamentally re-evaluate their staffing strategies. The findings unequivocally demonstrate that prioritizing the hiring of experienced personnel over less experienced ones is not merely a cost factor, but a critical prerequisite for maximizing the positive impact of all other project management policies, especially relationship-oriented ones. While experienced staff may incur higher upfront costs, their increased productivity, reduced errors, and decreased training commitments lead to substantial long-term savings in cost and schedule. Project leaders should advocate for strategic investments in robust initial capacity, challenging conventional cost-cutting practices that rely on less experienced staff.

2. Designing integrated policy portfolios, not isolated solutions:
The research provides compelling evidence that relying on single, isolated strategies is insufficient to resolve complex project overruns. Instead, project managers should develop and implement integrated policy portfolios that combine strategies for enhancing capacity with robust control and monitoring mechanisms. For instance, the research results highlight the efficacy of combinations such as active staff augmentation alongside co-creation policies (e.g., client training, external PM support) and stringent control measures (e.g., improved feedback mechanisms, increased monitoring). This holistic approach yields dramatically superior results in managing cost and schedule. Managers should conduct organizational assessments to identify their specific capacity and control gaps, then tailor integrated policy packages to address these multifaceted challenges.

3. Proactive relational governance and risk mitigation:
While fostering collaborative relationships is vital, unmanaged relational dynamics can erode project performance. Managers must establish proactive governance mechanisms to mitigate the risks associated with "cozy relationships." This involves:

- Establishing objective performance baselines: Set and adhere to project goals based on external benchmarks and initial plans, rather than allowing them to drift based solely on evolving internal relationships. This prevents performance erosion due to complacency or compromised objectivity.
- Continuous monitoring of relational health: Implement clear processes to consistently measure key performance indicators (KPIs) beyond traditional project metrics. This includes tracking deviations in errors, rework, schedule changes, service capacity, productivity, and costs against initial plans or benchmarks.
- Implementing robust feedback mechanisms: Design and enforce formal feedback loops (e.g., regular client meetings for quality control, structured project reviews with business development teams) that ensure transparent

communication and early identification of issues, thereby minimizing the detrimental effects of overly close relationships and maintaining accountability.

4. Leveraging comprehensive KPIs for adaptive management:
Beyond merely tracking progress, KPIs should serve as dynamic tools for adaptive project management. Organizations should establish a standardized reporting system focusing on key areas:

- Work progress and quality: Monitor actual work progress against plan, rigorously tracking quality metrics such as errors, rework rates, incident logs, and response times.
- Resource and cost efficiency: Continuously track service capacity, productivity, and actual vs. projected costs to identify deviations promptly.
- Schedule adherence and scope management: Monitor adherence to schedule baselines. Crucially, implement proactive scope management processes that not only track changes but also empower project managers to negotiate for additional resources or revenue for new requirements, transforming potential scope creep into opportunities for additional billable work.

5. Broad applicability across knowledge-intensive services:
The findings of this study are highly relevant beyond software development, directly applying to a wide range of knowledge-intensive service industries, including consulting, engineering, and architecture. These sectors share core characteristics with software development, such as high levels of client involvement, intense knowledge exchange, and reliance on human capital. Organizations within these sectors can leverage the insights from this research to adapt and implement similar integrated policy approaches, thereby improving their project management practices and achieving greater success. Managers in these fields are encouraged to pilot the combined policies (e.g., those involving staffing, relational capital growth, and control mechanisms) within their own contexts.

6.5.3 Limitations and future research

While this study offers significant theoretical and managerial contributions, it is essential to acknowledge its inherent limitations, which simultaneously pave the way for promising avenues of future research.

1. **Model scope and policy selection:**

This study's first limitation lies in its strategic choice of policies for investigation. The study’s approach focused on policies derived from existing literature and validated by experienced project managers, aiming to test established assumptions within the software development context and provide practitioners with actionable insights. However, the System Dynamics model's inherent capacity allows for an almost unlimited combination of policies, ranging from simple to highly complex. Furthermore, this research employed a testing approach rather than an optimization methodology to provide specific insights into the interaction between different model sectors (e.g., cost, schedule, quality).

Future studies could significantly expand the repertoire of actionable strategies by exploring new policy insights from diverse literature streams or by systematically searching for optimal policy combinations under specific criteria. Such optimization efforts could extend beyond the traditional cost-schedule dilemma to include other critical project factors such as team fatigue and turnover, thereby providing academics and practitioners with clearer priorities and decision rules tailored to various organizational contexts.

2. **Depth of relational dynamics and measurement:**

A second limitation stems from the focused scope of our investigation into Relational Motive to Co-Create Value (RMCCV), relational capital, and the resulting "cozy relationships". While this research sheds crucial light on the importance of motivating participants to co-create value and monitoring relational capital accumulation, we acknowledge that we are merely scratching the surface of this complex intersection between project management, System Dynamics, motives to co-create, and relational capital. Additionally, inheriting a limitation from Chapter 5, this study did not provide direct empirical measurements for motivations (RMCCV) but rather focused on the impact of RMCCV-oriented policies (actions) and the accumulation of relational capital. This decision was made to maintain clarity and manageability within the current research scope.

Future research should delve deeper into this high-potential theoretical combination, exploring additional layers of policies that directly influence relational structures and motivations. Complementary empirical studies could focus on validating the proposed theoretical framework by developing and applying direct measurements for both the RMCCV as an accumulation process and the evolution of relational capital.

3. Data and measurement challenges:
A third set of limitations arises from the inherent challenges associated with real-world project data availability and quality when expanding upon previous studies. Corporate information systems are frequently financial-oriented, while operational project data often resides under client control, significantly hindering comprehensive researcher access. This environment can foster reporting biases, as the pressure to comply with existing project Key Performance Indicators (KPIs) may compromise data accuracy, as noted by Ford and Sterman (2003a). Furthermore, while the approach integrated service quality literature (Parasuraman, Zeithaml and Berry, 1985) with System Dynamics principles (Oliva and Sterman, 2010) to measure quality based on the discrepancy between expected and actual outcomes, such empirical measurements are not yet common practice in many organizations, nor is consistent reporting to clients.

Future research should investigate strategies to overcome these data access barriers, potentially through novel collaborative frameworks with industry partners. Studies could also delve deeper into the under-reporting phenomenon and assess its pervasive impact on future project performance. Furthermore, significant effort should focus on developing long-term empirical approaches to track quality changes over time and integrate consistent quality reporting into standard organizational practices.

4. Future research on project failure and cancellation:
While this study effectively models the dynamics of project overruns and identifies successful mitigation strategies, a significant area for future research is to explicitly model the mechanisms and triggers for complete project cancellation. The research interviews highlighted that major causes for project termination often stem from severe cost overruns, persistent schedule overruns, and a drastic decrease in relational capital to critically low levels, indicating a complete breakdown of trust and collaboration.

Future System Dynamics models could explore the tipping points where these cumulative factors lead to irrecoverable project failure and subsequent cancellation. Such research would provide valuable theoretical insights into organizational decision-making under extreme stress and potentially identify earlier warning signals for impending project termination, enabling proactive intervention strategies.

7.Conclusions

7.1 Introduction

This thesis has explored the influence of relationships between service provider and client teams on software development project outcomes in terms of cost and schedule. It has proposed a novel dynamic theory of project management that integrates insights from project management, marketing-focused relationship management, and System Dynamics. This theory, articulated through a System Dynamics model grounded in existing literature and practical evidence, sheds light on the dynamic interplay between the relational motive to co-create value, accumulation of relational capital, and project performance.

While client involvement has increased in modern software development methodologies like Agile and Hybrid approaches, research on the impact of personal relationships within these collaborative settings remains limited (Rood *et al.*, 2018; Yahya and Maidin, 2023). This research directly tackles this knowledge gap by investigating the interplay between personal relationships and project outcomes within software development environments. Addressing this gap unlocks the potential for substantial cost and schedule savings, fostering motivated and successful teams and ultimately driving long-term success in software development projects. Our investigation has been guided by two overarching research questions:

- How do the relational motive to co-create value (RMCCV) and relational capital impact project results in terms of cost and schedule?
- How can service providers leverage the RMCCV and relational capital for better project results in terms of cost and schedule?

To address the research questions, we first addressed the impact of the RMCCV on service quality in software development projects in Chapter 2. The chapter initiated a theoretical exploration of the importance of motivating customers to co-create value within the software development context revealing the potential for service quality erosion, establishing the RMCCV as a critical element. Chapter 3 translated this novel theoretical framework into a generic System Dynamics project management model, which incorporated variables reflecting goals, expected behaviors, motivations, and a customer-centric service quality concept. The application of the theory formulated in Chapter 2 to a project setting (Chapter 3) uncovered the need to expand our approach due to the increasing prevalence of Agile and Hybrid methodologies, where customer involvement is intensifying and results are reported in terms of cost and schedule, highlighting the critical role of relationships in project success. To capture this fully, we needed to explore the underlying process of relationship development, moving beyond just the motivation to co-create.

Consequently, Chapter 4 explored the concept of relational capital – the accumulated stock of relationship development. This complementary perspective led to the creation of a new model specifically tailored to software development projects utilizing Agile and Hybrid methodologies, where relationships are particularly crucial. Besides reinforcing previous findings, this research unveiled a novel insight: the potential for long-term negative consequences arising from overly comfortable relationships.

Chapter 5 combined the RMCCV-oriented policies and relational capital, introducing a comprehensive simulation model or in other words a virtual world replicating the entire Hybrid software development process. The model expansion is necessary to delve deeper into the first overarching research question addressed in this thesis: How do the relational motive to co-create and relational capital impact project results in terms of cost and schedule?

Building upon the simulation model developed in Chapter 5, Chapter 6 investigated the effectiveness of a range of practical and commonly implemented policies in leveraging the relational motive and relational capital for improved project outcomes. After selecting policies on the basis of literature and interviews, these were tested following a layered approach. First single policies were tested, followed by those encompassing multiple policies. This resulted in 40 distinct simulations, enabling a comprehensive exploration of the second overall research question: How can service providers leverage the RMCCV and relational capital for better project results in terms of cost and schedule? Table 11 provides a summary of the objective and the theoretical implications from the different chapters of this thesis.

Table 11 - Thesis structure

Chapter	Study	Objective	Theoretical implications
1	Introduction	Introducing the relevance, and knowledge gap, research questions and approach	
2	How the relational motive to co-create value impacts service quality over time	Review of the literature to develop a dynamic theory explaining about the positive and negative impacts of relational motive on service quality, applied to generic provision of knowledge-intensive services.	(1) Acknowledgement that unmanaged RMCCV can lead to a paradoxical decline in service quality over time. (2) Bridge the gap between positive and negative relationship perspectives; (3) Introduces a novel context for RMCCV analysis - the B2B IT environment with long-term service delivery. (4) Established the importance of managing RMCCV and setting quality goals to prevent this erosion. Demonstrate the value of System Dynamics as a complementary method for service research.
3	Effects of relationships in the dynamics of information technology projects	Deepen the analysis of the importance of the relational aspects applied to software development projects using waterfall methodology	(1) Introduces relationships between service providers and clients as important for project outcomes. (2) Integrates different knowledge areas deepening and widening System Dynamics models (Gao and Zhang, 2022). In the present study, integrating knowledge from value co-creation and the dark side of relationships in a project management setting was important to uncover and understand previously hidden dynamics.
4	Strategies to improve project's results using relational capital in Agile software development	Broadening the scope of the relational aspects, introducing importance of the relational capital to software development projects, using Agile and Hybrid methodologies where the importance of relationships may be even more critical than when using other methodologies	(1) Contributes to the literature on project management by enhancing our understanding of how relationship capital develops and accumulates, establishing a new bridge between marketing and project management literature. (2) Introduces the role of relational capital to the System Dynamics literature applied to project management. (3) Introduces System Dynamics as an excellent method to study the integration of diverse knowledge domains, in our case project management, and marketing (4) Strengthens the use of System Dynamics for theory building. (5) Introduces project management as a new service setting for marketing research (6) Motivates service researchers to broaden their research by taking a long-term approach using System Dynamics to articulate their theories.

Table 11 - Continued

Chapter	Study	Objective	Theoretical implications
5	How the combination of the relational motive to co-create value and relational capital impact software development projects	Combining the RMCCV and relational capital and proposing a new simulation model integrating all previous. Validation of the model.	(1) Exposes the complex interplay of RMCCV and relational capital in project management (2) Establishes a novel and comprehensive relationships framework for service contexts (3) Integrates a relationship-centric framework into System Dynamics project management modeling. (4) Advances the understanding of relational capital's dual nature and dynamic evolution (5) Reinforces the suitability of System Dynamics for interdisciplinary knowledge Integration. (6) Strengthens System Dynamics as a tool for theory building. (7) Positions project management as a novel service setting for marketing research (8) Encourages the expansion of the research scope and time horizon in service research.
6	Relationship-based strategies to improve software development projects	Using the model to test different policies, providing managers with clear relationship-based strategies to improve project outcomes.	(1) Introduces a novel methodological approach that integrates insights from diverse fields, including project management, marketing, and System Dynamics (2) Makes substantial contributions to the project management literature: - Demonstrating that robust feedback mechanisms, effective monitoring practices, and strong relational capital are critical for improved project outcomes. - Identifying staffing as a prerequisite for relational policy effectiveness. - Proposing a theory of synergistic policy integration for complex challenges. - Introducing a novel framework for managing relational capital. - Expanding the range of available policies. (3) Contributes significantly to the marketing literature by: - Extending the scope of "dark side of relationships" and "motives to co-create" research. - Demonstrating the utility of System Dynamics for longitudinal studies of relational capital. (4) Advances the field of System Dynamics by: - Developing novel structures - Extending existing models.
7	Conclusions		

7.2 Answers to the research questions

7.2.1 First research question: How does the relational motive to co-create value and relational capital impact project results in terms of cost and schedule?

Answering the thesis' first research question prompted critical, novel insights for academics and practitioners. Firstly, this thesis confirms that the RMCCV and relational capital play a crucial role in the long-term evolution of project outcomes in terms of cost, schedule, and quality, particularly in IT service delivery. However, their impact is dynamic and evolves over time. Static assessments provide an incomplete picture as these factors constantly change (Neghina *et al.*, 2017), significantly influencing project outcomes. Secondly, understanding the "how" behind the relationship between RMCCV, relational capital, and project outcomes is key to unlocking the hidden dynamics of projects. Figure 72 provides a visual simplification of this dynamic: The increase in relational capital increases productivity up to a point but tends to erode that same productivity as it reaches higher values. Our results demonstrate that:

- Positive effects dominate initial stages**:** Using RMCCV-oriented policies and the consequent initial accumulation of relational capital will in the short term enhance performance in terms of cost and schedule. Improved communication (Gligor and Holcomb, 2013), increased business knowledge (Noordhoff *et al.*, 2011; Lee and Ha, 2018; Martins, Duarte and Costa, 2018), and subsequent productivity gains (Aisyah, Sukoco and Anshori, 2019; Zardini, Ricciardi and Rossignoli, 2015) drive these early successes. This aligns with marketing literature and project managers' expectations as team members adjust to the project environment and learn from each other.
- Negative impacts dominate over the long term, as the accumulation of relational capital fosters "cozy relationships." These relationships trigger a negative spiral characterized by decreased monitoring, reduced quality standards, lowered goals, and increased complacency (Villena, Choi and Revilla, 2021). This negative spiral is further exacerbated by blurred lines between service providers and customers (Pillai et al., 2017), loss of objectivity, knowledge redundancy, and increased dependency (Johnsen and Lacoste, 2016). These negative effects over time gradually outweigh the initial positive impacts, ultimately leading to a decline in project performance.

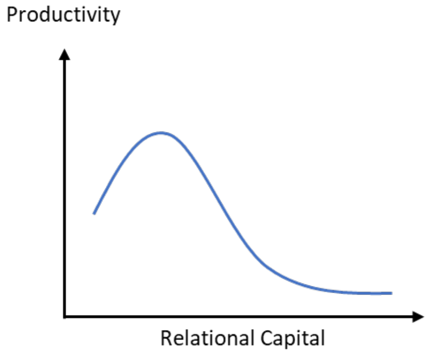


Figure 72 – Example of the nonlinear relationship between relational capital and productivity

The strength of positive and negative effects of RMCCV-oriented policies and relational capital on project results are intricately linked to initial staffing decisions, particularly the prevalent tendency towards project understaffing. This initial resource constraint creates significant pressure on project teams, compromising service quality and leading to increased errors and overall dissatisfaction. Conversely, the findings from Chapters 2, 3, 4, and 5 demonstrate that implementing RMCCV-oriented policies throughout the entire project lifecycle can effectively manage the accumulation of relational capital. These policies can mitigate the negative effects of "cozy relationships" and significantly enhance service capacity.

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7.2.2 Second research question: How can service providers leverage the relational motive to co-create value and relational capital for better project results in terms of cost and schedule?

Answering the second research question shifts attention from explanation to intervention, providing clear guidance for practitioners and academics on strategies to improve project results. A layered approach allowed us to identify the effectiveness of various policies and their combinations.

First, it is necessary to reflect on the efficiency of using isolated policies. While crucial for mitigating schedule overruns, staffing strategies often increase project costs. Prioritizing experienced staff consistently demonstrated superior performance in both schedule and cost outcomes. Understaffing severely hinders project results, generating pressure that initially degrades perceived quality and erodes relational capital. Moving on to schedule adjustments, they are generally inefficient in correcting overruns under the business-as-usual scenario. While a deadline extension policy initially reduces pressure, it weakens the service provider-client relationship over time, limiting its future effectiveness. Finally, while beneficial in improving service capacity and mitigating the negative effects of cozy relationships, RMCCV-oriented policies alone are insufficient to overcome project overruns. However, they demonstrably improved critical variables such as quality perception, goal adjustments, and error generation rates.

The second step is to understand the results of combining policies. It is clear that combinations of policies are more efficient than implementing them in isolation. Combinations involving a larger number of policies, particularly those that mix increasing capacity with monitoring and controlling, proved most effective. An important conclusion is that the choice to combine policies must consider that understaffing significantly limits the benefits of RMCCV-oriented policies due to maintaining relational capital below optimal levels. Moreover, while hiring is a key policy to increase service capacity, its efficiency is highly dependent on the experience level of the hired employees.

Finally, the most effective approach to mitigating the significant challenges posed by changing and adding requirements (a major source of project overruns, commonly known as "scope creep") involved combining policies that increase capacity with robust monitoring and control mechanisms. Scope creep adds unplanned work, renders previous work obsolete, and necessitates the integration of new software components. Our analysis revealed that a strategy combining RMCCV-oriented policies with adequate initial service capacity, while potentially resulting in a slightly higher initial schedule overrun compared to exclusively hiring highly experienced employees, ultimately delivers superior outcomes. This approach leads to lower overall project costs, higher levels of relational capital, and significantly reduced staff fatigue. Notably, the long-term benefits of this approach are likely to extend beyond the current project, as reduced staff fatigue contributes to improved performance and increased resilience for future projects.

7.3 Theoretical implications

The combined theoretical contributions of the five studies presented revolve around the critical role of relationship management in shaping project outcomes in terms of cost and schedule. The synthesis offered in this thesis bridges previously distinct literature on project management, marketing, and System Dynamics, introducing novel contexts and methods for analysis. This integration opens exciting new research avenues, which are discussed in section 7.5 – Limitations and Future Research. To clarify the theoretical implications with appropriate depth, the contributions are organized into three distinct groups corresponding to these literature fields, enabling a more structured exploration of how this thesis advances knowledge across these domains.

7.3.1 Theoretical implications for project management

1. Relationships matter

Exploring the impact of relational aspects on projects' results, while research acknowledges the importance of factors like trust (Swart, Bond-Barnard and Chugh, 2022), expectations (Sarangee *et al.*, 2022; Yahya and Maidin, 2023), and the role of project managers (Meng and Boyd, 2017), leadership (Thite, 1999; Anantatmula, 2010), and customer satisfaction (Cao, Ramesh and Abdel-Hamid, 2010), it often overlooks the intricate dynamics of relationships within project teams and with clients. Existing research frequently focuses on individual factors rather than the holistic impact of a network of relationships, thus overlooking how to effectively foster and manage these dynamics for optimal project outcomes. Furthermore, although Agile methodologies emphasize client involvement (Cao, Ramesh and Abdel-Hamid, 2010; Glaiel, Moulton and Madnick, 2014), the research often falls short of deeply exploring how the resulting relationships evolve, their impact on project dynamics, and how to effectively nurture them for optimal project outcomes. While Zhu and Cheung (2023) highlight the importance of incentivizing relationship investment in construction projects, their study lacks a deeper, direct connection to the marketing literature. It doesn't fully explore the behavioral dynamics of these relationships – how they evolve, the underlying causes and consequences, and how to leverage them effectively.

This research introduces a novel framework by combining the concepts of RMCCV and relational capital, which provides a powerful lens for understanding how relationships significantly influence the success of software development projects. The framework provides a structured approach to analyzing and managing the crucial interdependencies arising from relationships. By emphasizing the crucial role of relational capital and the need to motivate teams to co-create value (building upon the insights of Zhu

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and Cheung, (2023)), this research unlocks a deeper understanding of how to leverage relationships for improved project outcomes. This understanding provides a foundation for developing and implementing evidence-based strategies for nurturing and managing relationships throughout the project lifecycle. It enables project managers to make more informed decisions about how to invest in relationships, anticipate potential challenges, and ultimately enhance project success.

2. Bridging project management and marketing

Traditional project management research often focuses on internal factors within the project team, such as resource allocation, scheduling, and risk management. While acknowledging the importance of customer involvement (Glaiel, Moulton and Madnick, 2014), it often overlooks the intricate dynamics of client relationships and their impact on project outcomes. Existing research often fails to fully capture the feedback loops and ongoing interactions that emerge from client involvement throughout the project lifecycle (Křivánková and Remta, 2023).

This research bridges the gap between project management and marketing literature by explicitly integrating concepts such as RMCCV and relational capital. This integration provides a more holistic perspective on project success, redefining it from mere technical delivery and adherence to traditional metrics (e.g., cost, schedule) to encompass the active and continuous co-creation of value with the client, shaped by the dynamic interplay of RMCCV and relational capital. This thesis goes beyond simply acknowledging client involvement (as in Glaiel, Moulton, and Madnick, (2014)) by exploring the behavioral dynamics of these relationships and their impact on project outcomes. It investigates how to effectively motivate clients to actively participate in the project and co-create value, its impact on the accumulation of relational capital, and the consequences of that accumulation. Chapter 6 developed new strategies that help in improving client satisfaction, enhancing project value, and avoiding "cozy relationships" that may hinder innovation and critical feedback. This interdisciplinary approach aligns with the growing recognition that successful projects require a multidisciplinary perspective (Cao, Ramesh and Abdel-Hamid, 2010; Zhu and Cheung, 2023; Repenning, Kieffer and Repenning, 2017).

3. A behavioral approach to project management

Building on the previous two contributions, the complex interplay of behaviors within the project context is often overlooked. While research recognizes the importance of trust and the role of project managers, it often lacks a deeper understanding of how these factors translate into specific behaviors that drive project success. This research builds on previous work that shows that many of the critical relationships within a project are nonlinear and characterized by complex interactions (Ford, 1995), and that significant losses in efficiency due to communication and motivational issues (Abdel-Hamid and Madnick (1989). However, research has not fully explored how to address these behavioral challenges through a systematic approach.

This research introduces a behavioral approach to project management by focusing on how relationship dynamics influence the behaviors of all stakeholders involved in the project. Our framework emphasizes the importance of implementing RMCCV-oriented policies that drive specific behaviors, such as active client participation, open communication, and collaborative problem-solving. By integrating insights from value co-creation, the dark side of relationships, and relational capital literature, we uncover previously hidden dynamics and highlight the critical role of behavioral factors in determining project success. By understanding the behavioral dimensions of project relationships, project management literature can add a new dimension to the research on how to improve project results.

4. A dynamic approach to integrate relationships into project management

Traditional project management often emphasizes a process-oriented approach, focusing on predefined methodologies such as Waterfall or Agile. These methodologies provide a structured framework with clear processes and instructions. System Dynamics literature has used a dynamic approach to project management for over 50 years (Abdel-Hamid, 1984). This research builds on System Dynamics literature, expanding Jalili and Ford's (2016) argument that research often fails to fully consider the interdependencies and feedback loops that exist within the project ecosystem to the specific integration of how relationships impact project outcomes.

This research moves beyond a purely process-oriented approach or a static view of relationships by emphasizing the dynamic nature of project relationships and their impact on project outcomes. It introduces a "relationships framework" that integrates RMCCV and relational capital, providing a broader perspective on how relationships evolve and influence project success over time. This framework helps to understand how changes in one aspect of the project (e.g., client expectations, team dynamics) can have cascading effects on other aspects, leading to emergent behaviors and outcomes. This framework can and should be used as a stepping stone to bolster research on ways to improve project outcomes using relationship strategies.

5. Introducing new metrics and KPIs
Traditional project management often relies heavily on easily quantifiable metrics such as cost and time to completion. While quality is a crucial aspect of project success, it is often measured in a limited way, such as by counting the number of defects or errors. These traditional metrics do not take into account the client's evaluation of the work that is being done and the value it generates.

This research proposes a shift towards a more client-centric approach to measuring project success. We propose adapting the service quality model developed by Parasuraman et al. (1985) to measure the gap between client expectations and perceived performance to those new metrics and KPIs, which should include items such as work progress, quality (errors, rework, incidents, response times), service capacity, cost, schedule adherence, and scope management.

These new metrics provide a more comprehensive understanding of project performance and identify areas for improvement. By shifting the focus to client-centric metrics, project management can become more aligned with the ultimate goal of delivering value to the client.

7.3.2 Theoretical implications for marketing

1. Reciprocal interaction between RMCCV and relational capital
Prior research has separately examined the Relational Motive to Co-create Value (RMCCV) and relational capital. RMCCV focuses on building co-creation capabilities (Karpen, Bove and Lukas, 2012; Neghina *et al.*, 2015), while relational capital emphasizes the value of long-term relationships (Villena, Revilla and Choi, 2011), leading to smoother transactions and better resource access (Pillai *et al.*, 2017). This study reveals a reciprocal interaction: RMCCV strategies shape interactions that build relational capital, and in turn, relational capital influences the application of RMCCV strategies, with strong relationships both enabling and constraining them. By connecting these concepts, this research uncovers a deeper understanding of how relationships impact service delivery, enabling the identification of mutually beneficial policies.

2. Extending the scope of "motives to co-create value" and "relational capital" research

While prior research has examined customer motivation for co-creation across diverse service industries like healthcare (Bhatti, Glowik and Arslan, 2021), financial services (Neghina *et al.*, 2017), and tourism (Buhalis and Sinarta, 2019), and relational capital in supply chains (Autry and Golicic, 2010; Gligor and Holcomb, 2013; Villena, Choi and Revilla, 2021) and healthcare (Aaltonen and Turkulainen, 2018), the software development context has been notably absent. This study uniquely investigates both the RMCCV and relational capital within long-term software development projects. This setting is particularly relevant due to the intense client involvement required (Bardhan et al., 2010), where collaboration is key to success and strong client relationships are often formed (Aisyah, Sukoco and Anshori, 2019; Villena, Revilla and Choi, 2011). Clients provide essential knowledge of their needs (Noordhoff et al., 2011) and significantly shape service requirements and quality (Johnsen and Lacoste, 2016). By focusing on this underexplored area, this research identifies new strategies to motivate stakeholders and leverage relational engagement. Furthermore, the software development environment offers an ideal setting to observe the development of relational capital and explore ways to manage its potential downsides. This expansion of both the RMCCV and relational capital research provides novel insights and practical implications for the software development industry.

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3. Combining of short and long-term perspectives

While the value co-creation and relational capital literature acknowledge the importance of a long-term perspective (Neghina *et al.*, 2017; Villena, Revilla and Choi, 2011), research has been short-term focused, with empirical studies often relying on static measurements, limiting their ability to capture the dynamic nature of these phenomena (Vargo and Lusch, 2017; Vargo, Akaka and Wieland, 2020; Vargo *et al.*, 2023). Motives change over time (Neghina *et al.*, 2017), and relational capital accumulates over time (Villena, Revilla and Choi, 2011), producing effects that were unnoticed for long periods, making those effects more corrosive (Villena, Choi and Revilla, 2021). This study uniquely integrates both short and long-term perspectives, providing novel insights into the strength and evolving effects of variables over time. By analyzing how relational motive-oriented policies affect relational capital accumulation and how this accumulation influences project outcomes, this research offers valuable insights and potential policy recommendations for improving service delivery.

4. A dynamic approach with feedback loops

Marketing research has been building on statistical linear models that are incapable of addressing the increasing complexity and dynamics of marketing concepts and the feedbacks that exist in the service ecosystem in which services are being delivered (Spohrer and Maglio, 2008; Vargo *et al.*, 2023). This research introduces a dynamic approach to understanding the interplay of RMCCV and relational capital, incorporating feedback loops that reflect the evolving nature of these relationships. This approach directly addresses the call for dynamic strategy development in marketing research (Vargo and Lusch, 2017; Spohrer and Maglio, 2008), which emphasizes the importance of understanding how firms interact within service ecosystems. By incorporating feedback in the ecosystem, this research provides a more comprehensive understanding of the complex dynamics at play and reinforces the new orientation towards "an interactive, systems orientation" (Vargo *et al.*, 2023, p. 6). This novel approach aligns with the emerging emphasis on complexity economics and emergence in marketing research (Vargo and Lusch, 2017; Vargo *et al.*, 2023) and offers a valuable framework for studying complex, emergent phenomena within service ecosystems.

5. Bridging positive and negative relationship perspectives

By integrating both reinforcing and balancing feedback loops within a single framework, this study uniquely bridges the gap between positive and negative relationship perspectives in marketing literature. While previous research has often focused on these perspectives in isolation, this study demonstrates how both positive and negative consequences of relationships can emerge within the same context. Integrating these positive and negative consequences into the dynamic framework described in the previous theoretical implication, allows this research to operationalize the arguments from previous research (Vargo, Akaka and Wieland, 2020; Noordhoff *et al.*, 2011). This understanding is crucial for explaining the evolving nature of the RMCCV and relational capital, and for developing strategies to manage both positive and negative consequences to improve overall project outcomes.

6. Developing a broader marketing view

This research contributes to the broader marketing view advocated by Vargo and Lusch (2017), which emphasizes the importance of interdisciplinary collaboration and a focus on service ecosystems. By integrating knowledge from marketing (value co-creation, relational capital, dark side of relationships), project management, and System Dynamics, this study exemplifies how a transdisciplinary approach can enhance our understanding of complex service phenomena. This approach aligns with the calls for greater integration of diverse knowledge within marketing research adopting a systems perspective (Vargo and Lusch, 2017; Spohrer and Maglio, 2008). Furthermore, this research expands the scope of marketing beyond traditional boundaries by demonstrating its applicability in a novel context – software development projects. This not only enhances the practical relevance of marketing principles but also provides opportunities for marketing to learn from other disciplines, such as project management, and thereby deepen its own theoretical foundations. By giving a practical, empirically founded answer to the call to action for interdisciplinary integration, this research provides a methodological framework for studying complex service ecosystems and concepts, such as "emergence in marketing" as proposed by Vargo et al. (Vargo *et al.*, 2023). This approach can serve as a model for future research that seeks to address complex challenges within the evolving landscape of service ecosystems.

7. Establishing System Dynamics as a marketing research methodology

This research underscores the value of System Dynamics as a complementary method for service research. Marketing research has been increasingly calling for a system-oriented approach, able to deal with delays, nonlinearities, and feedback loops (Bettencourt, Lusch and Vargo, 2014; Vargo and Lusch, 2017; Vargo, Akaka and Wieland, 2020; Vargo *et al.*, 2023). System Dynamics effectively captures the dynamic nature of RMCCV and relational capital, feedback loops, nonlinear relationships(Spohrer and Maglio, 2008; Sterman, 2000), and integrates diverse knowledge (Zimmermann and Curran, 2023), offering a powerful tool for analyzing complex service ecosystems. This synergy between marketing and System Dynamics holds significant promise for both fields (Spohrer and Maglio, 2008; Lyneis and Ford, 2007; Bettencourt, Lusch and Vargo, 2014). By demonstrating the effectiveness of System Dynamics in the software development setting, this study reinforces System Dynamics as a valuable tool for advancing marketing research.

7.3.3 Theoretical implications for System Dynamics

1. Expanding the current knowledge of System Dynamics applied to project management: Relationships matter

This research significantly advances the understanding of System Dynamics applied to project management by integrating relationship dynamics into System Dynamics project management models. This research is the first to introduce a complete set of relationships model structures covering both the importance of motivating teams using relational motive-oriented policies, its implications on the accumulation of relational capital, and the consequences of this accumulation.

Although System Dynamics is already extensively applied to project management, it overlooked the crucial role of relationships in shaping project outcomes, particularly in knowledge-intensive and client-centric projects, such as software development. Previous studies within this domain primarily focused on operational aspects such as task dependencies, resource allocation, and schedule adherence. (Abdel-Hamid, 1984; Abdel-Hamid and Madnick, 1989; Abdel-Hamid and Madnick, 1989; Abdel-Hamid and Madnick, 1991; Abdel-Hamid, 1999; Ford, 1995). In the context of Agile and Hybrid projects, System Dynamics research started to pay attention to soft factors such as team dynamics (Ching and Mutuc, 2018; Fatema and Sakib, 2018) and iteration length effects (van Oorschot, Sengupta and Van Wassenhove, 2018), without diving further into the importance of relationships on project results over time. This research closes this gap by introducing a novel framework that explicitly incorporates relationship dynamics, encompassing relational capital, motivations, and client-centric service quality. By integrating these concepts, and combining the positive and negative consequences of the accumulation of relational capital, our model uncovers previously hidden dynamics and offers a more comprehensive perspective on project success.

This novel layer of knowledge allows for the definition of a new set of relationship-focused policies that influence project dynamics. For instance, knowledge management policies designed to formalize and transfer project knowledge offer long-term benefits and positive side effects beyond the immediate project scope. Additionally, policies that promote joint decision-making on goals and manage expectations can combat negative feedback loops that erode both goals and expectations. This research is actively building on Meng and Boyd's (2017) prediction that relationship management is poised to become the central focus of the next generation of project management strategies.

2. Extending existing System Dynamics models

Furthermore, this research extends existing System Dynamics models by proposing innovative structures for capturing and managing RMCCV-oriented policies. Previous models, while acknowledging the importance of client involvement, often treated it as a static parameter or a single, unidirectional influence (e.g. (Cao, Ramesh and Abdel-Hamid, 2010; Glaiel, Moulton and Madnick, 2014)). In contrast, our framework introduces a dynamic perspective on relational capital, capturing its evolution over time and incorporating decision rules for implementing RMCCV-oriented policies. A critical and novel feedback loop, in particular, is introduced to explain the "dark side" of relationships: as RMCCV-oriented policies are implemented, they contribute to the accumulation of relational capital. However, as this capital reaches higher levels, it can lead to complacency, a reduction in monitoring, and a tacit erosion of standards. This dynamic then acts to limit the use and effectiveness of future RMCCV-oriented policies, as overly comfortable relationships can resist or de-prioritize efforts to maintain quality and accountability. This allows for a more strategic approach to managing relationships and evaluating the impact of different policy interventions on project outcomes.

3. Innovating System Dynamics models applied to project management

This study introduces a novel approach to modeling work effort within the System Dynamics framework. Unlike previous research, which predominantly employed task-based units such as Delivered Source Instructions (DSI) (van Oorschot, Sengupta and Van Wassenhove, 2018) or more abstract concepts like "Tasks" (Abdel-Hamid and Madnick, 1989; Li *et al.*, 2018), this study utilizes "hours" as the primary unit of work. This shift in perspective, informed by extensive interviews with project practitioners and observations of market practices, offers several key advantages. Firstly, "hours" represent a tangible and universally understood unit of work, facilitating easier comprehension and engagement from all project stakeholders, including project managers, developers, and clients. Secondly, this approach simplifies the model by focusing on a readily measurable and quantifiable unit, enhancing its clarity and reducing the cognitive burden associated with more abstract or project-specific units. By adopting "hours" as the unit of work, this study aims to enhance the model's transparency, improve stakeholder understanding, and ultimately increase the model's practical applicability and impact within the project management domain.

Additionally, this study introduces a novel approach to measuring quality. The study proposes the adoption of a customer-centric approach proposed by service quality literature (Parasuraman, Zeithaml and Berry, 1985; Parasuraman, Zeithaml and Berry, 1988; Parasuraman, Berry and Zeithaml, 1991) where quality results from the difference between quality expectations and quality perceptions. This approach builds on the acknowledgment that service quality is intangible and, therefore, difficult to measure (Lovelock and Gummesson, 2004; Jain and Gupta, 2004). While the prevailing engineering perspective, looking at quality as a function of errors, is still very important, we broaden this approach by including the customer-centric view of quality, long argued by the service quality literature. The importance of this addiction is paramount to the improvement of expectations management and goal setting, expanding the customer's center role in software development to quality, and improving the ability of System Dynamics models to capture real-world hybrid project management dynamics.

Finally, this study innovates by developing new structures to add quality items to be measured and monitored according to the new approach to managing service quality discussed in the previous paragraph. The introduction of structures explicitly stating the expectations and perceptions about items such as service capacity, errors, cost, and schedule is pivotal in the improvement of projects' results as Chapters 5 and 6 confirmed. This integration is vital for several reasons:

- **Enhancing expectations management:** By explicitly considering customer expectations, we can better align project goals and deliverables with desired outcomes (Gronroos, 2007).
- **Improving goal setting:** A customer-centric focus helps set more meaningful and impactful project objectives (Oliva and Sterman, 2010).
- **Expanding customer role:** This approach empowers customers by actively involving them in the quality assessment process.
- **Directing behavioral intentions:** By managing expectations and goals this approach directs behaviors towards the intended results (Saad Andaleeb and Conway, 2006).
- **Enhancing System Dynamics modeling:** This study provides a standard for adding new model elements.

7.4 Managerial implications

This thesis demonstrates that effective relationship management between service provider and customer teams holds enormous potential for improving project outcomes. This section offers eight initiatives to guide managers in optimizing relationship management and project delivery, particularly within B2B IT service delivery and software development.

1. Improving initial project planning
Poor initial planning and budgeting often cause project imbalances. To rectify this, project managers should enhance initial budget development by incorporating:

- Error Rate: Accounting for a realistic number of mistakes that will likely happen.
- Sprint Capacity Adjustments: Prepare for dynamic adjustments to sprint capacity.
- Staff Experience Level: Consider the experience level of assigned staff in cost estimation.

2. Setting clear goals and preventing service erosion
A critical starting point for managers is the establishment of clear service quality goals anchored in industry benchmarks for errors, quality, and project outcomes at least. These goals should be widely communicated and used as continuous reference points to counteract the potential erosion of standards as relationships evolve. This proactive goal-setting prevents the decline in service quality and aligns the entire organization toward maintaining high standards.

3. Developing effective relationship management strategies
Managers must develop and implement strategies that leverage software development's collaborative nature while mitigating potential downsides. This involves recognizing clients as active participants and implementing relationship management strategies to prevent negative effects from overly familiar relationships. Essential measures to maintain balanced, productive client relationships include standardized procedures, formalized knowledge-sharing protocols, implementing matrix structures in project development, and limiting extended customer engagements.

4. Promoting knowledge management
Effective knowledge management is essential for relationship value enhancement and knowledge transfer during personnel transitions. Managers should establish collaborative environments that integrate client resources, stimulate cross-stakeholder knowledge creation, and implement joint decision-making frameworks. Mandatory knowledge-sharing protocols and staffing strategies emphasizing co-creation competencies, complemented by client training initiatives, significantly improve project performance metrics. These approaches foster shared accountability and continuous organizational learning within project ecosystems.

5. Investing in monitoring and planning systems

Comprehensive monitoring and planning infrastructures are indispensable for project governance. These should encompass relationship dynamics surveillance to preemptively identify deterioration patterns, analytical benchmarking against industry metrics, and simulation-based process optimization for strategic decision support. Complementary formal governance mechanisms—including precise contractual specifications and systematic external evaluation protocols—establish performance parameters and generate critical data for continuous improvement initiatives.

6. Staffing strategy and monitoring performance

Optimal staffing allocation and robust performance monitoring are critical for project success. A higher proportion of experienced personnel significantly enhances project outcomes, requiring strategic resource allocation to mitigate operational pressure and temporal inefficiencies. Adequate staffing levels fundamentally determine service capacity, deficiencies generate systemic imbalances that compromise other enhancement initiatives. Comprehensive monitoring frameworks, incorporating multidimensional Key Performance Indicators (KPIs) like error rates, capacity utilization, financial parameters, temporal progression, and formalized service quality metrics, enable proactive intervention and performance optimization.

7. Combining policies for better outcomes

Our analysis reveals critical implementation considerations for integrating conventional project management methodologies, relational capital dynamics, and RMCCV-oriented strategies. Multi-policy integration with sufficient resource allocation yields improved performance benefits. However, capacity constraints fundamentally inhibit relational capital development irrespective of other initiatives. Furthermore, stimulating relational capital accumulation necessitates parallel governance mechanisms, such as enhanced monitoring and benchmarking, to mitigate the negative effects of "cozy relationships." Organizational capacity to accommodate requirement volatility also depends critically on specialized personnel accessibility and comprehensive RMCCV policy implementation.

8. Understanding the trade-offs

Finally, the present research underscores the inherent trade-offs involved in project management decisions. The choice between policy combinations is dictated by different priorities, with managers weighing potential cost overruns or schedule overruns. Understanding these trade-offs is crucial for informed decision-making.

All in all, the managerial implications derived from the present thesis underscore the importance of a multifaceted approach to relationship management and project delivery. The high confidence in the simulation model allows us to trust that these implications help managers navigate complex project dynamics effectively, leading to sustained success in service delivery and project management.

7.5 Limitations and future research

7.5.1 Limitations and future research originated by those limitations

This thesis, while offering significant theoretical and managerial contributions, is subject to several inherent limitations that concurrently provide avenues of future research, advancing the understanding of relationship dynamics in projects.

1. Scope and simplification of the simulation model

First, the simulation model presented in this thesis is a simplification of reality (Sterman, 2000). The research primary focus is on the relationship between project outcomes and relationship dynamics, necessitating aggregations and assumptions to ensure model readability and tractability. While a wide range of relationship management influences exist, this thesis prioritized factors deemed most significant based on existing literature and expert input.

Future research could expand the model's scope by incorporating additional theoretical constructs related to relational influences, such as specific mechanisms of communication development, conflict resolution, or other motives to co-create beyond the RMCCV. Researchers could also delve into a more granular examination of specific structures and processes underlying RMCCV-oriented policies, such as the effectiveness of particular training programs or the detailed impact of matrix organizational structures on relationship dynamics. Finally, incorporating identified barriers to co-creation (Schüler, Fee Maier and Liljedal, 2020), such as exploitation and frustration, into the model could provide richer insights into their detrimental impact on project outcomes.

2. Operationalization of variables and the behavior-intension gap

A critical limitation concerns the operationalization of all variables within our System Dynamics model. Translating abstract theoretical constructs, such as RMCCV and relational capital, into measurable and dynamic model components necessarily involves simplification. Individual personalities, motivations, emotional states, and cognitive biases can significantly impact team dynamics. Unforeseen events or crises can trigger unpredictable emotional responses and behavioral changes within the team. The model, while acknowledging the importance of human interaction, may not fully capture this complexity. This means the complex gap between a stakeholder's motivation or intention to act (e.g., to co-create value) and their ultimate actions is not fully captured, limiting insights into the nuanced behavioral responses to policies or evolving relational dynamics.

Future research should deepen the behavioral approach introduced in this thesis by explicitly modeling the mechanisms that translate motives and intentions into observable behaviors. Integrating insights from organizational behavior, social psychology, and cultural psychology could enhance the model's capacity to represent the complexities of human interaction, emotional states, cognitive biases, and unforeseen events within project teams. Furthermore, exploring the role of cultural differences on project behaviors and outcomes, and addressing ethical considerations related to influencing human behavior within project contexts, represent important research avenues.

3. Data availability, quality and reporting biases

While expanding on previous studies using real-world project data, this thesis faced inherent data availability and quality limitations. The limited motivation to share critical information, the limitation to access information, and the traditional corporate systems emphasizing accounting details over crucial operational aspects challenge our understanding and validation efforts. Additionally, this study faced a lack of existing empirical measurements on some of the variables used. This challenge is compounded by the pressure to comply with existing project KPIs, which can lead to reporting biases that compromise data accuracy (Ford and Sterman, 2003b).

Future research could focus on improving the support systems within organizations to capture a broader range of KPIs relevant to decision-making, moving beyond purely accounting details. Methodologies for enhanced data sharing between service providers and clients, while respecting confidentiality, could also be explored. Additionally, research should delve deeper into the under-reporting phenomenon and assess its pervasive impact on project performance. Expanding the model's validation to other project settings where comprehensive information is more readily available could uncover broader insights and enhance generalizability.

4. Measurement of quality and lack of empirical tracking
The decision to incorporate non-traditional, customer-centric definition of quality (the gap between client expectations and perceptions, based on Parasuraman et al., 1985) in the theoretical framework and model poses a significant limitation for empirical validation. While this approach provided valuable theoretical insights and aligns with a broader view of service delivery, software development companies rarely systematically track quality using this conceptualization. This absence of formal assessment of client expectations at project initiation or consistent measurement of perception changes throughout project development made it impossible to report comprehensive empirical results on quality alongside cost and schedule in the analysis.

Future research should establish those empirical quality measurements for software project outcomes and develop long-term approaches to track quality changes over time. Periodic service quality measurements during the development of projects will better capture the dynamic nature of quality.

5. Limited scope of policy exploration
The selection of specific policies for simulation, influenced by the company studied in Chapter 4 and literature deemed applicable to existing mental models, constrained the full exploration of the model's vast policy combination potential. The inherent complexity of a large number of parameters and options in the model necessitated a focused approach to maximize learning, which inevitably limited the investigation of highly diverse or unconventional policy combinations.

Future studies should investigate a wider array of diverse policy combinations, including those less intuitively obvious or requiring more radical organizational shifts, under various project scenarios. This broader exploration would enhance the generalizability of findings and uncover potentially novel and highly effective intervention strategies.

6. Duration of observed project effects
A limitation arises from the typical duration of projects modeled (60-100 weeks). While this period allows for observation of significant dynamics, the full impact

of RMCCV-oriented policies, particularly their long-term benefits and the accumulation of relational capital, may manifest over even longer periods, extending beyond the scope of a single project.

Future research should investigate the cumulative and compounding long-term benefits of RMCCV-oriented policies beyond the scope of a single project. Exploring how the sustained application of these policies affects the accumulation and utilization of relational capital across a portfolio of projects over extended periods would provide deeper insights into their full effectiveness and inform long-term strategic investments.

7.5.2 Future research arising from key theoretical implications and new insights

Beyond addressing the inherent limitations of this study, the novel theoretical implications and insights generated by this thesis open several exciting and promising avenues for future research, moving beyond what the current study could accomplish.

1. Decomposing the bidirectional relationship between the RMCCV and relational capital

This thesis uniquely established a mutually reinforcing, bidirectional relationship between RMCCV-oriented policies and relational capital. The findings demonstrate that RMCCV-oriented strategies fundamentally shape interactions that generate relational capital, while accumulated relational capital simultaneously modulates the effectiveness of RMCCV strategies, both catalyzing and constraining them across project lifecycles.

Future research should systematically decompose this dynamic interplay through longitudinal empirical studies, identifying potential mediating and moderating variables within this relationship (e.g., organizational culture, specific communication channels, project complexity). Such investigation would significantly enhance understanding of relationship-mediated service delivery mechanisms. Moreover, integrating these conceptual advances into project management frameworks would enrich both theoretical domains. Methodologically, developing more granular System Dynamics models that capture these nuanced feedback structures would facilitate deeper structural analysis of behavioral patterns and enable the identification of novel policy interventions for optimizing project performance across the cost-schedule-quality triad. This directly responds to calls for a broader marketing view and advances System Dynamics modeling.

2. Advanced modeling of project failure and cancelation

While this study effectively models the dynamics of project overruns, a significant and underexplored area for future research is to explicitly model the mechanisms and triggers for complete project cancellation. Our preliminary interviews highlighted that major causes for project termination often stem from severe cost overruns, persistent schedule overruns, and the consequent deterioration of relationships between the service provider and the client, hinting at a drastic decrease in relational capital to critically low levels.

Future System Dynamics models could explore the "tipping points" where these cumulative factors lead to irrecoverable project failure and subsequent cancellation. Such research would provide valuable theoretical insights into organizational decision-making under extreme stress and potentially identify earlier warning signals for impending project termination, enabling proactive intervention strategies and potentially contributing to a behavioral theory of organizational failure.

3. Expanding the behavioral and dynamic approach in project management

This thesis introduced a novel behavioral and dynamic approach to project management by focusing on how relationship dynamics influence stakeholder behaviors. This dynamic view, integrating feedback loops, offers a richer understanding than traditional static or process-oriented approaches.

Building on this foundation, future research could further develop the behavioral aspects by integrating more comprehensive psychological and sociological theories into System Dynamics models. For example, future models could incorporate psychological theories on motivation, group dynamics, or social identity, as well as sociological theories on organizational culture and power structures. This would allow for a deeper understanding of emergent behaviors within project teams and client interactions. Additionally, extending the dynamic approach to model broader project ecosystems, incorporating external market shifts, competitive dynamics, or long-term organizational learning, could provide a more holistic view of project success and failure. This would reinforce the use of System Dynamics as a unifying framework for interdisciplinary research, as it provides a common language and methodology for scholars to transcend disciplinary silos and build more comprehensive, systems-level theories.

4. Innovating metrics and KPI implementation

This research proposed a shift towards more client-centric metrics, including adapting the SERVQUAL model for quality measurement in projects. This conceptual shift, while powerful, requires empirical validation of its practical utility. Future research should focus on developing practical implementation strategies for these proposed client-centric quality KPIs and documenting their effectiveness in real-world software development environments. Studies could explore best practices for integrating these metrics into existing project management information systems, training project teams on their use, and demonstrating their impact on project performance and client satisfaction. This would bridge the gap between theoretical advancement and practical application of novel metrics.

5. Interdisciplinary extensions and generalization

This study leveraged an interdisciplinary approach, bridging project management, marketing, and System Dynamics. This integration not only advanced knowledge within each field but also demonstrated the power of such synthesis. Future research should continue to explore novel interdisciplinary combinations. For instance, integrating insights from economics (e.g., incentive structures, contract theory), legal studies (e.g., contractual incompleteness, dispute resolution), or even neuroscience (e.g., decision-making biases at a more fundamental level) could enrich the understanding of project dynamics. Furthermore, rigorous comparative studies across various knowledge-intensive industries (e.g., engineering, consulting, R&D) could test the generalizability of the "relationships framework" and identify industry-specific adaptations.

7.6 Concluding remarks

This thesis investigated the impact of relationships on project management within the context of software development. The primary objective was to improve our understanding of how relationships influence project outcomes and how these relationships can be strategically leveraged to achieve better results. The findings presented in this dissertation offer valuable insights for both project managers and the broader scientific community. We have shed light on the crucial role that relationships play not only in software development projects but also in similar service settings. These findings aim to stimulate further research in this domain, encouraging exploration of the multifaceted nature of relationships in project management. Furthermore, this research underscores the potential benefits of investing in relationship management and developing appropriate systems to support informed decision-making. Effective relationship management strategies can dramatically improve project outcomes, particularly in knowledge-intensive environments like software development. Beyond project success, these strategies can foster a more positive work environment for all team members, potentially reducing fatigue and burnout.

This thesis contributes to improving project management practices, ultimately leading to improved project outcomes, particularly in terms of cost and schedule, while also providing a framework for understanding and managing quality dynamics, and fostering healthier working environments within the industry.

8. Appendix

8.1 Appendix 1 – Parameters of the model presented in Chapter 2

Parameters	**Values**		
	Equilibrium	**Sim 1 effect of time**	**Sim 2 Policy 1: 25% increase in Desired relational motive**
Initial value RMCCV	1	1	1
Desired Relational Motive to Co-create Value	1	1	1 + step (0.25; 16)
Alienation switch	1	1	1
Desired workforce factor	1	1	1
Dialogue switch	1	1	1
Experienced employees	2	2	2
Experienced productivity	1	1	1
FINAL TIME	104	104	104
Quality pressure switch	1	1	1
Rookie employees	2	2	2
Rookie productivity fraction	0,3	0,3	0,3
Schedule pressure switch	1	1	1
Test switch	0	1	1
Time for lack of training effect	24	24	24
Time to adjust productivity	3	3	3
Time to alienation effect	36	36	36
Time to perceive quality	2	2	2
Time to quality pressure effect	12	12	12
Training switch	1	1	0
Workforce adjustment time	6	6	6

	Sim 3 Policy 2: 50% increase in Desired relational motive	Sim 4 Policy 3: 25% increase in Service Quality Goals	Sim 5 Policy 4: 50% increase in Service Quality Goals	Sim 6 Policy 5: 25% increase in Desired relational motive and Service Quality Goals	Sim 7 Policy 6: 50% increase in Desired relational motive and Service Quality Goals
	1	1	1	1	1
	1 + step (0.5; 16)	1	1	1 + step (0.25; 16)	1 + step (0.5; 16)
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	2	2	2	2	1
	1	1	1	1	1
	104	104	104	104	104
	1	1	1	1	1
	2	2	2	2	2
	0,3	0,3	0,3	0,3	0,3
	1	1	1	1	1
	1	1	1	1	1
	24	24	24	24	24
	3	3	3	3	3
	36	36	36	36	36
	2	2	2	2	2
	12	12	12	12	12
	0	1	1	1	1
	6	6	6	6	6

8

8.2 Appendix 2 – Sources for Chapters' 2 and 3 parameters

Parameters	Source
Initial value RMCCV	Neghina *et al.* (2017)
Desired Desired Motive to Co-create Value	Neghina *et al.* (2017)
Experienced employees	Interviews
Experienced productivity	Oliva and Sterman (2010)
Rookie employees	Interviews
Rookie productivity fraction	Oliva and Sterman (2010) + interviews
Time for lack of training effect	Interviews
Time to adjust productivity	Oliva and Sterman (2010) + interviews
Time to alienation effect	Interviews
Time to perceive quality	Interviews (this is a parameter to explore in simulations)
Time to quality pressure effect	Interviews (this is a parameter to explore in simulations)
Workforce adjustment time	Oliva and Sterman (2010) + interviews

8.3 Appendix 3 – Questionnaire to support the semi-structured interviews from Chapter 2

Questionnaire to support the identification of project dynamics

1. For how many years do you manage projects?
2. What is the average length of the projects you are involved with (in months)?
3. What is the average number of staff resources involved in the projects?
4. Are the services customized to the client?
5. What is the participation of the client during the project?
    a. Analysis?
    b. Development?
    c. Project management?
6. What is the average number of staff invested by the client?
    a. Which are their levels of experience?
7. How many clients have you worked with? In your career?
8. After a project, do you usually stay in the client for other projects? For How long?
9. Do you consider yourself a friend of any member of any client's team? How did you get to be his friend?
10. (New formulation) Maybe more neutral, in the sense of 'Do you consider the way of working with the client team purely business-driven, or is there also a friendship relation? Does this change over de course of the project?
11. During a project, do you engage in any hobby or "out of work" activity with any of the members of the client's team?
12. Do you recognize relevant work from your client team? Or is it just project management?
13. What is the mix of experience in your client's team? How many experienced? How many juniors?
14. Do you recognize any stressful milestones during the project? Can you describe them?
15. What are the common activities at the beginning of a project?
    a. Who is usually involved?
    b. How difficult it is to start working with the client's team?
    c. Is the client's input important for the project at that time?
16. What are the activities in the middle of the project?
    a. Does it get easier to work with the client's team?
    b. Do you think the client's team will ever feel the project as their own?

17. Do you make any adjustments to your work during the project? When? Why?
    a. Does your project director or the client's project director are active participants in the project?
18. Do you use any knowledge management tools and procedures?
    a. Are they mandatory?
    b. Do you use them the same way during the project?
19. How do you have the testing or quality assurance planned?
    a. Do you always follow the plan?
20. What and when are the moments that add more pressure?
21. What are the common activities at the end of a project?
22. Are your projects usually on time and on budget?
    a. Why?
    b. If they are not, what happens?
23. Do you consider your projects as successful?
24. Do you know how positively or negatively well the client evaluated your projects?
25. Do you think their evaluations change during the course of the project?
26. Do you identify any difference between the attitude of the client's team working on the project and the client's management team towards the project?

8.4 Appendix 4 – Questionnaire to support the semi-structured interviews from chapter 4

Framing Questions

1. For how many years have you managed projects?
2. What is the average duration of the projects you are involved with (in months)?
3. What is the average number of staff resources involved in the projects?
4. Are the services customized to the client?
5. What is the participation of the client during the project?
    a. Analysis?
    b. Development?
    c. Project management?
6. What is the average number of staff invested by the client?
    a. Which are their levels of experience?
7. How many clients have you worked with? In your career?
8. After a project, do you usually continue with the client for other projects? For How long?
9. How long have you worked with Agile methods?

Methodology Questions

10. Can you describe how do you apply the methodology to your clients? (process description – this question might be very detailed which is good)
11. How do you plan the team for an Agile project?
12. Do you recognize relevant work from your client team? Or is it just project management?
13. What is the mix of experience in your client's team? How many experienced? How many juniors?
14. How do you replan the team during a project?
15. What are the major benefits from using this method?
16. What are the main disadvantages of using this method?
17. Where and how is the client involved?
18. Are your projects usually on time and on budget?
    a. Why?
    b. If they are not, what happens?
19. Do you consider your projects as successful?

Relationship questions

20. In your opinion, is your relationship important for smooth project development?
    a. Can you identify some of the most evident benefits?
21. Do you consider yourself a friend of any member of any client's team? How did you get to be his friend?
22. Do you consider the way of working with the client team purely business-driven, or is there also a friendship relation? Does this change over the course of the project?
23. During a project, do you engage in any hobby or "out of work" activity with any of the members of the client's team?
24. Do you recognize any stressful milestones during the project? Can you describe them?
25. Do you make any adjustments to your work during the project? When? Why?
    a. Does your project director or the client's project director actively participate in the project?
26. What and when are the moments that add more pressure?
27. How does the team (client and yours) address this pressure? How is this overcome?
28. Do you know how positively or negatively well the client evaluated your projects?
29. Do you think their evaluations change during the course of the project?
30. Do you identify any difference between the attitude of the client's team working on the project and the client's management team towards the project?
31. Do you trust your client's team? How does your trust evolve over time?
32. Do you feel the client develops some kind of dependence on your team? If yes, how does it evolve over time?

8.5 Apendix 5 – Model validation of Chapter 4

8.5.1 Model validation

Documentation:
The model is an integral part of the paper, and the documentation is complete as well as comments on the variables stating the different sources and assumptions.

Replicability
We provide a full simulation matrix in the supplementary materials, with all the parameters that change for each simulation run explored.

Model testing
Of the 12 tests proposed by Sterman (2000), we present the following:

- Boundary adequacy

To ensure the model accurately captures project processes, business rules, and mental models regarding policies, structure, and parameters, all causal loop diagrams, model structures, and the sector model were extensively reviewed by project managers.

The important concepts in the model regarding relationships are endogenous and capture the known dynamics.

- Structure assessment

The model effectively replicates existing knowledge in the field and accurately captures the behavior of the actors involved in the project. The model's design allows for comprehensive independent testing of each individual structure. Consequently, a wide range of simulations and sensitivity tests were conducted on each component, both in isolation and as part of the complete model. This rigorous testing process ensures the model's behavior aligns with established knowledge and expectations.

  - From the simulations conducted to test the structure of the model, its interactions, and identify abnormal behaviors we highlight:
  - Simulating the model having perfect conditions (enough resources) and switching off rework resulted in a behavior exactly as the original plan.
  - Switching on rework results in schedule and cost overruns.

   o The same principle was done to test the consequences of relational capital (Communication, monitoring, quality cuts, and goals) one at a time, staff changes, and scope changes.

- Dimensional consistency

The model contains no unit errors, although presents three warnings due to the use of lookup functions with Units. However, these warnings are similar to Oliva and Sterman (2010) and result from using variables inspired by them.

- Parameter assessment

The model uses previous project management models, Company A's decision rules, project data, and data from interviews to estimate the model's parameters.

- Extreme conditions

When testing the structure of the model, extreme conditions were simulated, helping us to ensure the model's consistency.

- Behavior reproduction

The model's calibration process involved two key steps – Averages Calibration and Specific project calibration.

Averages Calibration: The model was initially calibrated to match the average values observed in project data. Table 15 in Appendix 7 summarizes these results, and Figure 73 presents a simulation comparing the planned and actual outcomes for a dummy project. This comparison demonstrates a good fit with the reference modes presented in Chapter 4.

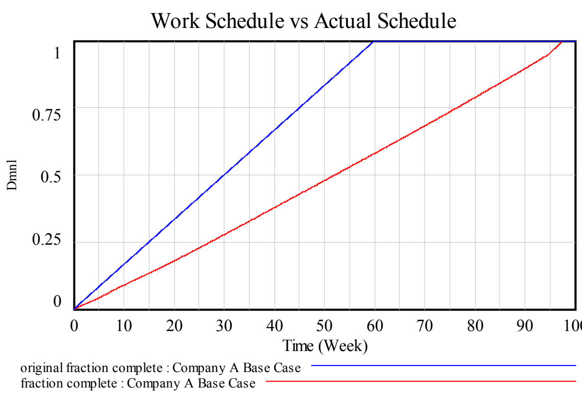

Figure 73 – Model results: Schedule from initial plan versus simulated schedule with chosen policies

Specific Project Calibration: Subsequently, Project number 2 was chosen for simulation. The model was calibrated based on the project plan and then further adjusted to reflect the specific execution conditions. Figure 74 (similar to Figure 33) compares Project 2 data with simulated results, highlighting the model's ability to accurately reproduce the project's actual behavior.

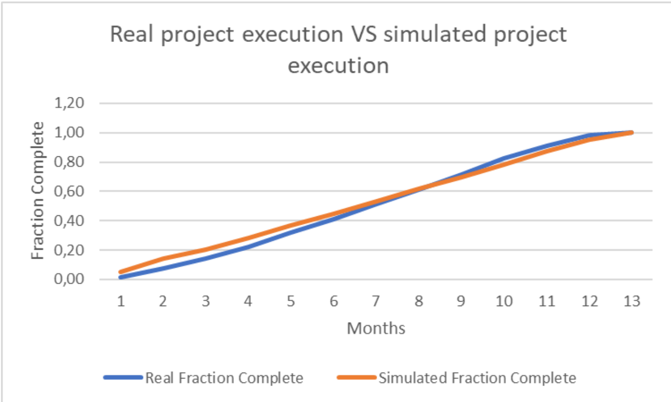

Figure 74 – Real vs simulated project data

Overall, the model replicates the average behavior of projects and the specific behavior of a project when calibrated to its conditions.

8

Sensitivity analysis

Following Rahmandad and Sterman's (2012) recommendations we developed additional sensitivity testing for the parameters in Table 12, chosen due to the managers' perceptions about the most important challenges they face.

Table 12 - Monte Carlo parameters and ranges

			Schedule results (Weeks)				Cost Results (Euro)			
Parameter	Lower Limit	Upper Limit	Lower Limit	% Overrun	Upper Limit	% Overrun	Lower Limit	% Overrun	Upper Limit	% Overrun
DESIRED RATIO OF ROOKIES	0,2	0,8	56,63	-5,62%	65,62	9,37%	€ 449.037,00	-9,90%	€ 524.389,00	5,22%
INITIAL NUMBER OF EXPERIENCED	3	7	70,48	17,47%	60,27	0,45%	€ 545.051,00	9,37%	€ 430.220,00	-13,67%
ROOKIE PRODUCTIVITY FRACTION	0,2	0,4	64,05	6,75%	59,29	-1,18%	€ 520.380,00	4,42%	€ 474.029,00	-4,88%
TIME TO DEVELOP COZY RELATIONSHIPS	4	12	61,62	2,70%	61,87	3,12%	€ 498.362,00	0,00%	€ 498.355,00	0,00%
Original policy: Hiring 50% rookies + automatic inc sprint cap			60		60		€ 498.355,00	0,00%	€ 498.355,00	0,00%

Table 12 reveals a crucial project dynamic: increased experienced staff correlates with improved schedule and cost performance, supporting Kunc's (2008) argument. However, practical implementation is often hindered by staff availability or organizational culture.

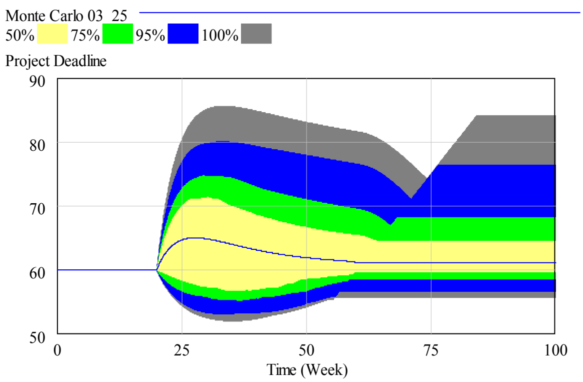

Figure 75 – Monte Carlo simulation results for project deadline

Figure 75 demonstrates significant variability in project deadlines, aligning with both historical project data and simulation results. Notably, the distribution reveals a substantial skew towards deadline extensions, indicating a considerably higher probability of schedule overruns than on-time completion.

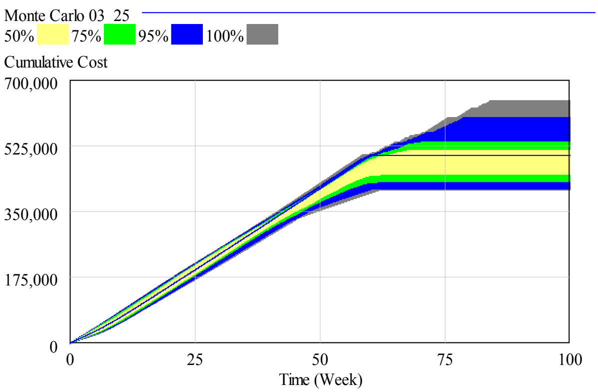

Figure 76 – Monte Carlo simulation results for cumulative cost

Figure 76 shows a narrower range of cost variations compared to project deadlines, consistent with historical data and simulation outputs. The simulation's cost distribution indicates that the median (P50) cost is lower than the baseline, suggesting two key points: a tendency towards cost adherence, and the potential for cost optimization within current project constraints.

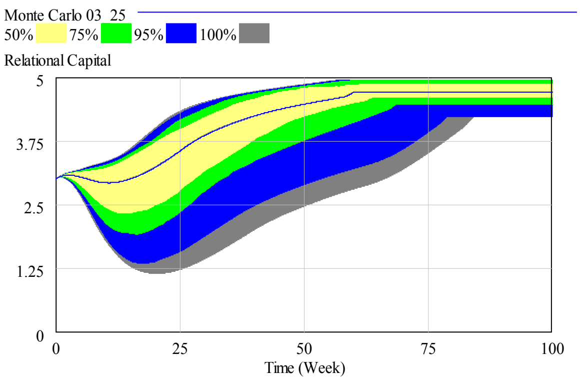

Figure 77 – Monte Carlo simulation results for relational capital

Figure 77 demonstrates considerable variability in relational capital. The distribution exhibits a pronounced skew, indicating an initial decline followed by a subsequent recovery. Notably, the simulation reveals a strong correlation between lower relational capital and significant schedule overruns. Furthermore, the probability of relational capital falling below the baseline is substantial.

8.5.2 Model Policies

The policies analyzed in Chapter 4 are summarized in Table 13.

Table 13 - Policies' results and foundation

Simulations (run names)	Schedule		Cost		Comment
	Weeks	% Overrun	Euros	% Overrun	
Initial Plan	60		€ 377.479,00		Initial plan for the project. Used for budgeting and proposal submission. Source: Authors replication of Company A's rules and assumptions.
Business as Usual	69	15,00%	€ 432.804,00	14,66%	Scenario: Starting understaffed with less than 4 experienced equivalent employees. No hiring; use overtime and work intensity. Source: Interviews and project data.
Hiring 50% rookies + manual inc sprint cap	59	-1,67%	€ 490.677,00	29,99%	Starting with the planned experienced equivalent staff, allowing hiring under the conditions defined for the financial market, where they aim at having 50% of rookies. Source: Interviews.
Hiring 50% rookies + automatic inc sprint cap	60	0,00%	€ 498.355,00	32,02%	
Hiring 80% rookies + Aut Sprint Cap	65	8,33%	€ 522.777,00	38,49%	Starting with the planned experienced equivalent staff, the scenario fits the mental models of the other teams from Company A, where there is pressure to hire as many rookies as possible. Source: Interviews.
Desired relational capital	60	0,00%	€ 498.355,00	32,02%	Starting with the planned experienced equivalent staff, this scenario uses the goal (DRC) as a policy, highlighting the potential of policies focusing on improving a project's relational capital. Source: Literature and interviews.

Table 13 - Continued

Simulations (run names)	Schedule		Cost		Comment
	Weeks	% Overrun	Euros	% Overrun	
External PM Support	59	-1,67%	€ 477.710,00	26,55%	Starting with the planned experienced equivalent staff, this scenario uses external teams to support project management, considering an average improvement in fighting the negative consequences of cozy relationships. Source: Literature.
External PM Support without Hiring	64	6,67%	€ 438.514,00	16,17%	
External PM Support - Hiring + Desired Relational capital	63	5,00%	€ 429.443,00	13,77%	
BAU + Desired Relational Capital	69	15,00%	€ 436.418,00	15,61%	Starting understaffed with less than 4 experienced equivalent employees, this scenario explores the impact of using the DRC goal.

Several simulation runs were conducted to evaluate different project management approaches, from which we decided to highlight ten, which directly impact Company A's mental models, as well as many other software development companies. The first run simulates the project as initially planned. The subsequent eight runs test various policies combining the project manager's preferences with additional strategies identified in the literature review in section 4.3, which highlighted the need for client involvement, joint decision-making, and constant evaluation of project progress .

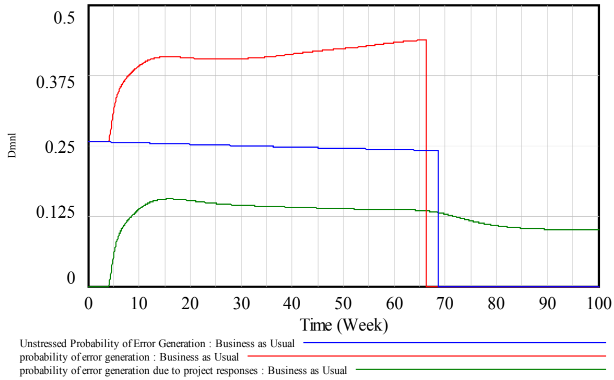

Figure 78 – Probability of error generation versus unstressed probability of error generation

The 'Business as Usual' scenario models Company A's standard project execution, characterized by a team with over 50% experienced employees and the implementation of three prevalent policies identified through interviews: accepting schedule overruns, increasing work intensity, and utilizing overtime. Additional performance metrics were incorporated, vital for relational capital development, including formal quality assessments for errors, development capacity, project progress, and deadlines. These metrics facilitated timely adjustments to perceptions and expectations regarding project performance across cost and schedule dimensions. Despite these measures, the simulation revealed persistent schedule and cost overruns of approximately 15%, a significant deviation from the average overruns reported in Appendix 7 and Table 15 (17% cost, 58% schedule). This discrepancy underscores the sensitivity of project outcomes to specific scenario conditions, where starting the project with the resources initially planned already improves significantly the schedule overrun (from 58% to 15%). In this scenario, the cost and schedule overruns result essentially from the introduction of unplanned rework and quality assessments led to increased work intensity and overtime, paradoxically elevating the probability of error generation due to project responses (Figure 78). This effect was exacerbated by the emergence of 'cozy relationships,' which diminished monitoring effectiveness (Figure 79).

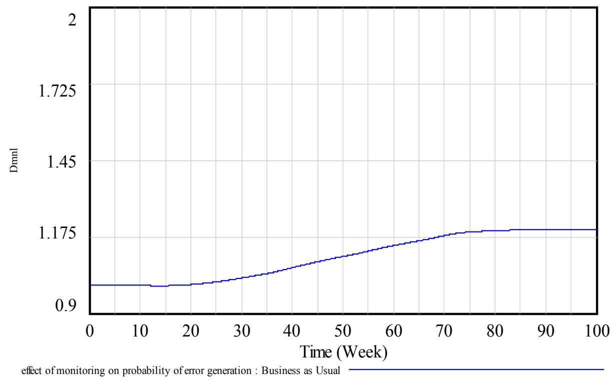

Figure 79 – Effect of monitoring on probability of error generation

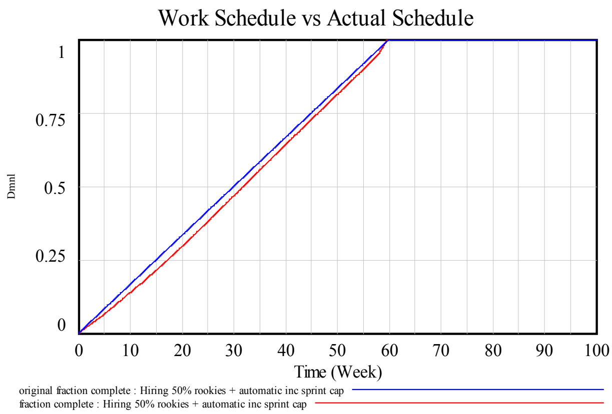

Figure 80 – Planned versus actual project schedule when hiring 50% of rookies is allowed

To mitigate the overruns observed in the 'Business as Usual' scenario, a standard approach is to augment staffing. We simulated this by incorporating a hiring policy that added 50% rookie staff. While this strategy eliminated schedule overruns (Figure 80), it resulted in a significant cost overrun of approximately 32%. Contrary to the expectation that increased staffing (Figure 81) would lead to earlier project completion and reduced errors, thereby offsetting costs, the probability of error generation remained similar to the 'Business as Usual' scenario. The escalated cost overruns can be attributed to the sheer increase in staff and the detrimental impact of 'cozy relationships.' High relational capital levels led to diminished monitoring, compromised quality standards, and diluted project goals, effectively locking the project into a suboptimal performance trajectory and preventing subsequent staff reductions.

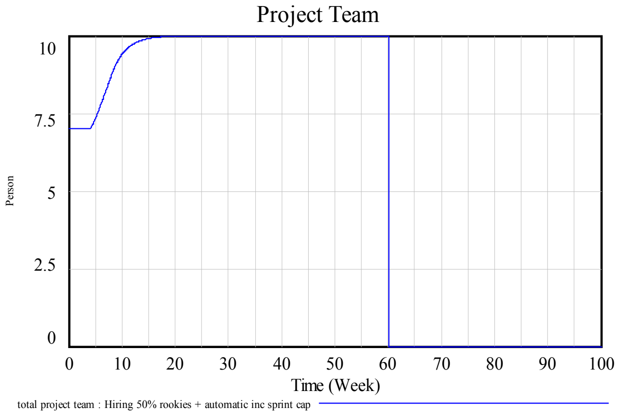

Figure 81 – Evolution of the number of staff when hiring 50% of rookies is allowed

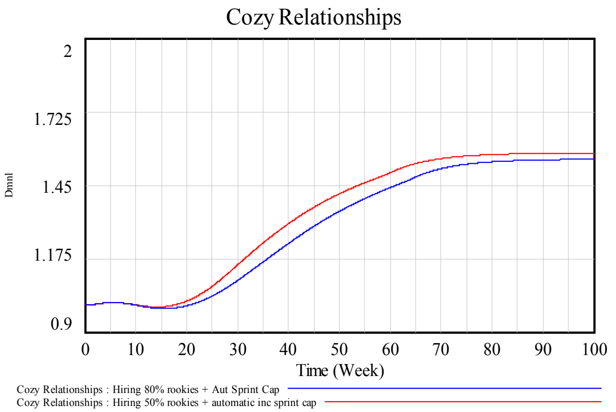

Figure 82 – Development of cozy relationships from the two different hiring strategies

Driven by these findings, we explored Company A's experience mix policy outside the financial sector, which involves hiring 80% rookie staff ('Hiring 80% rookies + Aut Sprint Cap'). This scenario highlighted the critical role of the experience mix, resulting in 8.3% schedule overruns and 38.49% cost overruns compared to initial plans, significantly higher than those with a more experienced team. This scenario also necessitated substantial overtime, contributing to higher error rates and employee fatigue. Conversely, relational capital remained low during the initial project phase, exhibiting lower levels of cozy relationships as depicted in Figure 82, lowering its negative effects. One critical analysis stands out regarding staffing decisions: investing in experienced staff guarantees better results than investing in rookies.

To explore the synergistic effects of combining literature-supported and Company A practitioner-driven policies, we evaluated a strategy that integrated a 'desired relational capital' target with the 50% rookie hiring rule. This approach, common in System Dynamics, leverages the goal as a control variable, underscoring the potential of relational capital management. Recognizing the inherent tendency for relational capital to increase in Agile and Hybrid software development, we further augmented this policy by progressively raising the desired relational capital throughout the project: starting at 3 (representing no prior joint experience), increasing to 4 at week 10, and reaching 4.5 at week 25. This mirrors real-world efforts by software development companies to manage relational capital through strategies such as standardizing interactions, minimizing non-project-related communication, segregating functions, and establishing quality baselines for deliverables and milestones.

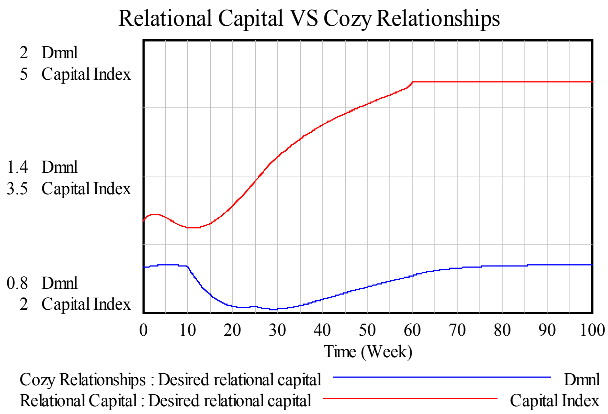

Figure 83 – Evolution of relational capital and cozy relationships when desired relational capital is managed

The results of this combined policy were consistent with the 50% rookie hiring scenario, yielding no schedule overruns but a 32% cost overrun. However, this approach revealed substantial potential for project optimization. By not allowing 'cozy relationships' to grow (Figure 83), increasing the desired relational capital mitigates the detrimental effects of cozy relationships, achieving the lowest probability of error generation (Figure 84), suggesting significant improvements are possible through strategic relational capital management. The project dynamics were notably altered: reduced errors led to a less intensive rework cycle and a lower overall workload compared to scenarios without relational capital management. Furthermore, monitoring (Figure 85) and goal definition pressure remained constant (Figure 86), and acceptance pf quality cuts dumped (Figure 87), eliminating any acceptance of quality compromises. This sustained focus on quality results in superior overall quality deliverables. This policy underscores the necessity for further research to fully capitalize on the dynamic shifts introduced by relational capital management.

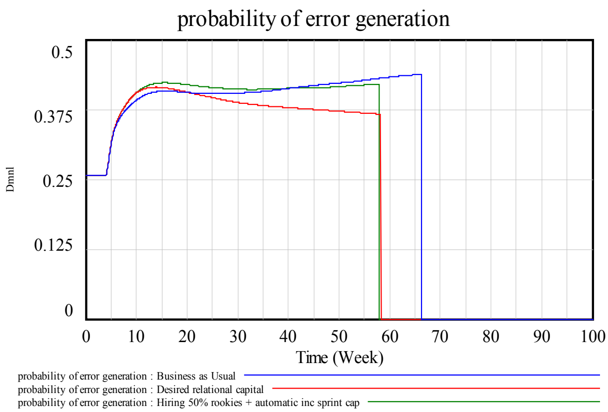

Figure 84 – Probability of error generation for business as usual, manage the desired relational capital and hiring policies

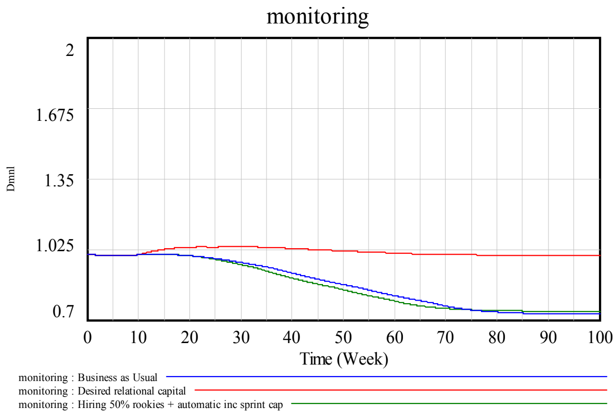

Figure 85 – Comparison between managing or not desired relational capital for monitoring

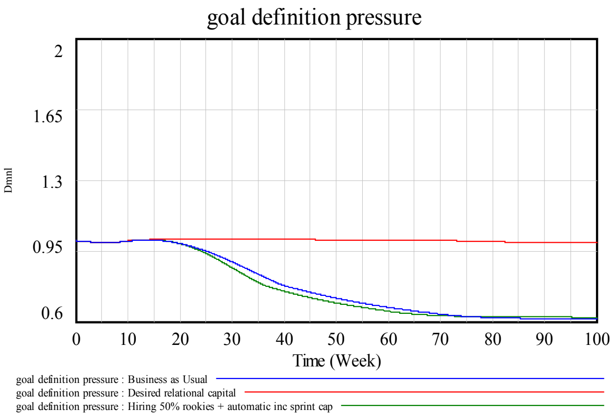

Figure 86 – Comparison between managing or not desired relational capital for goal definition pressure

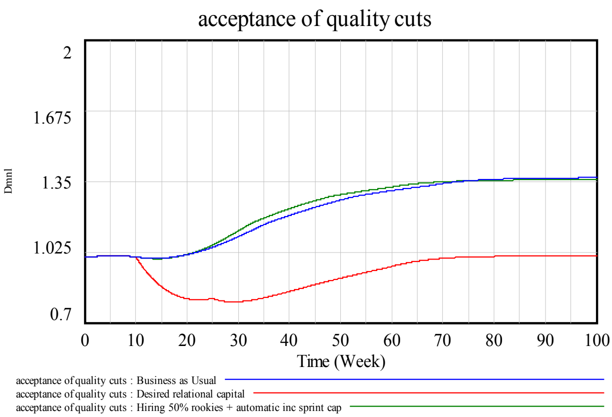

Figure 87 – Comparison between managing or not desired relational capital for acceptance of quality cuts

Due to Company A's difficulties in having additional staff readily available to increase project staff, we sought to evaluate the isolated effect of relational capital management on project outcomes, distinct from the influence of staff hiring. Therefore, we compared a relational capital management intervention to a business-as-usual control. The findings indicated that active relational capital management did not yield a substantial improvement in cost and schedule performance, with both scenarios experiencing approximately 15% overruns. Nevertheless, the intervention was associated with a statistically significant reduction in error generation across the project's phases. Although the final results for the overruns are similar, the project dynamics are very different.

This study evaluated the impact of external project management support, a strategy increasingly employed in Agile and Hybrid software development, on project outcomes. Externalizing roles such as project manager, Scrum Master, and product owner are common in these environments. Compared to a business-as-usual baseline, implementing external project management support alone (run: External PM Support Without Hiring) significantly reduced schedule overruns from 15% to 6.67%, albeit with a marginal increase in cost overruns from 14.66% to 16.17%, despite the added project management costs.

Building upon the observed influence of relational capital management, we then tested a combined approach: external project management support with active relational capital management (run: External PM Support – Hiring + Desired Relational Capital). This combination further improved performance, resulting in a 5% schedule overrun and a 13.77% cost overrun. This supports the hypothesis that while relational capital management may have limited independent impact, it can enhance other project management strategies by introducing improved control dynamics.

To comprehensively assess the effects of external project management support, we investigated two additional policy combinations. First, we combined external project management support with the hiring of 50% Rookies (run: External PM Support). This resulted in a further schedule improvement, completing the project one week before initially planned, matching the performance of a pure staffing strategy. However, cost overruns significantly increased to 26.55% (compared to 13.77% without hiring), illustrating the inherent trade-off between schedule and cost. Notably, this strategy yielded lower cost overruns than the pure staffing strategy (26.55% vs. 29.99%), despite the added project management costs. This approach also demonstrated a significant increase in "Cozy Relationships," a decrease in workweek duration (returning to normal around week 35) as depicted in Figure 88, and a substantial reduction in error generation (Figure 89), leading to fewer total project hours.

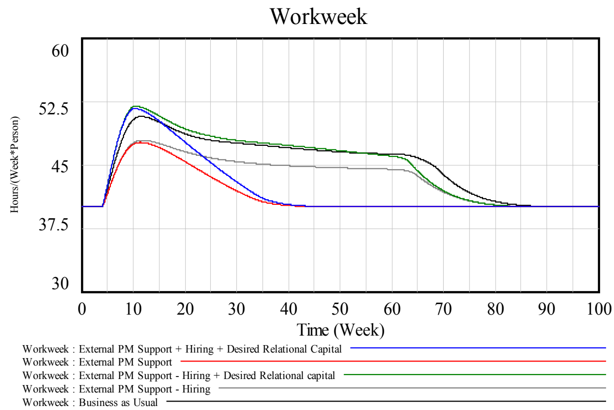

Figure 88 – Comparison of workweek results for the combination of policies using external project management support

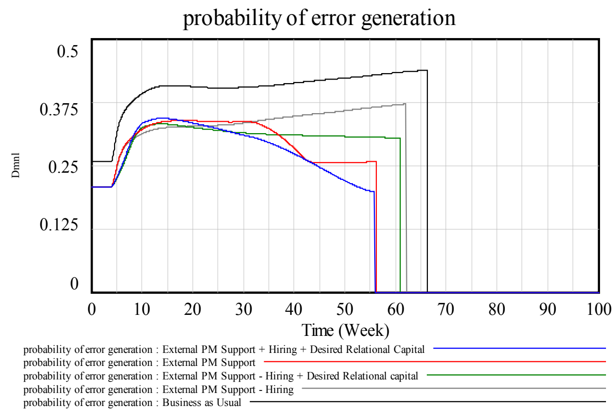

Figure 89 – Comparison of probability of error generation results for the combination of policies using external project management support

Second, we tested the combination of external project management support, hiring, and active relational capital management (run: External PM Support + Hiring + Desired Relational Capital). This resulted in a reduction of cost overruns from 26.55% to 25.08% while keeping the completion one week ahead of schedule compared to the policy without managing relational capital. These improvements stemmed from reduced staffing needs in later project stages and lower error rates, as illustrated in Figure 90 and Figure 91. The reduced error rates and staffing needs are attributed to a distinct dynamic, similar to that observed in the previous scenario using relational capital management.

Specifically, as Figure 91 reveals, relational capital management dampened "Cozy Relationships," mitigating the negative effects on monitoring, quality cut acceptance, and goal definition pressure, thereby maintaining standards closer to initial values. This effect may be particularly beneficial for long-term or subsequent projects.

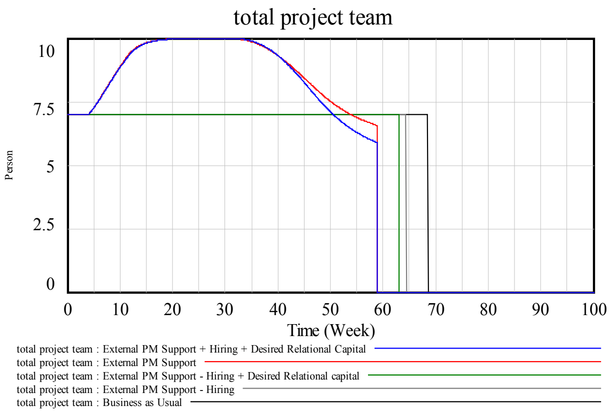

Figure 90 – Comparison of project team results for the combination of policies using external project management support

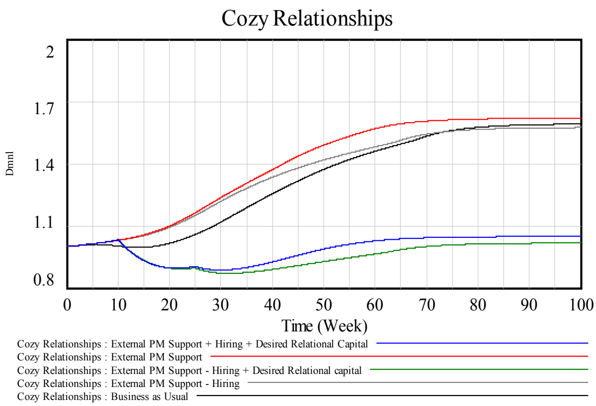

Figure 91 – Comparison of cozy relationships results for the combination of policies using external project management support

8.5.3 Details on the relational capital sector

Appendix 5 details the novel relational capital framework within our System Dynamics model. Relational capital is quantified using Barão and Silva's (2011) 1-5 scale, aligning with established research. In this scale, 1 indicates minimal relational capital, 3 represents a neutral starting point without prior project biases, and 5 denotes maximum relational capital. Therefore, new projects with new clients and teams begin at level 3. This approach strengthens theoretical alignment and enhances both model applicability and empirical data integration.

8.5.3.1 The accumulation of relational capital

The accumulation of relational capital, grounded in social capital theory—specifically Relational Capital Theory—is central to understanding Agile and hybrid project dynamics. As discussed in Section 4.3.2, these methodologies foster continuous client-service provider collaboration (Beck *et al.*, 2001), generating sustained interactions (Villena, Revilla and Choi, 2011; Cummings and Dennis, 2018) that cultivate strong interpersonal bonds (Aisyah, Sukoco and Anshori, 2019). Relational capital, defined as the network of personal relationships developed over time (Cummings and Dennis, 2018), is significantly amplified by Agile's collaborative practices, resulting in a complex interplay of beneficial and detrimental outcomes.

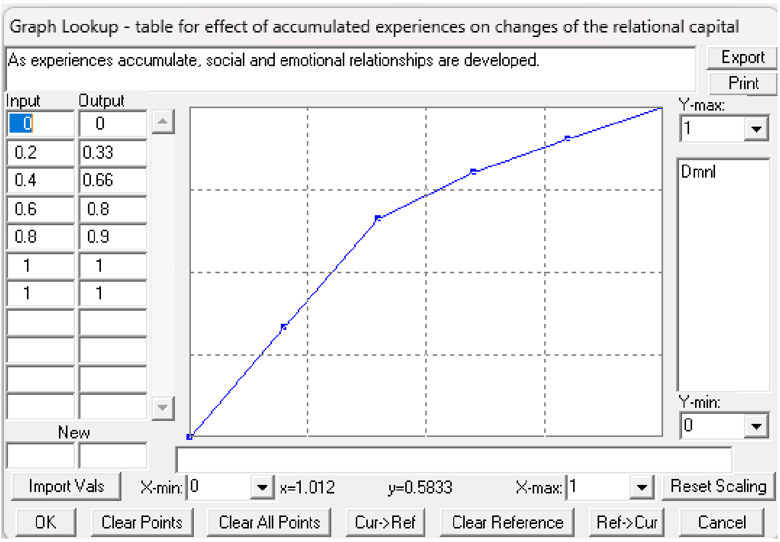

Figure 92 – Nonlinear function for the effect of accumulated experiences on changes in relational capital

In Agile software development, the inherently collaborative nature of the process—daily meetings, sprint planning, reviews, and ongoing communication—constitutes a substantial investment of time and effort, directly contributing to relational capital development. The 'Effect of Accumulated Experiences' captures this relational capital accrual through a nonlinear function (see table for the effect of accumulated experiences on changes in relational capital), as depicted in Figure 92.

The relational capital accrual function exhibits a rapid initial increase, reflecting the establishment of the team-client relationship, followed by a gradual maturation phase. This dynamic is grounded in relational capital and value co-creation literature, which emphasizes interactions as value-generating.

Relational capital is influenced by three key factors: accumulated experiences, quality impact, and deadline impact. Quality impact integrates three measurable quality dimensions: error generation probability, service capacity, and work quality. Deadline impact quantifies the effects of schedule alterations. An arithmetic average of these three effects – accumulated experiences, quality impact, and deadline impact – determines the overall relational capital change. While a multiplicative approach was considered, we adopted Sterman's (2000, p. 528) additive model, which is appropriate when effects are strongly separable, a condition we posit for these three factors. Notably, quality impact is derived from a multiplicative perception-quality effect. Furthermore, the inherent mitigation of extreme scenarios within Agile methodology supports the additive approach's suitability for our empirical context.

The model incorporates a 'Desired Relational Capital' variable to simulate organizational efforts in actively managing this critical resource. Software development companies are increasingly standardizing client-team interactions to define acceptable and desirable relationship parameters. While this represents a simplified subsystem warranting future research, the 'Desired Relational Capital' variable facilitates the exploration of strategic relational capital management. Companies can establish target relational capital levels based on its impact on project outcomes. Achieving these targets requires (1) understanding relational capital's influence on projects (a primary research focus) and (2) implementing effective management levers (e.g., team rotation, controlled social interactions, matrix structures, control milestones), a domain for future inquiry. Organizations are transitioning from unstructured social events to controlled management practices, reflecting a growing awareness of the need to balance relationship building with control to optimize project outcomes while mitigating potential negative effects (Villena, Choi and Revilla, 2021).

8.5.3.2 Positive effects

Client involvement is integral to Agile methodologies, exemplified by daily meetings, sprint reviews, and planning sessions. As detailed in Section 2.1, the Agile Manifesto emphasizes continuous collaboration between service providers and customers (Beck *et al.*, 2001). This ongoing interaction facilitates the incorporation of software requirements and user feedback, ensuring continuous evaluation of quality, functionality, and customer satisfaction (Repenning, Kieffer and Repenning, 2017; GAO, 2020). This process is inherent to Agile and hybrid development, requiring no additional investment beyond standard project execution.

While relational capital yields various benefits, including increased trust and collaboration, our interviews highlighted improved communication as the primary outcome, often encompassing these other factors. Furthermore, within our modeling framework, these secondary benefits are represented as a direct effect on software development capacity. Therefore, we focused on improved communication as the principal effect of relational capital, aligning with both empirical findings and our modeling strategy. This approach captures the most salient and directly observable impact of relational capital within our study's context.

To accurately reflect both literature and practitioner insights, we developed two nonlinear variables: the effect of relational capital on communication and the effect of communication on service capacity. The simplified representation of the effect of relational capital on communication is depicted in Figure 93, and explains that relational capital accrual, driven by project progress and accumulated experience (Villena, Revilla and Choi, 2011), enhances communication efficacy (Gligor and Holcomb, 2013) and deepens shared business knowledge (Noordhoff *et al.*, 2011; Lee and Ha, 2018; Martins, Duarte and Costa, 2018).

The estimation of this nonlinear function, following Sterman's (2000) methodology, resulted in an S-shaped format with specific characteristics. Firstly, a normalized relational capital of one yields a neutral effect on dialogue, ensuring no impact. Secondly, a normalized relational capital of zero implies relational difficulties, leading to a decrease in communication. Thirdly, a saturation point exists beyond which increased normalized relational capital does not further enhance communication. We posited that the maximum effect of normalized relational capital on communication is limited to a 20% deviation from the baseline value, representing the communication level under initial conditions without prior shared experiences.

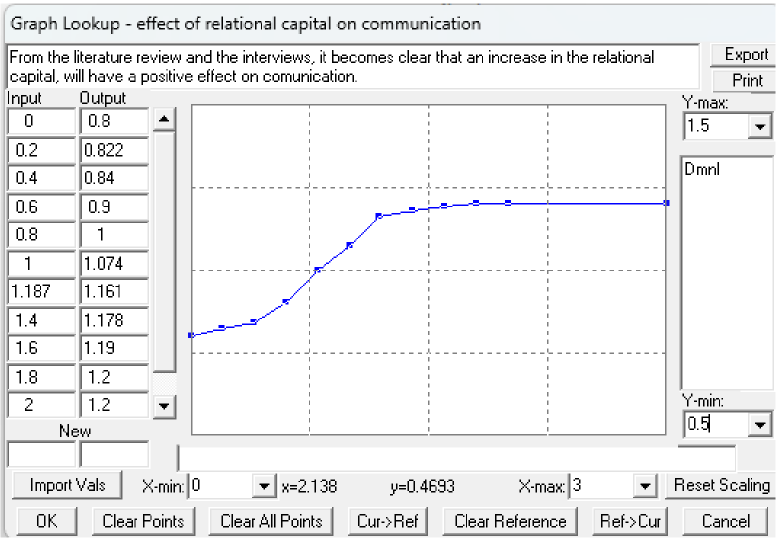

Figure 93 – Effect of relational capital on communication

The second nonlinear function, 'effect of communication on service capacity' (Figure 94), models the impact of enhanced communication efficacy (Gligor and Holcomb, 2013) and deepened shared business knowledge (Noordhoff *et al.*, 2011; Lee and Ha, 2018; Martins, Duarte and Costa, 2018) on software development capacity (Aisyah, Sukoco and Anshori, 2019; Zardini, Ricciardi and Rossignoli, 2015; Bagdoniene and Valkauskiene, 2018). This improved capacity, in turn, accelerates project progress, reinforcing relational capital accrual.

Knowledge sharing reduces the experienced employee's training time down to a threshold, freeing up resources for development tasks and enhancing software development capacity. These observations align with interview testimonies, where project managers consistently reported that improved communication accelerates team interactions, fosters "less formal"[1] exchanges, and reduces both rookie training time and daily problem resolution[2].

1. Description often used in the interviews conducted to the project managers.
2. Problems such as authorizations and validations both from the service provider and the client.

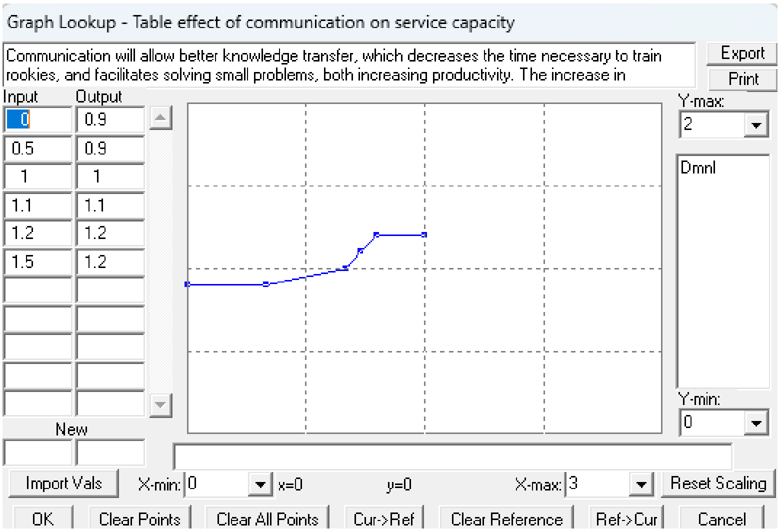

Figure 94 – Effect of communication on service capacity

The 'effect of communication on service capacity' (Figure 94) is modelled as a nonlinear function, where a communication level of one yields a neutral effect on productivity. The upper and lower saturation points are set at 20% and 10% variations in software development capacity, respectively. These boundaries acknowledge the inherent constraints of labor intensity on productivity gains (Oliva and Sterman, 2010). The interviews conducted, highlight communication's critical role in mitigating daily project challenges, significantly improving software development capacity.

It is important to acknowledge that these simplifications are subject to further refinement and may vary across organizational contexts, although we anticipate only minor adjustments would be necessary.

8.5.3.3 Negative effects from cozy relationships

As detailed in Section 4.3.2, relational capital can engender "cozy relationships," potentially leading to diminished monitoring, lowered standards and goals, and distorted quality perceptions, ultimately impacting project performance in terms of cost, schedule, and quality. To model the impact of cozy relationships on software development capacity, we employed the same two-stage nonlinear function approach used previously. The first function captures the effect of cozy relationships on behavioral patterns, while the second models the effect of these behavioral patterns on software development capacity.

8

8.5.3.3.1 The effect of monitoring on project performance

The 'effect of cozy relationships on monitoring' function, presented in Figure 95, mirrors Oliva and Sterman's (2010) quality assessment nonlinear function, featuring a tolerance zone around the neutral value. This function reflects interview insights, indicating that when cozy relationships are at a neutral level (value of one), the system is in equilibrium. Values exceeding one signify monitoring relaxation, consistent with the literature (Villena, Choi and Revilla, 2019; Villena, Choi and Revilla, 2021), as discussed in Section 4.4.1. Conversely, values below one indicate the absence of cozy relationships and the presence of tense relationships, resulting in heightened monitoring, sometimes used as a tool by the customer against the service provider[3].

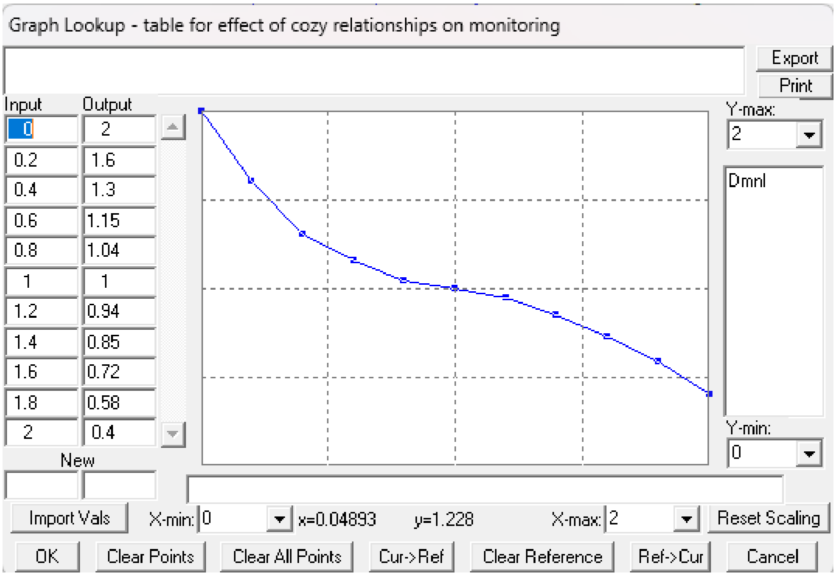

Figure 95 – Nonlinear function for the effect of cozy relationships on monitoring

As established by Oliva and Sterman (2010), and corroborated by our interviews, reduced monitoring amplifies error rates. This relationship is modeled by a nonlinear function, depicted in Figure 96, which exhibits almost an inverted S-shape. This function demonstrates that the probability of error generation fluctuates significantly near the neutral value, but plateaus at the extremes. This reflects the logical argument that even with complete monitoring absence, error rates will not exceed a certain threshold. However, to align with project manager descriptions, the variation is set at 50% on either side of the spectrum. By

3. Description often used in the interviews conducted to the project managers.

influencing the probability of error generation, monitoring directly impacts project progression, as increased errors necessitate resource reallocation for rework.

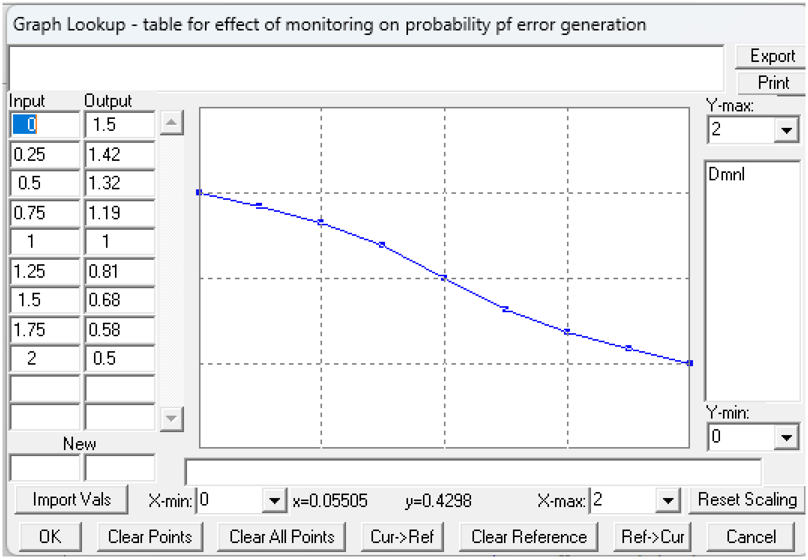

Figure 96 – Nonlinear function for the effect of monitoring on error generation

8.5.3.3.2 The effect of the acceptance of quality cuts on project performance

To explain how cozy relationships impact project performance, we model their potential to precipitate an erosion of performance and quality standards (Villena, Choi and Revilla, 2021), leading to a decline in software development capacity. This process is analyzed in detail by Oliva and Sterman (2001; 2010) referred to as cutting corners. Software is mostly intangible and therefore difficult to measure (Oliva and Sterman, 2001; Oliva and Sterman, 2010). This difficulty increases when clients are evaluating their work because of their intense participation in the service delivery, which in turn makes it easier to accept some quality concessions or some cutting corners as Oliva and Sterman put it in their 2001 paper.

The model captures these effects through two nonlinear variables: 'acceptance of quality cuts,' which measures the impact of cozy relationships on the willingness to accept quality deviations, particularly from the customer, and 'effect of quality pressure on expected service capacity,' which quantifies the resulting service capacity changes.

The 'acceptance of quality cuts' function, depicted in Figure 97, reflects the behavioral shift when relational motives increase, leading clients to accept minor quality reductions. Despite being widely documented in the dark side of relationships literature, project managers often struggle to explicitly acknowledge this phenomenon, even when providing illustrative examples. This function exhibits three key characteristics: firstly, a cozy relationship value of one yields a neutral effect on quality cut acceptance; secondly, a value of zero, similar to monitoring, implies no acceptance of quality loss. While one might expect no impact for values below one, interviews revealed instances of relationship strain leading to increased performance pressure; thirdly, the upper saturation point is set at 1.55, indicating a maximum customer tolerance of 55% quality deviation (authors' estimation).

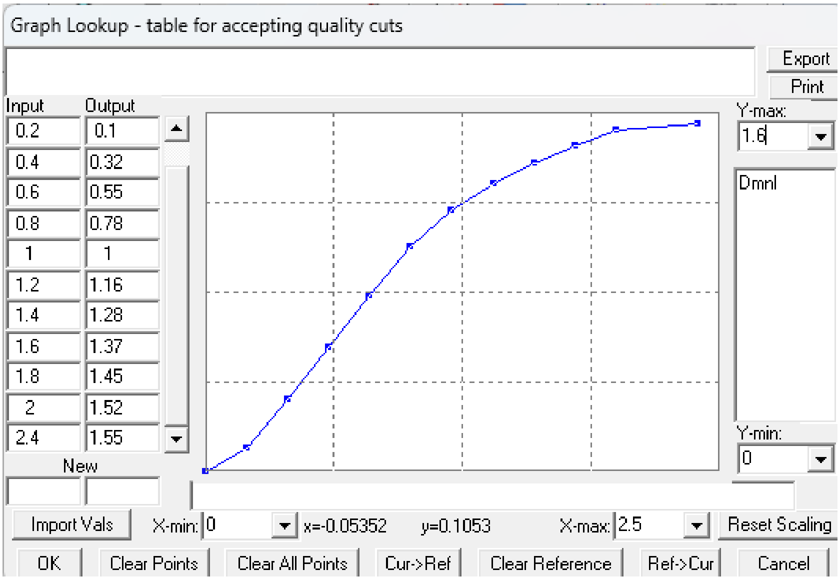

Figure 97 – Nonlinear function for the effect of cozy relationships on accepting quality cuts

The effect of quality pressure on expected service capacity depicted in Figure 98 follows the same assumptions used by Oliva and Sterman (2010) for creating the nonlinear function for service quality but inverted. There is a tolerance zone around the reference point of (1; 1) meaning that around that area, the customers' behaviors are harder to change. On the other hand, at the extremes, they are easily changeable. This effect influences service capacity for software development but also expected service capacity, mimicking the process of the adjustments to the new standards and expectations of the parties (Lusch, Vargo and O'brien, 2007; Payne, Storbacka and Frow, 2008; Komulainen, 2014; Neghina *et al.*, 2017).

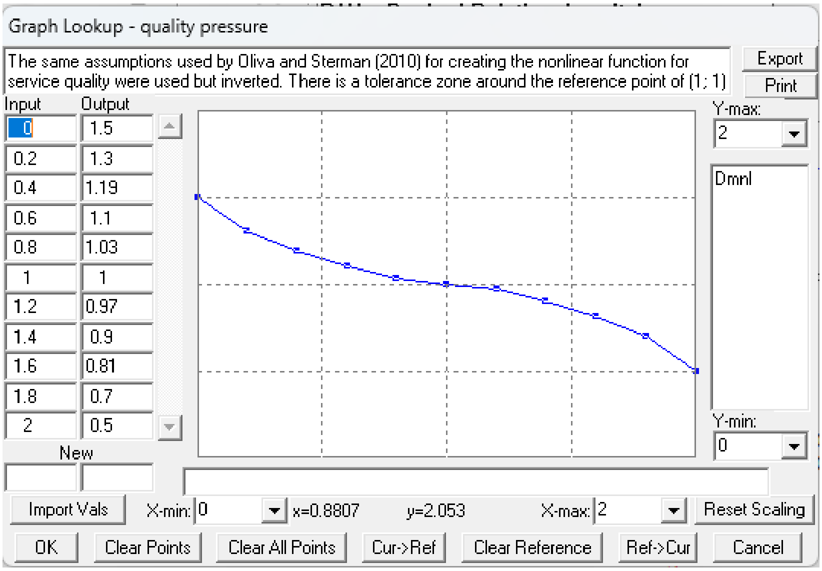

Figure 98 – Nonlinear function for the effect of quality on project performance

8.5.3.3.3 The effect of goal definition pressure on project performance

The final effect of cozy relationships that the model explores is the effect of goal definition pressure on performance. Cozy relationships contribute to the blurring of boundaries between service providers and customers (Pillai *et al.*, 2017), hindering the formulation of adequate goals (Villena, Revilla and Choi, 2011; Johnsen and Lacoste, 2016; Villena, Choi and Revilla, 2021) regarding schedules, milestones, capacity, and functionalities, and hindering the unbiased evaluation as customers are evaluating the work where they have an important contribution.

Project managers observed that deep customer involvement facilitates goal and schedule adjustments when necessary, due to increased awareness of project constraints. This feedback loop is well-documented in the literature (Lyneis and Ford, 2007; Oliva and Sterman, 2010), with Abdel-Hamid (1999) specifically addressing the influence of goals on project performance.

The model captures these effects through two nonlinear variables: “impact of relational capital on goal definition pressure” and “effect of goal definition pressure on goals”.

As discussed in Section 4.3.2, evidence suggests that increased cozy relationships correlate with decreased goal definition pressure, particularly with active client participation. The 'impact of relational capital on goal definition pressure' function (Figure 99) exhibits four key characteristics: firstly, a neutral effect on goal setting occurs when goal definition pressure is one; secondly, maximum goal increase pressure occurs when cozy relationships are zero, reflecting potential schedule pressure due to deteriorated relationships; thirdly, a negative slope indicates decreasing schedule pressure with increasing relational motives; and fourthly, a saturation point (2) exists, beyond which further increases in cozy relationships do not decrease goal definition pressure below 0.5.

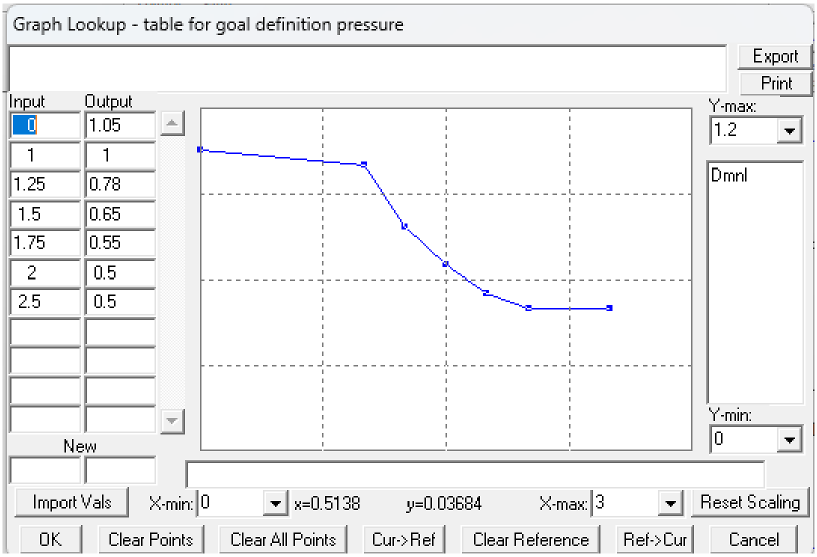

Figure 99 – Nonlinear function for the effect of cozy relationships on goal definition pressure

The 'effect of goal definition pressure on goals' (Figure 100) is modeled using a nonlinear variable, simplifying the modeling effort while capturing relevant dynamics from project management and System Dynamics literature. To further simplify model comprehension, ripple effects of increased goal definition pressure are omitted, as their inclusion would only exacerbate negative impacts when goal definition pressure falls below one. This function, inspired by Oliva and Sterman (2010), features a tolerance zone around baseline values, with more pronounced changes at extreme relationship conditions. This aligns with interview findings, indicating minimal goal-setting pressure changes near baseline values, but significant variations with strong or poor relationships.

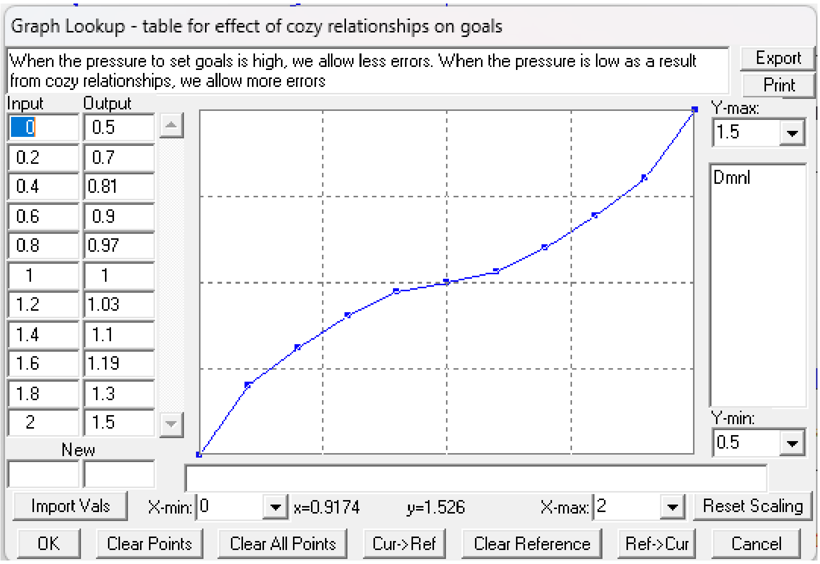

Figure 100 – Nonlinear function for the effect of goal definition pressure on goals

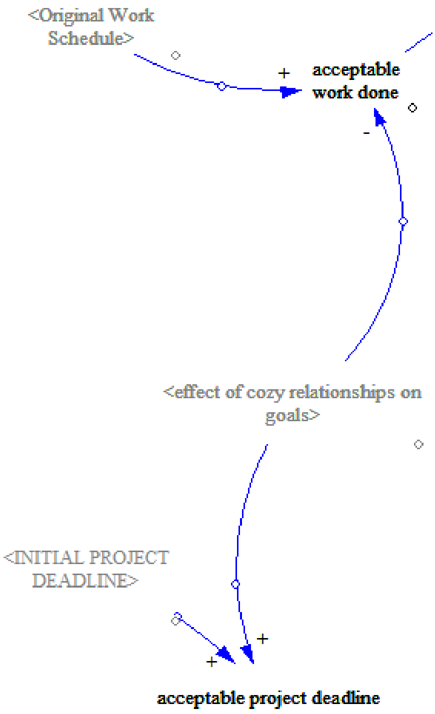

Figure 101 – Example of how goals affect projects' performance

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The 'effect of goal definition pressure on goals' is pivotal in elucidating the dynamics affecting project performance. This effect influences the acceptable probability of error generation, project deadline, work completion, and perceived service capacity gap for software development (Figure 101 provides an illustrative example). As confirmed by the dark side of relationships literature, increased cozy relationships foster a tendency to define progressively lower goals, reflecting an adjustment to declining expectations (Sterman, 2000). Adopting Oliva and Sterman's (2010) approach to measuring service quality (expectations minus perceptions), we propose quantifying quality across these four dimensions. The setting of lower goals, in turn, reduces expectations, creating a complex dynamic that may partially explain the limited reported ruptures between customers and service providers, despite substantial overruns documented by specialized media (see Introduction).

8.6 Appendix 6 – Agile and Hybrid project management methodologies details

8.6.1 The Agile method

Agile project management, defined as an iterative, incremental, and adaptive approach (GAO, 2020; Beck et al., 2001), thrives in dynamic environments with frequent requirement changes. The Agile manifesto (Beck *et al.*, 2001) defined a set of principles that generated several frameworks, from which Scrum has established itself as one of the most important Agile frameworks, garnering widespread adoption and recognition among practitioners and organizations (Imani, Nakano and Anantatmula, 2017; Cooper and Sommer, 2018; Yahya and Maidin, 2023).

Starting with the roles, the scrum team includes at least the Product Owner, Scrum Master, and Development team, and they collaborate to deliver tangible results at regular intervals. The main responsibilities of each role are:

- Product Owner (PO) - responsible for ensuring that the development team builds the right features in the right order to maximize value for the business and end-users. The PO defines the product vision, manages the backlog and establishes the priorities for the features to be implemented, define user stories with acceptance criteria that articulate the functionality from an end-user perspective, provides permanent feedback to the team and gathers new requirements and feedback from the different stakeholders, and is critical in the planning processes and in the communication with all stakeholders.
- Scrum Master (SM) - responsible for the facilitation and coordination of all Agile events (Sprint Planning, Daily Standups, Sprint Review, and Sprint Retrospective), helping the team to use the processes effectively, empowering the team, coaching, solving conflicts, and finally, track and report relevant metrics that help the team and the organization assess progress and make informed decisions.
- Development team - responsible for the software development transforming product backlog items into working software, collaborating with the product owner to understand and implement the highest-priority backlog items. The service provider often includes the project manager role that is responsible for the project overall and takes the planning decisions from the service provider's perspective. The client may include one product manager that

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helps the Product Owner to define the product strategy and prioritize the necessary developments to achieve the goals of the product or project.

Moving forward to explaining the artifacts, they are oriented to track progress and maintain transparency, providing valuable insights into the project's status. These artifacts include:

- Product or Project Backlog - A prioritized list of desired features and functionalities captured from requirements, which can be very small and vague in the case of pure Agile (Cao, 2022). The project backlog is divided into elements, called release backlog, that represent integral parts of the total project that can be used as soon as they are delivered. This gives the project the incremental character that allows a faster start compared to traditional methods that release the project only when all the agreed features and functionalities are developed and tested.
- Sprint Backlog – A subset of the project backlog selected for the current sprint, containing specific tasks to be completed within the sprint duration. The sprint, usually between two to four weeks, is where the software development takes place and is supported by formal meetings known as ceremonies. Throughout the sprint, the software is being developed, tested and validated and at the end of the sprint there is an evaluation of what was done, to learn important lessons for the future and decide if what was done can be integrated into the increasing stock of work considered done.

Finally, the ceremonies are critical in supporting the Agile Scrum's process fostering collaboration and reflection. Scrum ceremonies provide structured opportunities for collaboration, reflection, and adaptation, where the project's team engages in an intense co-creation process. These ceremonies include:

- Sprint planning – meeting where the team defines the sprint backlog, selecting tasks from the project backlog and estimating their effort.
- Daily scrum – fifteen minutes daily meeting where team members share updates on their progress, identify roadblocks, and seek assistance.
- Sprint review – meeting held at the end of the sprint where the team demonstrates the completed increment to stakeholders, seeking feedback and incorporating it into future sprints.
- Sprint retrospective – meeting where the team reflects on the past sprint, identifying areas for improvement and adjustments for future sprints.

8.6.2 The Hybrid method

Hybrid methodologies combine plan-driven with Agile approaches in an attempt to bridge the gap between upfront planning and iterative development, offering flexibility for changing requirements while maintaining structure for long-term success. The Hybrid methodologies promote clear commitments regarding time and cost, demanding a thorough understanding of initial requirements and goals.

The most common Hybrid combinations are:

- Water-Scrum-Fall: This method leverages Waterfall for the initial and final phases (requirements gathering and testing) while employing Agile Scrum for the development phase itself (West *et al.*, 2011).
- Waterfall-Agile: This approach utilizes Waterfall exclusively for the initial phase, focusing on requirements definition and planning, before transitioning to Agile for the remaining project duration (Hassani, El Bouzekri El Idrissi and Abouabdellah, 2018).
- Hybrid V-Model: This variant utilizes the V-model for the initial and final phases (integration and system testing) while employing Scrum for the development phase, encompassing implementation and unit testing (Hayata and Han, 2011).
- Scrum-Stage-Gate: This approach integrates the Stage-gate model throughout the project for administrative and strategic activities, while simultaneously running Scrum for the operational tasks throughout the project's lifespan (Conforto and Amaral, 2016; Cooper and Sommer, 2018).

8.7 Appendix 7 – Dedicated appendixes of Chapter 4

8.7.1 Perceived importance of relational capital by project managers

Table 14 - Perceived importance of relational capital by project managers

Interview Number	Is relational capital critical?	Do relationships evolve into friendship?	Citations
I1	Yes	Yes	"Improves communication and facilitates decision making; Avoids problems at the end; Increases the probability of winning new projects." "It is getting easier to convince the client about project decisions"
I2	Yes	Yes	"Improves communication. Improves the management of expectations. Improves Project Management. Improves the definition of requirements." "I even think the client becomes more satisfied with the job being done... The client starts to accept our opinions."
I3	Yes	Yes	"Developing close relationships is important because it improves communication and knowledge transfer. Improves the management of expectations, which improves the client's quality perceptions, and reinforces the client's commitment." "When you develop relationships and you work with the client for several years, he will always trust you and he will understand if things go wrong."
I4	Yes	Yes	"Friendship emerges naturally from working over extended periods and sharing problems and goals. They tend to understand the problems we face and help us deal with them."
I5	Yes	Yes	"You must understand that the relationship between us and the client evolves over time and allows us to improve our knowledge about the client and their needs, and to overcome problems". "When you have a good relationship with your client it is easier to overcome moments of tension".
I6	Yes	Yes	"Intimacy in this relationship can result in better solutions. It becomes easier to identify the value of our propositions, ideas, and estimations. Motivating the client's team to actively participate is critical".

Table 14 - Continued

Interview Number	Is relational capital critical?	Do relationships evolve into friendship?	Citations
I7	Yes	Yes	"If you have close relationships with your client, it will be easier to solve problems."
I8	Yes	Yes	"You can easily overcome problems, but most importantly you learn more about their needs and their ways of working."
I9	Yes	Yes	"The client provides the business knowledge, and they are the ones who understand the problem that needs to be solved".
I10	Yes	Yes	"When you work together with someone for long periods, you experience drawbacks but also many good results with them, which connects you in a way that everyone understands problems and limitations, being focused on producing the best possible outcome under those limitations." "Because the client is working on the project, he is co-responsible for the decisions, which makes it easier to deal with the schedule overruns."
I11	No	No	"I try to limit my interactions to the mandatory ones from the methodology, and I don't find it useful to develop close relationships or friendships with clients. They are not our colleagues".

8.7.2 Summary of plan VS real project indicators

Table 15 presents the differences between the initial project plans against the real implementation of the projects for the five projects analyzed.

Table 15 - Summary of project data

Project	Type	Cost (Euros)			
		Plan	Real	Diference	%
1	Hybrid	€ 23.778,88	€ 25.536,72	€ 1.757,84	7,39%
2	Hybrid	€ 136.353,45	€ 141.726,35	€ 5.372,90	3,94%
3	Hybrid	€ 56.212,98	€ 62.741,33	€ 6.528,35	11,61%
4	Hybrid	€ 109.782,00	€ 159.560,00	€ 49.778,00	45,34%
5	Agile	€ -	€ -	€ -	
	Average for cost	€ 81.531,83	€ 97.391,10	€ 15.859,27	17,07%
	Simulated project	€ 372.000,00	€ 425.504,00	€ 53.504,00	14,38%
Project		Schedule (weeks)			
		Plan	Real	Diference	%
1	Hybrid	15	17	2	13,33%
2	Hybrid	33	48	15	45,45%
3	Hybrid	21	40	19	90,48%
4	Hybrid	24	44	20	83,33%
5	Agile	0	0	0	
	Average for schedule	23	37	14	58,15%
	Simulated project	60	97	37	61,67%
Project		Staff			
		Plan	Real	Diference	%
1	Hybrid	1,43	1,02	-0,41	-28,50%
2	Hybrid	4,29	2,72	-1,57	-36,54%
3	Hybrid	2,81	1,48	-1,33	-47,23%
4	Hybrid	4,20	2,25	-1,95	-46,32%
5	Agile	4,00	3,83	-0,17	-4,27%
	Average for staff	3,35	2,26	-1,08	-32,57%
Project		Experience Level			
		Plan	Real	Diference	%
1	Hybrid	80,37%	79,41%	-0,01	-1,20%
2	Hybrid	36,73%	36,73%	0,00	0,00%
3	Hybrid	68,49%	54,99%	-0,13	-19,71%
4	Hybrid	36,90%	41,73%	0,05	13,09%
5	Agile	50,00%	59,81%	0,10	19,61%
	Average for experience	54,50%	54,54%	0,00	2,36%

8.8 Appendix 8 – Model validation of Chapter 5

8.8.1 Model validation

Documentation
The model is an integral part of the paper, and the documentation is complete as well as comments on the variables stating the different sources and assumptions.

Replicability
We provide a full simulation matrix in the supplementary materials, with all the parameters that change for each simulation run explored.

Model testing
Of the 12 tests proposed by Sterman (2000), we present the following:

- Boundary adequacy

To ensure the model accurately captures project processes, business rules, and mental models regarding policies, structure, and parameters, all causal loop diagrams, model structures, and the sector model were extensively reviewed by project managers.

The important concepts in the model regarding relationships are endogenous and capture the known dynamics.

- Structure assessment

The model effectively replicates existing knowledge in the field and accurately captures the behavior of the actors involved in the project. The model's design allows for comprehensive independent testing of each individual structure. Consequently, a wide range of simulations and sensitivity tests were conducted on each component, both in isolation and as part of the complete model. This rigorous testing process ensures the model's behavior aligns with established knowledge and expectations.

  - From the simulations conducted to test the structure of the model, its interactions, and identify abnormal behaviors we highlight:
  - Simulating the model having perfect conditions (enough resources) and switching off rework resulted in a behavior exactly as the original plan.
  - Switching on rework results in schedule and cost overruns.

- o The same principle was done to test the consequences of relational capital (Communication, monitoring, quality cuts, and goals) one at a time, staff changes, and scope changes.

- Dimensional consistency

The model contains no unit errors, although presents three warnings due to the use of lookup functions with Units. However, these warnings are similar to Oliva and Sterman (2010) and result from using variables inspired by them.

- Parameter assessment

The model uses previous project management models, Company A's decision rules, project data, and data from interviews to estimate the model's parameters.

- Extreme conditions

When testing the structure of the model, extreme conditions were simulated, helping us to ensure the model's consistency.

- Behavior reproduction

The model's calibration process involved two key steps – Averages Calibration and Specific project calibration.

Averages Calibration: The model was initially calibrated to match the average values observed in project data. Table 15 in Appendix 7 summarizes these results, and Figure 102 presents a simulation comparing the planned and actual outcomes for a dummy project. This comparison demonstrates a good fit with the reference modes presented in Chapter 4.

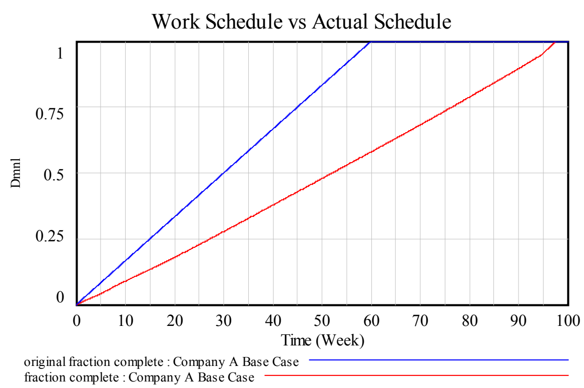

Figure 102 – Model results: Schedule from initial plan versus simulated schedule with chosen policies

Specific Project Calibration: Subsequently, we tested the mode against projects number 1, 2,3, and 4 (see sections 8.9.2 to 8.9.5 for details). The model was calibrated based on the project plan and then further adjusted to reflect the specific execution conditions.

Overall, the model replicates the average behavior of projects and the specific behavior of a project when calibrated to its conditions.

Sensitivity analysis

Following Rahmandad and Sterman's (2012) recommendations we developed additional sensitivity testing for the parameters in Table 12, chosen due to the managers' perceptions about the most important challenges they face.

Table 16 - Monte Carlo parameters and ranges

			Schedule results (Weeks)				Cost Results (Euro)			
Parameter	Lower Limit	Upper Limit	Lower Limit	% Overrun	Upper Limit	% Overrun	Lower Limit	% Overrun	Upper Limit	% Overrun
DESIRED RATIO OF ROOKIES	0,2	0,8	61,25	-4,67%	73,56	14,49%	€ 439.631,00	-8,82%	€ 541.077,00	12,22%
INITIAL NUMBER OF EXPERIENCED	2	4	70,19	9,25%	61,75	-3,89%	€ 511.895,00	6,17%	€ 472.896,00	-1,92%
ROOKIE PRODUCTIVITY FRACTION	0,2	0,4	68,25	6,23%	62,12	-3,32%	€ 519.014,00	7,65%	€ 457.710,00	-5,07%
TIME TO DEVELOP COZY RELATIONSHIPS	4	12	64,44	0,30%	64,31	0,09%	€ 481.347,00	-0,17%	€ 483.050,00	0,19%
Original policy: BAU + Hiring 50% rookies + Improving Feedback Mechanisms			64,25		64,25		€ 482.149,00	0	€ 482.149,00	

Table 16 confirms the crucial project dynamic identified in Chapter 4: increased experienced staff correlates with improved schedule and cost performance, supporting Kunc's (2008) argument. Additionally, improving rookie productivity fraction can lead to significant improvements in projects' outcomes.

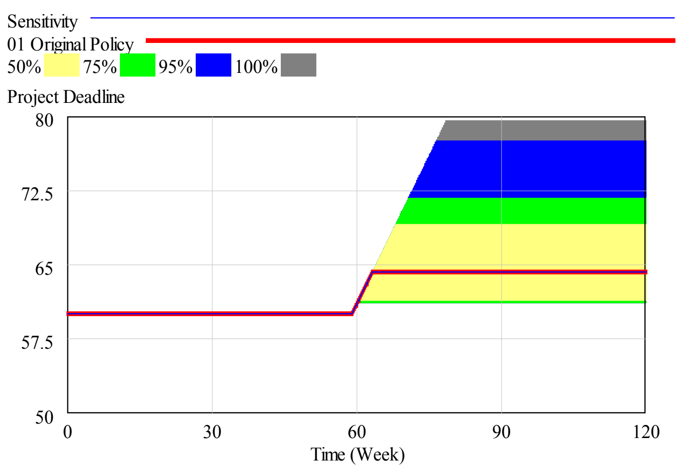

Figure 103 – Monte Carlo simulation results for project deadline

Figure 103 demonstrates significant variability in project deadlines, aligning with both historical project data and simulation results. Notably, the distribution reveals a substantial skew towards deadline extensions, indicating a considerably higher probability of schedule overruns than on-time completion.

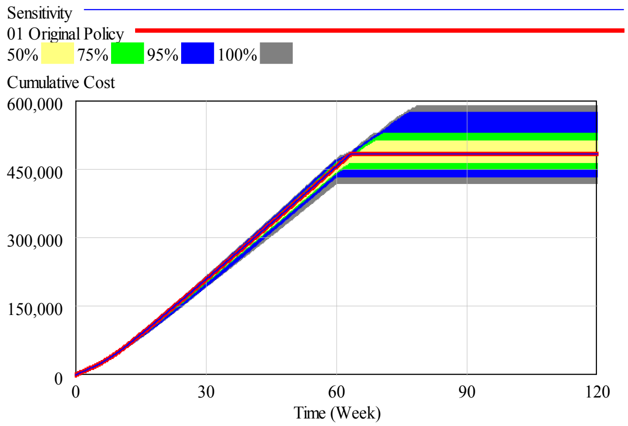

Figure 104 – Monte Carlo simulation results for cumulative cost

Figure 104 shows a narrower range of cost variations compared to project deadlines, consistent with historical data and simulation outputs, suggesting a tendency towards cost adherence, and the potential for cost optimization within current project constraints.

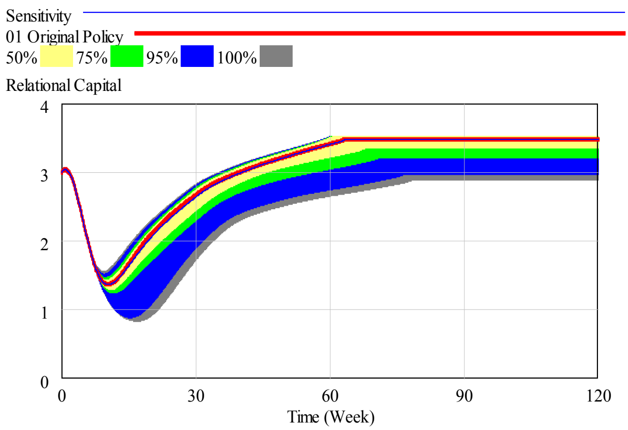

Figure 105 – Monte Carlo simulation results for relational capital

Figure 105 demonstrates considerable variability in relational capital. The distribution exhibits a pronounced skew, indicating an initial decline followed by a subsequent recovery. Notably, the simulation reveals a strong probability of relational capital falling below the baseline is substantial.

8.8.2 Project 1

To establish the model's ability to replicate real-world project behavior, a case study was conducted using data from Project 1, a Hybrid Agile project developed at Company A.

Project 1 was initially planned for a 15-week duration with a team of two full-time developers (one experienced, one rookie) and one project manager. As discussed in Chapter 4, the project started understaffed but maintained a relatively stable resource allocation. This project's final outcomes, which serve as the reference mode for validation, recorded a 13.33% schedule overrun and a 7.39% cost overrun, despite using less staff on average than initially planned.

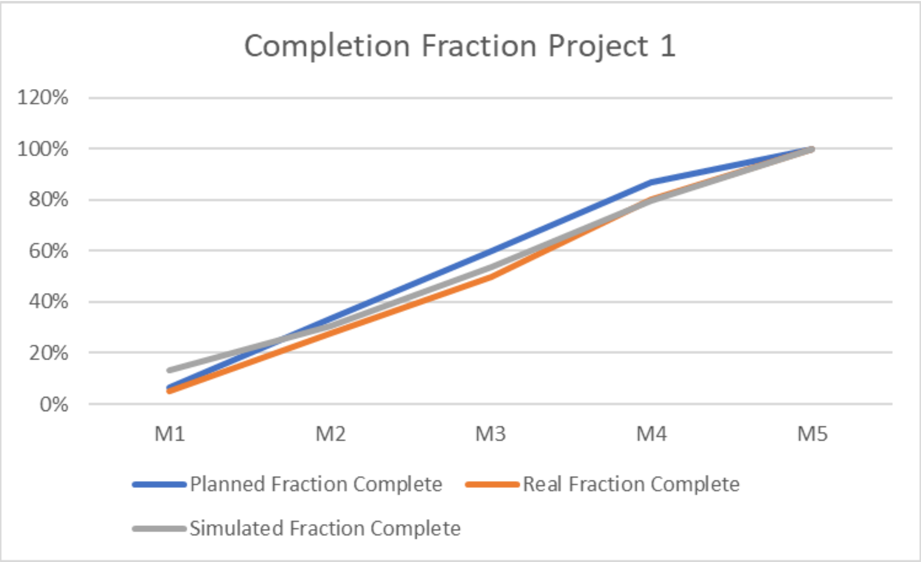

Figure 106 – Planed VS real VS simulated behavior of completion fraction for project 1

The model was calibrated to reflect the specific initial conditions and resource allocation of Project 1. The resulting simulation demonstrated strong behavior reproduction validity, yielding the same schedule overrun and a cost overrun of 12,06%. This close quantitative alignment is further supported by the visual comparison in Figures 106 and 107, which depict a strong fidelity between the real and simulated behavior. As Figure 106 illustrates, the simulated completion fraction curve closely follows the real-world trajectory, diverging from the initial plan in a similar fashion. Figure 107 similarly shows that the model accurately captures the behavior of 'work done' over time, providing strong evidence of the model's realism.

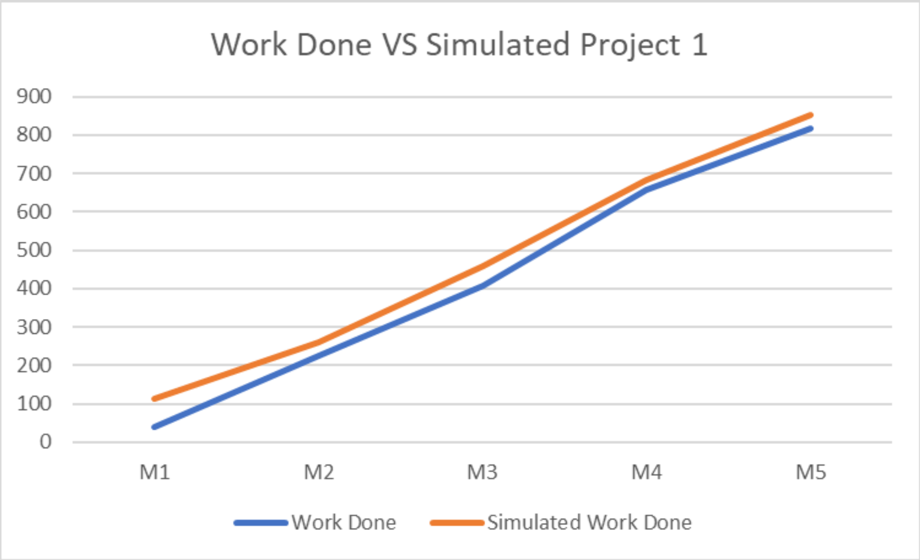

Figure 107 – Real VS simulated behavior of work done for project 1

8.8.3 Project 2

To further establish the model's behavioral validity, a second case study was conducted using data from Project 2. This project was planned for a total of 4.4 staff, with a 63.27% rookie fraction. Notably, for the financial market, staff with up to 5 years of experience are often classified as rookies. The project began severely understaffed with only 0.5 experienced staff and no rookies, a common practice during the initial detailed analysis phase with the client.

The model was calibrated to this unique starting condition. The final project outcome, which serves as the reference mode for validation, recorded a 45.45% schedule overrun and a 3.94% cost overrun. The resulting simulation demonstrated strong behavioral reproduction validity by capturing this behavior well, yielding a similar schedule overrun and a 5.1% cost overrun. This close quantitative alignment is further supported by the visual comparison in Figures 108 and 109, which depict a strong fidelity between the real and simulated behavior.

As Figure 108 illustrates, the simulated completion fraction curve closely follows the real-world trajectory. Similarly, Figure 109 shows that the model accurately captures the behavior of 'work done' over time, demonstrating its ability to replicate the project's actual development process despite a highly atypical initial staffing allocation.

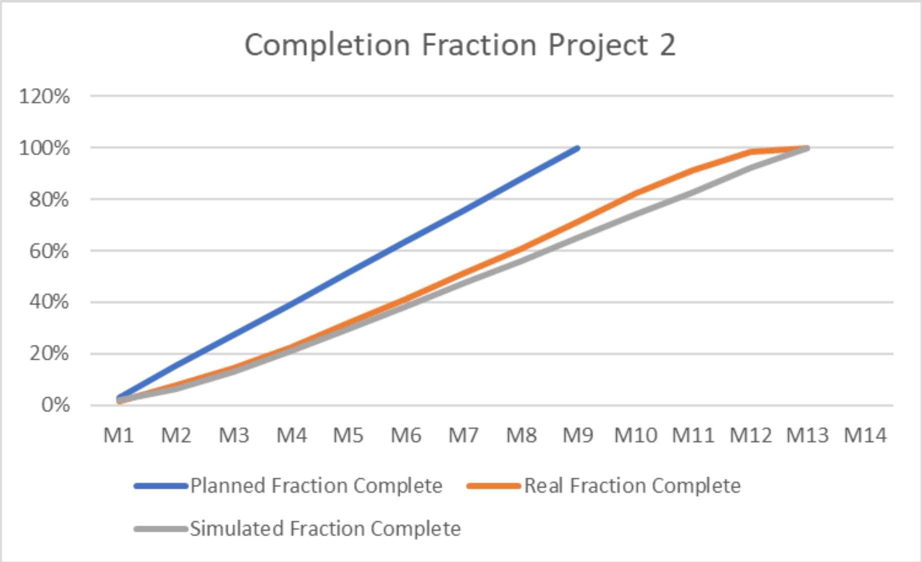

Figure 108 – Planed VS real VS simulated behavior of completion fraction for project 2

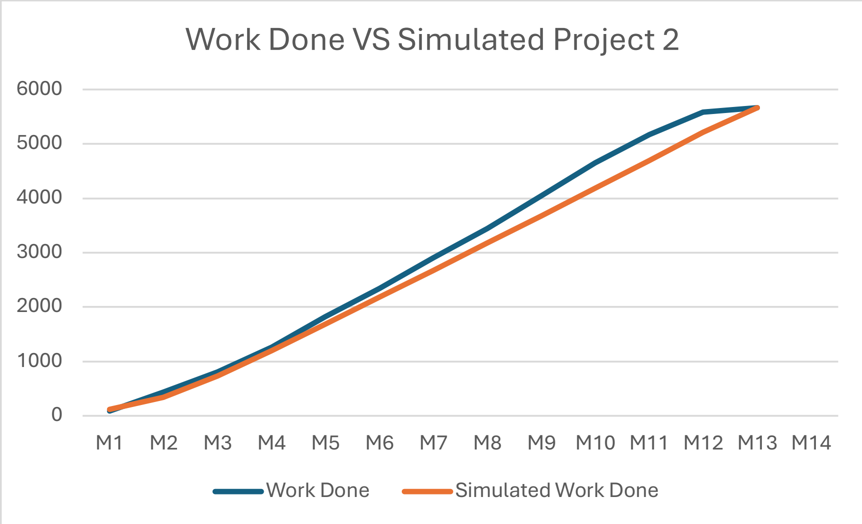

Figure 109 – Real VS simulated behavior of work done for project 2

8.8.4 Project 3

Project 3 represents a more complex case study for validation, demonstrating the model's robustness in replicating highly atypical project behavior. The project was planned for a 21-week duration with 2.8 resources (1.9 experienced, 0.9 rookies). However, it was completed in 40 weeks, resulting in a 90.48% schedule overrun and an 11.61% cost overrun. The project was staffed on average with 47.23% fewer resources than planned.

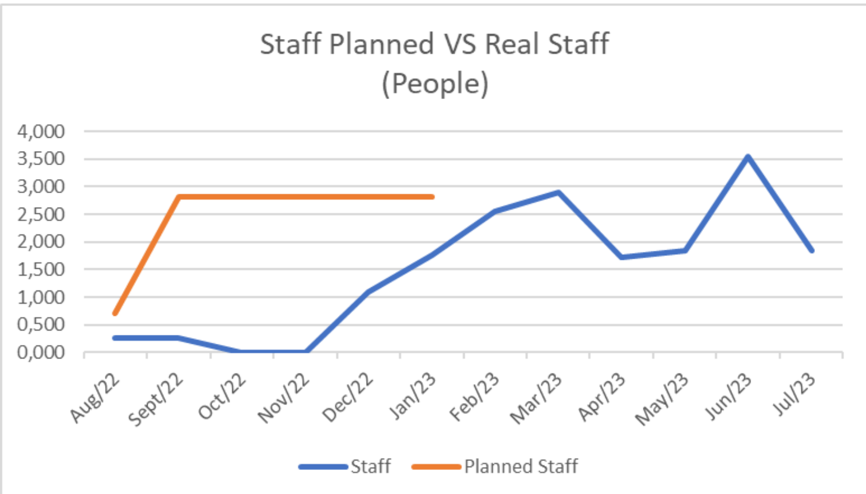

Figure 110 – Planed VS real resource allocation for project 3

A key dynamic of this project's reference mode was a highly oscillating resource allocation, which is generally considered a poor project management practice. As Figure 110 illustrates, this resource allocation pattern directly influenced the project's work done over the period. This oscillation can be attributed to Company A's policy of operating with close-to-full allocation, which necessitates diverting resources from existing projects to new ones and often requires waiting for the hiring process to be completed. Additionally, priorities could be changed to attend to other projects facing challenges.

The model was calibrated to this complex set of conditions, with a key assumption that instead of stopping the project, resources were delayed for one month, reflecting the late start of the project. The resulting simulation demonstrated a strong match with the real project data and provided significant insights. The model produced slightly larger overruns, with a 100% schedule overrun and an 18.53% cost overrun. The discrepancy between the simulated and real outcomes highlights the potential for underreporting in the real project data, a pervasive practice arising from pressure to comply with cost and schedule constraints. Extensive simulations revealed a strong possibility of adding extra staff at later stages but not reporting it, to accelerate delivery of the project. Our most plausible simulation considers a maximum total staff of 4, instead of the slightly above 3 reported.

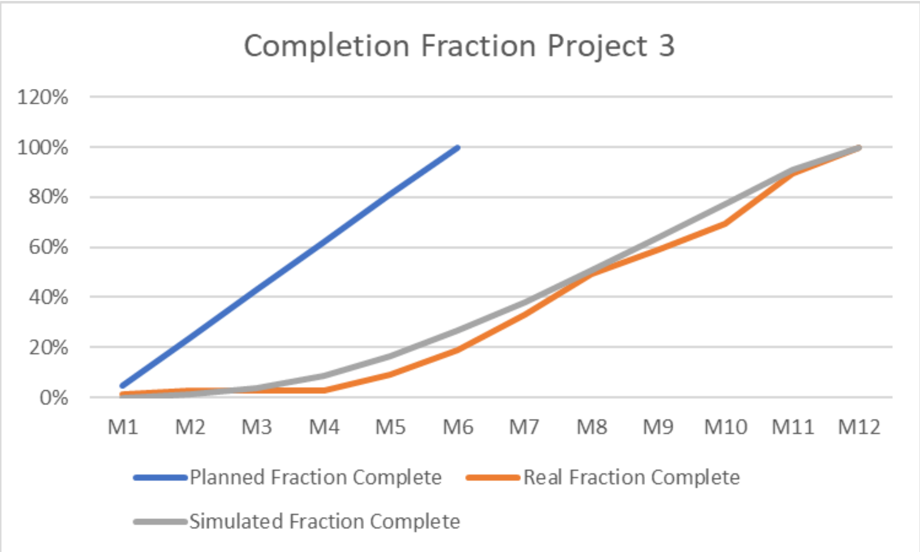

Figure 111 – Planed VS real VS simulated behavior of completion fraction for project 3

As Figures 111 and 112 depict, the simulation results provide a very good match with the real project data, despite the complexity of the reference mode and the likely data anomalies. The model successfully captures the behavior of the completion fraction and work done, underscoring its utility not only for behavioral reproduction but also for uncovering hidden dynamics and potential underreporting practices that can significantly disturb a project's performance.

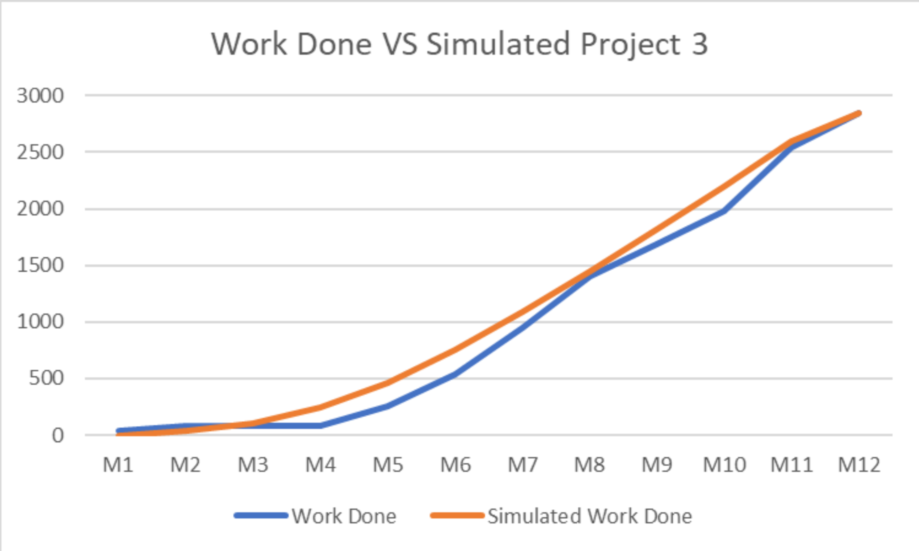

Figure 112 – Real VS simulated behavior of work done for project 3

8.8.5 Project 4

To conclude the case study validation, data from Project 4 was used to test the model's robustness against complex real-world conditions. This project shared similar complexities with Project 3, particularly in its highly variable resource allocation throughout the lifecycle and severe initial understaffing. It was initially planned for a duration of 24 weeks with a total staff of 4.2 resources and a budget of €109,782.

However, the final project data recorded a completion time of 44 weeks, resulting in an 83.33% schedule overrun and a total cost of €159,560, a 45.34% cost overrun. This project’s data exhibited a substantial anomaly: the reported total cost was significantly higher than the labor cost recorded in the company’s systems (€99,781), indicating a non-transparent cost difference of over €50,000. This data limitation prevents a perfect quantitative fit and must be acknowledged as a factor influencing the model's performance.

Furthermore, this data problem is reinforced by calculating the hourly cost for this project, which is nearly double that of the other projects, a clear indicator of a reporting issue within the company's systems.

Despite these data anomalies, the model was calibrated to this unique set of conditions and demonstrated strong behavioral reproduction validity by following the same general trend as the real-world data, as depicted in Figures 113 and 114. The model produced a simulated schedule overrun of 91.6%, which, while higher than the real overrun (83.33%), is remarkably close given the complexities. Furthermore, the simulated cost was €104,446, a value that falls between the reported staff costs (€99,781) and the total reported project costs (€159,560). This suggests that the model's estimate is a more plausible representation of the actual costs, excluding the unrecorded or non-transparent expenses. This final validation case not only provides evidence for the model's realism but also highlights a critical insight: the model can serve as a diagnostic tool, shedding light on hidden project management issues and data irregularities that can significantly disturb a project's performance.

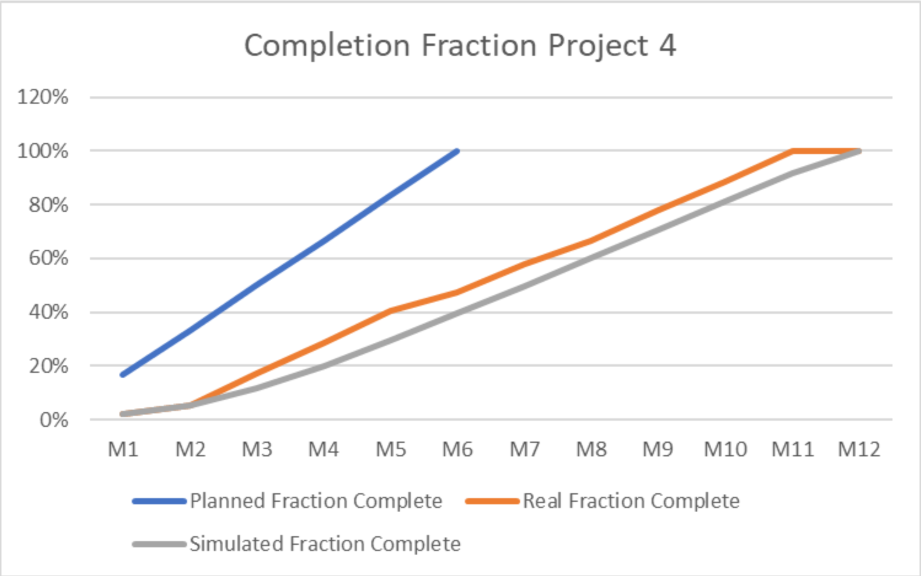

Figure 113 – Planed VS real VS simulated behavior of completion fraction for project 4

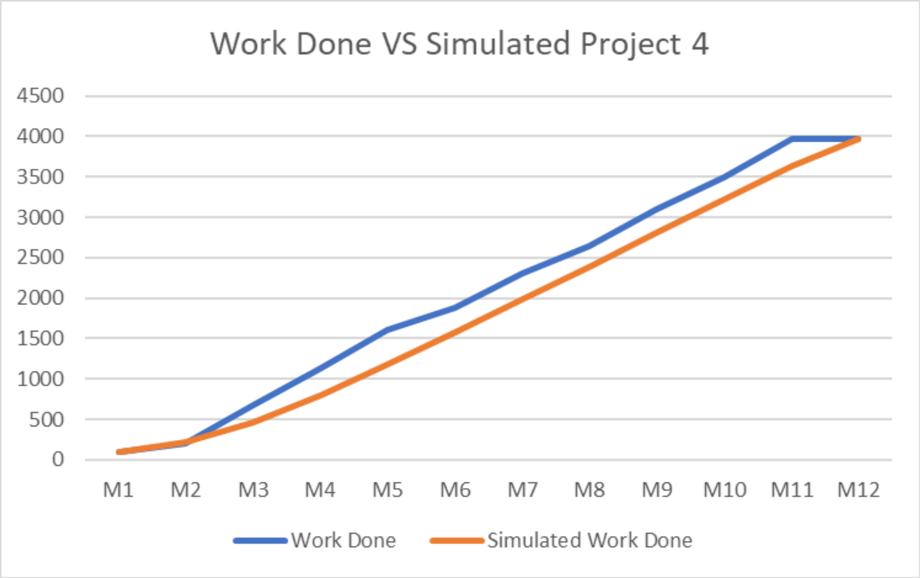

Figure 114 – Real VS simulated behavior of work done for project 4

8.9 Appendix 9 – Additional policy analysis of Chapter 6

Appendix 8 provides a comprehensive overview of all policies tested in Chapter 6. As highlighted in the chapter, the selection of these policies wasn't aimed at finding an optimal combination; instead, the focus was on evaluating strategies commonly recognized and used by project managers, as well as those identified in academic literature. The appendix details this layered analysis, which begins with the Business-as-Usual scenario (reflecting average real-life project outcomes) before progressively exploring the impact of adding various policy layers.

8.9.1 Business-as-usual scenario

8.9.1.1 Business-as-usual scenario according to Company A's business rules

The base case scenario leverages Company A's standard policies for the finance sector outlined in Table 16. Because we have made a deep analysis of software development projects in the finance sector, we replicate their assumptions and not the rest of the company's preferred options. These adjustments primarily involve the increase of the target percentage of experienced team members to 50% and implementing a permanent adjustment to sprint capacity. Additionally, the base case scenario already explores the two preferred responses by project managers to project imbalances – work intensity and overtime.

Table 17 - Business as usual policy decisions

Business as Usual Assumptions
Switch to Turn On Errors = 1 (errors are considered)
39% of understaffing of resources, with over 50% of experienced: • 3 experienced. • 2 rookies.
Switch Dialogue = 1
The client and the team only control the quality for schedule and service capacity • SWITCH FOR QUALITY FOR DEADLINE = 1 • SWITCH FOR QUALITY FOR WORK DONE = 1
Automatic sprint capacity change – the sprint capacity is re-evaluated after each sprint.
Switches from cozy relationships are ON: • Switch for Goal Definition Pressure = 1 • Switch for Quality Cuts =1 • Switch for Monitoring =1

Figure 115 depicts the outcomes under business-as-usual policies. The project exhibits a schedule overrun of 58,85% (35.31 weeks), almost replicating the average overrun of 58,15%. Conversely, the cost overrun of 10.53% (€39.174) falls below the average of 17%. However, it's crucial to note that this cost overrun average might be skewed by a single project, presenting four times the cost overrun of the second worst in this regard. Comparing these simulated results to observed projects reveals an excellent correspondence in schedule adherence and a reasonable alignment in cost management. However, a potential underreporting of costs within Company A warrants further investigation.

Despite operating at peak intensity and incurring significant overtime, the existing team consistently falls short of the desired service capacity. This excessive workload raises the risk of errors. Additionally, the limited use of formal measurement tools allows relational capital to rebound after an initial decline, even surpassing pre-project levels. This aligns with project manager observations (detailed in Chapter 4), suggesting that stronger relationships mitigate the negative impact of deteriorating project outcomes. Furthermore, these findings resonate with Company A's broader business context, where clients continue to engage the company despite facing substantial project overruns.

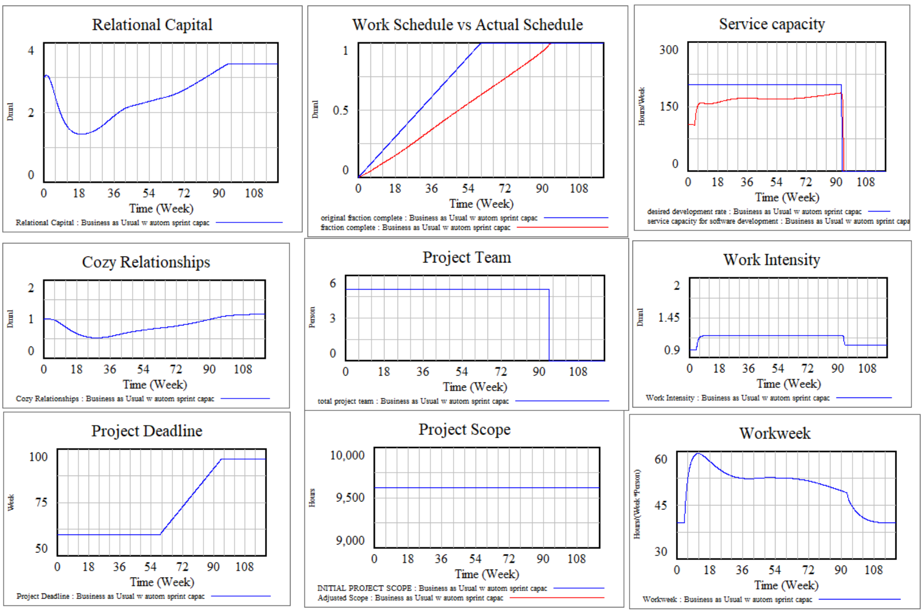

Figure 115 – Summary of the Business as Usual scenario

8.9.1.2 Business-as-usual scenario with the acceptance of new requirements and changes in requirements.

The addition of new requirements (maximum of 64 hours of work per sprint) and the constant changes in requirements (maximum of 32 hours of work per sprint) result in 113 weeks to complete (89,48% of schedule overrun) and costs 494.111€ (32,83% overrun), which also reflect the reality already described in Chapter 1.

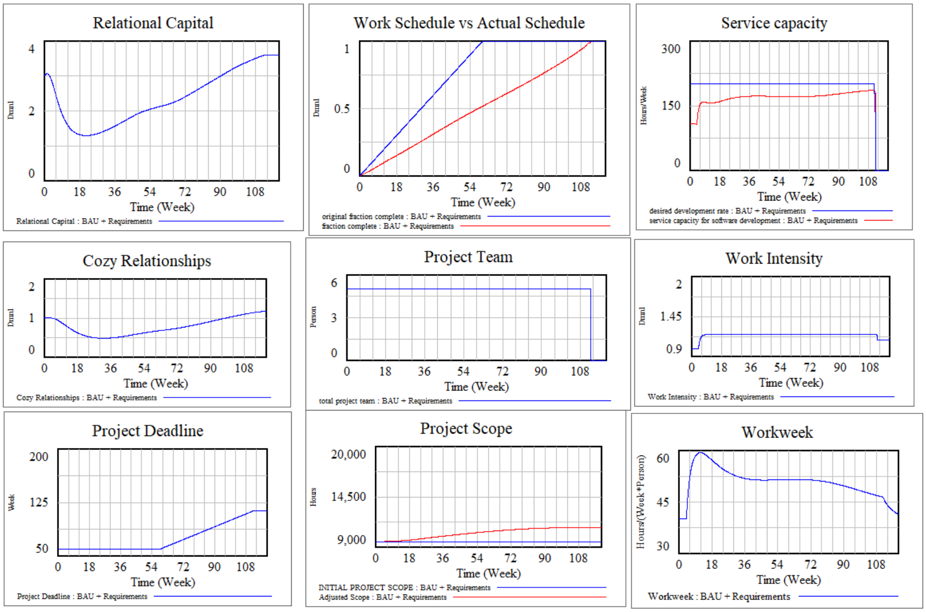

Figure 116 – Summary BAU with new and changes in requirements

8

8.9.2 Policy 1 – Staffing

Table 18 summarizes the results from staffing strategies.

Table 18 - Staffing strategies results

Policy #	Simulation	Schedule		Cost	
		Weeks	**% Overrun**	**Total Cost**	**% Overrun**
Base Case	**Business as Usual With Automatic Adjustments**	**95,31**	**58,85%**	**€ 411.174**	**10,53%**
Policy 1.1	Staffing: No understaffing	66,31	10,52%	€ 412.741	10,95%
Policy 1.2	Staffing: Hiring 50% Rookies	65,37	8,95%	€ 491.297	32,07%
Policy 1.3	Staffing: Hiring 80% Rookies	73,56	22,60%	€ 540.718	45,35%
Policy 1.4	Staffing: Hiring 20% Rookies	62,06	3,43%	€ 443.013	19,09%

8.9.2.1 Policy 1.1 – No understaffing

Our initial simulation explores a scenario where the project commences as per the original plan, with appropriate staffing levels and adjusted sprint capacity. This approach requires careful initial staffing planning, particularly considering the time senior employees allocate to training new hires and non-project tasks. To accurately model this, we assume a starting team of five experienced employees and two rookies, resulting in an effective workforce of 4.6 full-time equivalents. This represents a modest increase compared to the originally planned team of four.

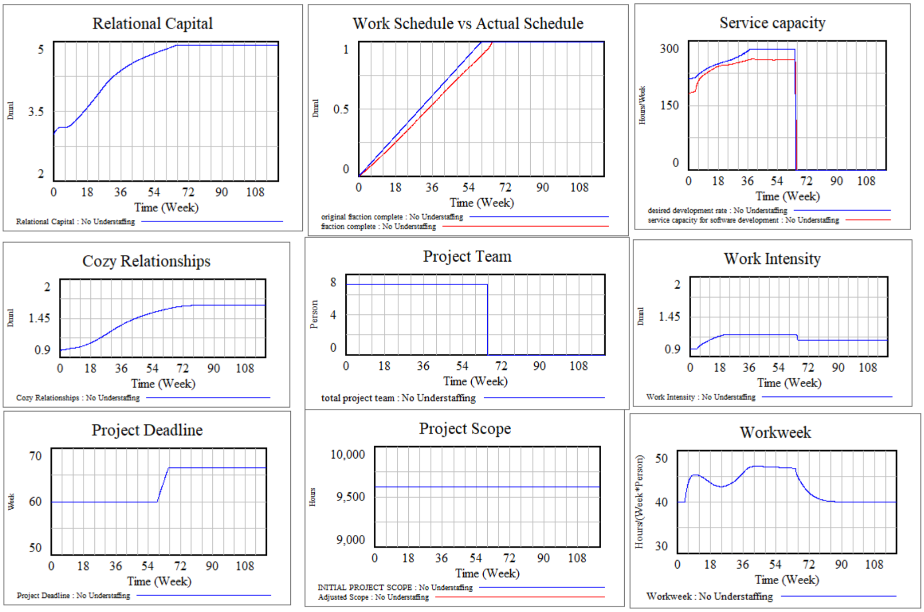

Figure 117 – Summary of results from no understaffing

The results from starting the project according to the plan are encouraging, with schedule overruns of only 10.52% and cost overruns of 10.95%, caused by the rework cycle, which is usually not accounted for when planning, as is the case for Company A. As depicted in Figure 117, despite the overruns, relational capital thrives throughout the project, nearly reaching its peak by the end. This behavior of relational capital can be attributed to the relative short overruns and the monitoring tools in place experiencing rising complacency.

While work intensity reaches its maximum capacity, workweek fluctuations are controlled. One might anticipate a lower error probability given the similar work intensity to the base case but with reduced overtime and a more experienced team. However, the observed growth in relational capital and the potential for complacency ("cozy relationships") lead to a counterintuitive increase in error probability towards project completion. This suggests a potential decrease in monitoring associated with stronger team relationships as Figure 118 reveals.

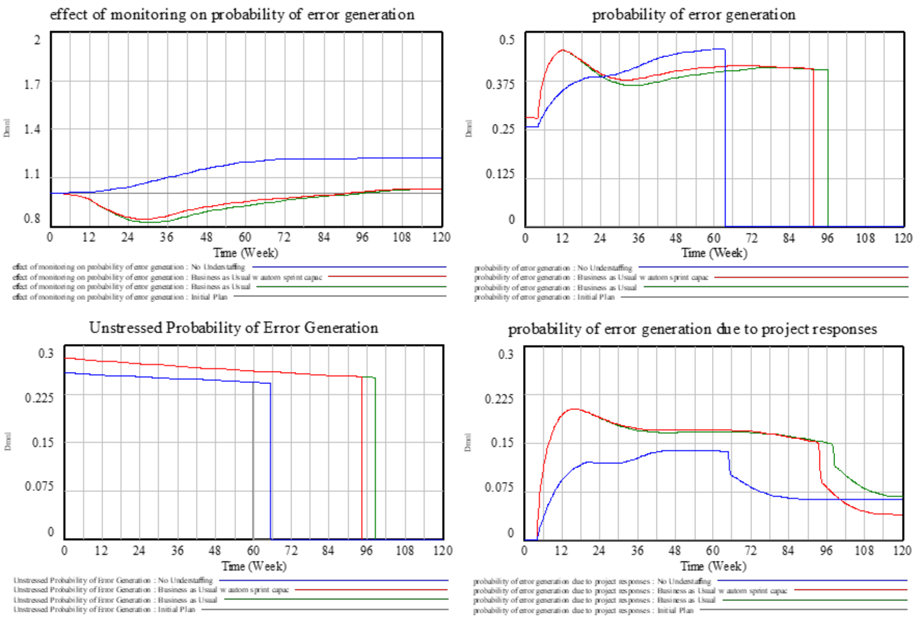

Figure 118 – Causes of probability of error generation

8.9.2.2 Policy 1.2 – Business-as-Usual with hiring 50% of rookies (Company A's financial market rule)

Following the analysis of projects commencing with adequate staffing, the investigation shifted to scenarios reflecting Company A's common practice of initial understaffing. Policy 1.2 models this prevalent situation, allowing for hiring with Company A's existing rule of a 50% rookie ratio—a strategy often observed in the financial sector.

The simulation results (Figure 119) indicate a significant reduction in schedule overrun (from 58.85% to 8.95%) compared to the Business-as-Usual (BAU) scenario. However, this improvement comes at the expense of a substantially larger cost overrun (from 10.53% to 32.07%). The model shows the team quickly reaching its maximum allowed size, reflecting the urgent need to address the initial capacity gap. Despite this, work intensity remains at its maximum level, and overtime, though oscillating, persists at high levels throughout the project. These dynamics underscore the inherent challenges of integrating a significant proportion of new, less experienced staff. While new hires address the raw capacity deficit, their onboarding necessitates training and mentoring from experienced team members, temporarily diverting valuable expertise and impacting overall productivity, thereby contributing to the elevated cost overrun.

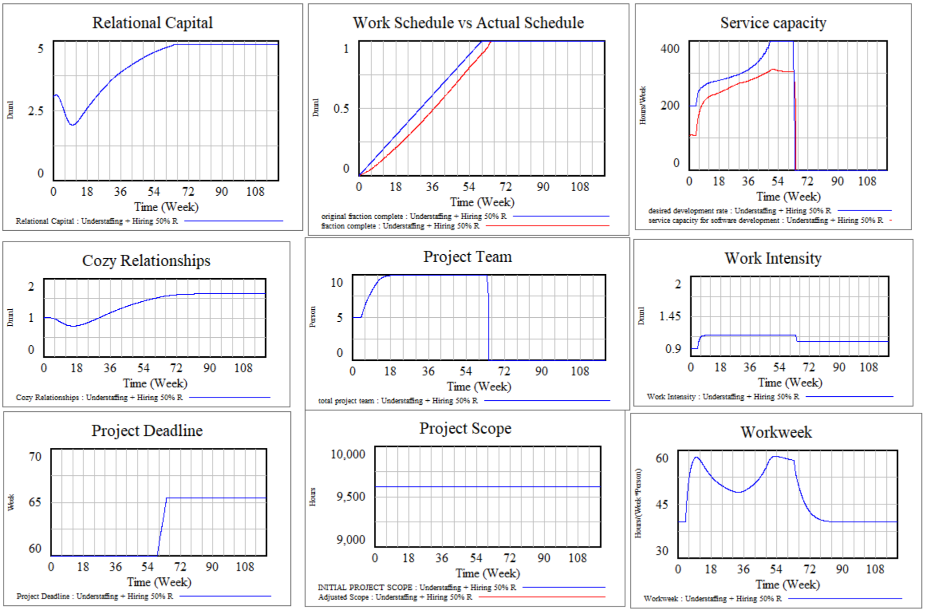

Figure 119 – Summary of BAU with hiring 50% of rookies

8.9.2.3 Policy 1.3 – Business-as-usual with hiring 80% of rookie employees (Company A's general industry mental model)

Driven by the aim to further reduce cost overruns, Policy 1.3 simulated a strategy with an increased proportion of rookie employees, reaching an 80% ratio—a prevalent business model in IT companies, often based on a mental model observed in Company A's general industry projects. Despite its widespread acceptance among project managers, this policy produced counterintuitive and significantly worse results than the previous scenario (Figure 120). The simulation revealed a staggering 22.60% schedule overrun and a 45.35% cost overrun.

Under this high rookie ratio, the model showed the team quickly reaching maximum capacity, while work intensity and workweek duration remained at their maximum throughout the entire project. These extreme conditions reflect the immense burden placed on the few experienced staff members, who must not only perform their own tasks but also continuously train, mentor, and correct the errors of a large influx of inexperienced personnel. This overwhelming demand on experienced staff, coupled with the lower initial productivity and higher error rates of rookies, exacerbates rework cycles and diminishes overall project efficiency. Such sustained, maximum pressure raises serious doubts about the sustainability and long-term viability of this policy in real-world project environments.

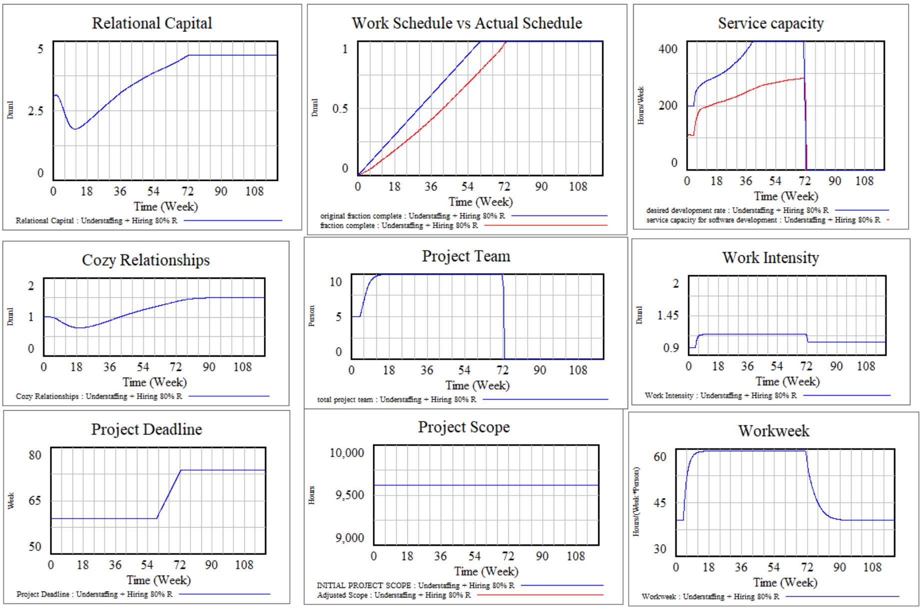

Figure 120 – Summary of BAU with hiring 80% of rookies

8.9.2.4 Policy 1.4 – Business-as-usual with hiring 20% of rookie employees

Consequently, to optimize the staffing mix, Policy 1.4 was tested, which reduced the proportion of rookie employees to 20%, thus investing significantly in experienced personnel. This strategy yielded the most favorable results among all tested hiring approaches (Figure 121). It achieved a remarkably minimal 3.43% schedule overrun, making it the best staffing strategy for schedule performance, and a 19.09% cost overrun, positioning it as the second-best for cost.

Under this policy, the project team does not reach its maximum allowed size, indicating a more efficient allocation of resources. While work intensity still reaches its maximum, overtime is notably lower compared to Policy 1.2 (hiring 50% rookies). This optimal mix significantly increases overall productivity while simultaneously reducing rework cycles. The superior performance of Policy 1.4 can be directly attributed to several factors: investing in experienced staff leads to a more rapid accumulation of relational capital, fostering more efficient collaboration and knowledge sharing. Furthermore, the reduced reliance on overtime minimizes error rates, and the lower training requirements for experienced staff enable a higher allocation to direct development tasks, which contributes to both reduced labor needs and a shortened overall project duration.

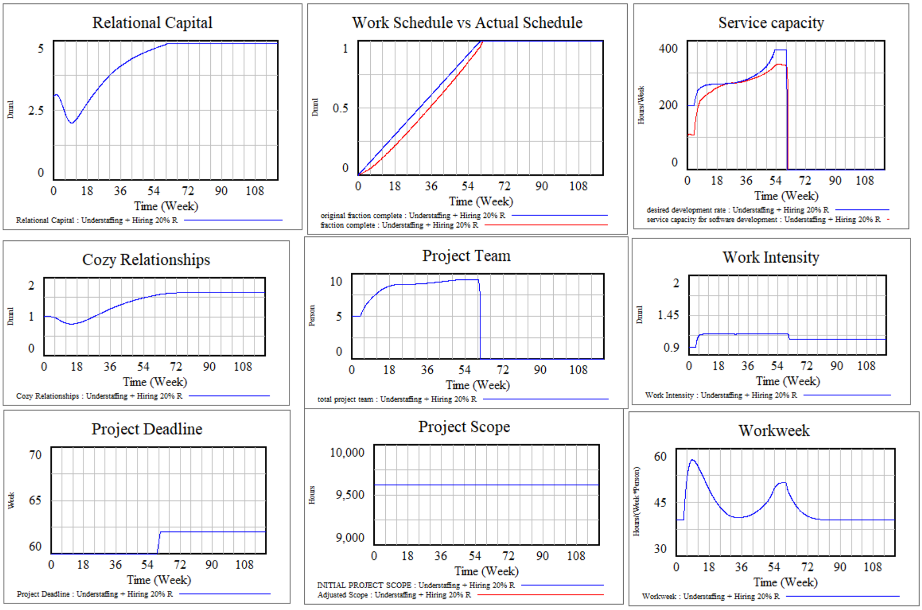

Figure 121 – Summary of BAU with hiring 20% of rookies

8.9.3 Policy 2 – Business-as-usual with postponing schedule

A separate policy investigated the effect of postponing the project schedule. However, this strategy yielded no changes in the probability of error generation, and the results remained identical to the BAU scenario for both schedule and cost overruns. As detailed in Chapter 6, this policy proves ineffective because it is constrained by a persistent and significant lack of service capacity. The inherent gap between required and available capacity is so substantial that the anticipated decrease in team pressure, which might typically result from a schedule extension, has virtually no impact. Essentially, merely extending the timeline fails to address the root cause of the overruns, making it a futile intervention in the face of severe capacity limitations.

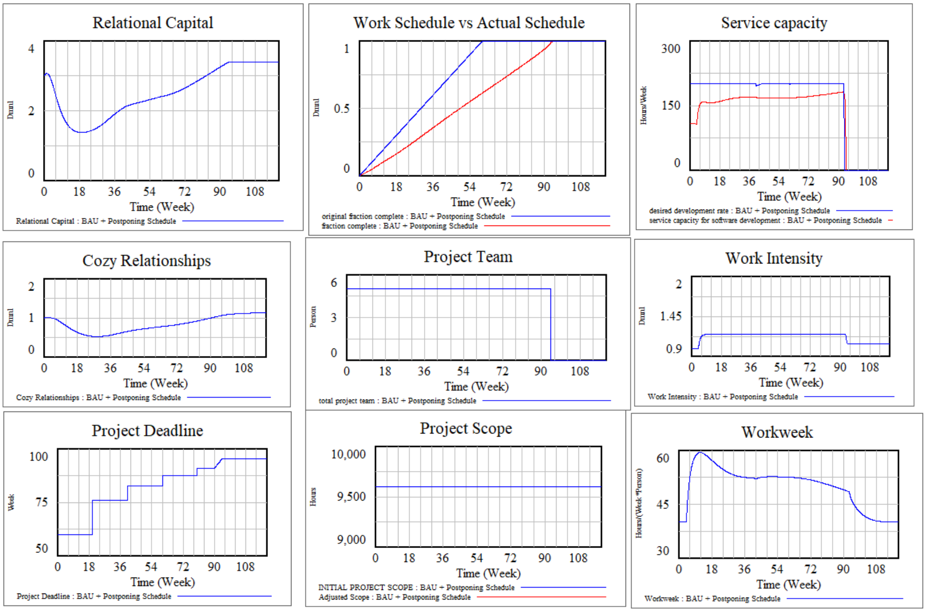

Figure 122 – Summary of BAU with postponing schedule

8.9.4 Policy 3 – Relational motive to co-create value oriented policies

Table 19 summarizes the results from RMCCV-oriented policies.

Table 19 - Results from RMCCV-oriented policies

Policy #	Simulation	Schedule		Cost	
		Weeks	**% Overrun**	**Total Cost**	**% Overrun**
Base Case	**Business as Usual With Automatic Adjustments**	**95,31**	**58,85%**	**€ 411.174**	**10,53%**
Policy 3.1	Improving feedback mechanisms	91,06	51,77%	€ 392.107	5,41%
Policy 3.2	Training	92,12	53,53%	€ 396.869	6,69%
Policy 3.3	Account Management	93,75	56,25%	€ 407.837	9,63%
Policy 3.4	External PM capacity	85,94	43,23%	€ 411.673	10,66%
Policy 3.5	Increase Monitoring	92,5	54,17%	€ 403.129	8,37%

8.9.4.1 Policy 3.1 – Business-as-usual with improving feedback mechanisms

While Company A currently monitors deadlines and work completion, the model considers enhancing feedback mechanisms by activating quality switches for error probability, service capacity, and cost (as detailed in Table 20), which are measures for which Company A has systems that allow it, as most software development companies do. This introduces three additional quality control measures, potentially impacting customer perceptions and, consequently, the accumulation of relational capital. The model utilizes Parasuraman et al. (1985) approach to measure quality gaps (the difference between expected and perceived quality) for these five items. The model considers how relationship development, mirroring Company A's processes, influences goal setting for each item. However, organizations can weaken this link by establishing goals based on benchmarks rather than solely on relationships.

Table 20 - Variables considered to monitor during the project

Easily available monitoring variables to improve monitoring
SWITCH FOR QUALITY FOR DEADLINE = 1
SWITCH FOR QUALITY FOR WORK DONE = 1
SWITCH FOR QUALITY FOR PROBABILITY OF ERROR GENERATION = 1
SWITCH FOR QUALITY FOR SERVICE CAPACITY = 1
SWITCH FOR QUALITY FOR COST = 1

Policy 3.1 isolates the impact of enhanced feedback mechanisms within the context of initial understaffing. The results are encouraging, with significant improvements compared to the baseline scenario. Schedule overruns decrease from 58.85% to 51.77%, and cost overruns drop from 10.53% to 5.41% (Figure 123). This positive shift is primarily attributable to stricter monitoring, which reduces the probability of error generation (red line in Figure 124). Consequently, less rework is required, leading to a reduced overall workload. Compared to the base case, relational capital and the potential for “cozy relationships” remain lower. This can be explained by the inclusion of three additional measured items. These expanded metrics foster clearer expectations informed by a broader range of data points.

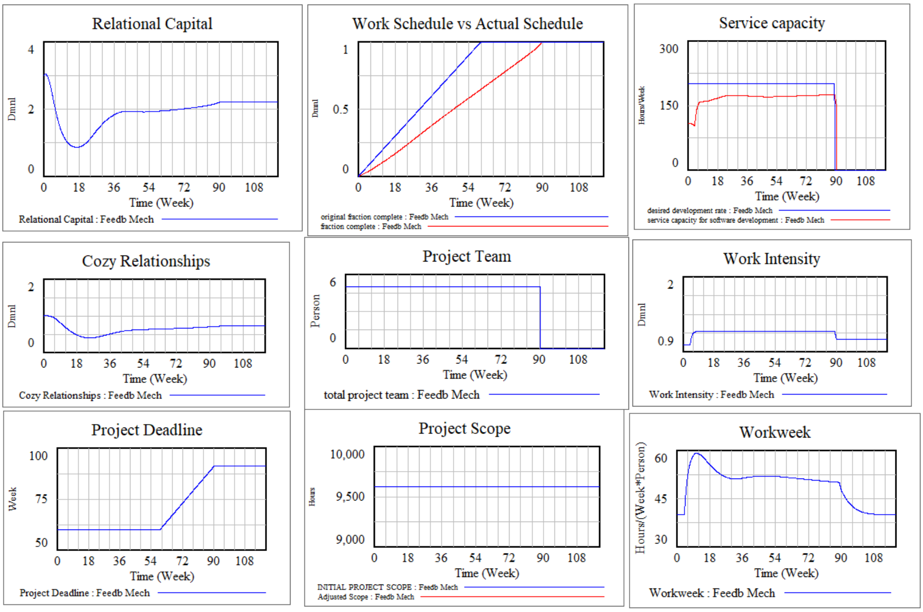

Figure 123 – Summary of results from improving feedback mechanisms

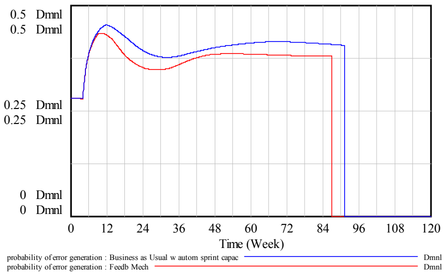

Figure 124 – Business as Usual VS Improving feedback mechanisms

8.9.4.2 *Policy 3.2 – Business-as-usual and training the client's team*

Policy 3.2 investigates the challenges and potential of investing in client team training and development, a strategy fundamentally aligned with the RMCCV emphasis on co-creation and customer resource development (Karpen, Bove and Lukas, 2012). Literature highlights that improving customer knowledge (Komulainen, 2014) and service provider collaboration skills (Lusch, Vargo and O'brien, 2007) can significantly impact results by fostering individual and collective learning (Pillai *et al.*, 2017). The model incorporates the positive effect of training on service capacity but also acknowledges the time investment required from the team (at least 2 hours per week). This creates a complex net effect: an estimated 10% improvement in knowledge transfer and communication, potentially enhancing service capacity, directly contrasts with the immediate cost of dedicated team time. This modeled time investment, often perceived as considerably higher by project managers (up to 4 hours per week), directly explains why this policy is frequently sidelined as "rarely used" in practice despite its recognized long-term benefits.

Simulations show Policy 3.2 improves outcomes: schedule overruns decrease from 58.85% in the Business-as-Usual scenario to 53.53%, and cost overruns from 10.53% to 6.69%. While these improvements are evident, the significant trade-off between immediate time investment and long-term relational benefits creates a practical adoption dilemma that warrants further consideration.

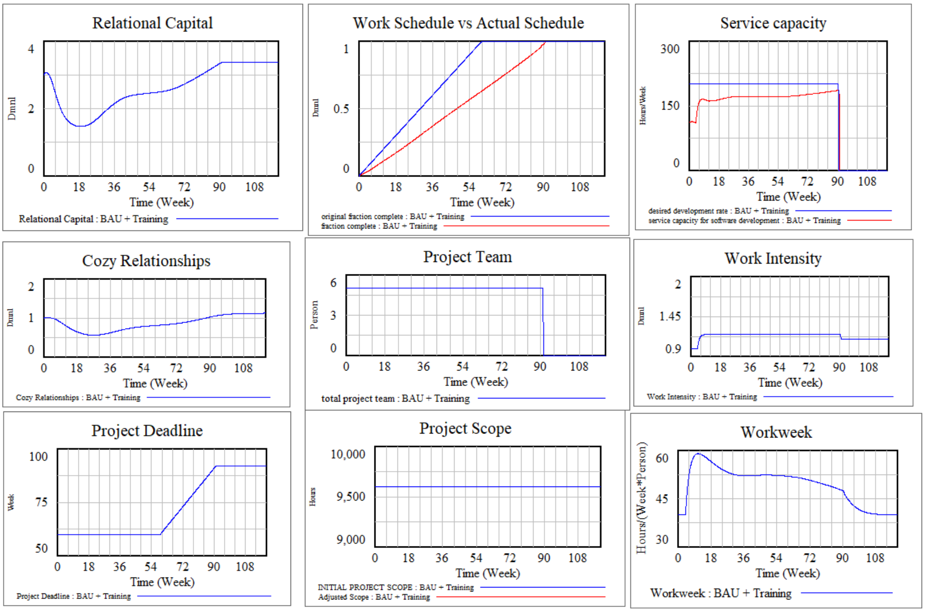

Figure 125 – Summary of results from training the client's team

8.9.4.3 Policy 3.3 – Business-as-usual with account management

Policy 3.3 explores the impact of adopting matrix structures through introducing account management, a prevalent practice in IT and consulting sectors. While the organizational structure of account management is widespread, its active use as an isolated policy for direct project improvement is tested here. This approach aims to achieve two key objectives: firstly, to increase the number of decision-makers and information channels, thereby mitigating over-reliance on specific resources; and secondly, to foster alternative problem escalation channels that facilitate problem-solving from diverse perspectives. This proactive "helicopter view" is intended to mitigate the negative effects of overly "cozy relationships" within the project team. However, implementing this policy comes with an estimated overhead cost, modeled conservatively at 2 hours per week for the account management team, an allocation that may prove insufficient for larger or more complex projects.

Despite these intended benefits, the use of account management in isolation yields negligible improvements in overall project outcomes. Schedule overruns remain high at 56.25%, and cost overruns at 9.63%, making results considerably worse than Policy 3.1 (improving feedback mechanisms) and strikingly similar to the Business-as-Usual scenario. This outcome aligns with expectations: the chronic service capacity deficit persists, necessitating sustained high work intensity and overtime. These operational constraints critically prevent the intended benefits of enhanced account management from materializing. Instead, the ongoing pressure contributes to increased errors and lower perceived quality across the five evaluated items, hindering the positive accumulation of relational capital. This highlights that merely establishing additional communication or oversight channels, without addressing core capacity limitations, is insufficient to drive significant project improvement.

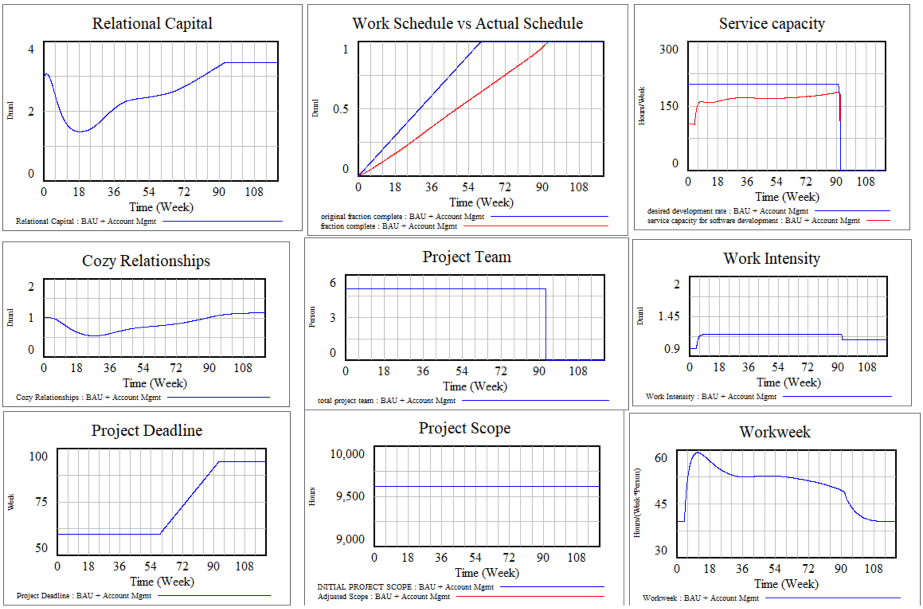

Figure 126 – Summary of results from account management

8.9.4.4 Policy 3.4 – Business-as-usual with external project management support

Policy 3.4 investigates a common practice in software development projects and is recognized in the literature (Anantatmula, 2010; Meng and Boyd, 2017). The policy involves hiring external project management support, leveraging Company A's experience in both providing and receiving additional project management support. These external resources act as independent and unbiased team members, bolstering coordination and planning capabilities while remaining immune to internal pressures and existing relationships.

Policy 3.4, leveraging external project management support, demonstrates encouraging results in schedule overrun, reducing it to 43,23%. However, cost overruns see a slight increase to 10,66%. Relational capital also fails to fully recover to its baseline level. Positively, this policy generates the fewest errors among the relational motive-tested approaches, likely contributing to the lowest accumulated workload. While promising, the policy's effectiveness seems contingent on larger teams with adequate service capacity.

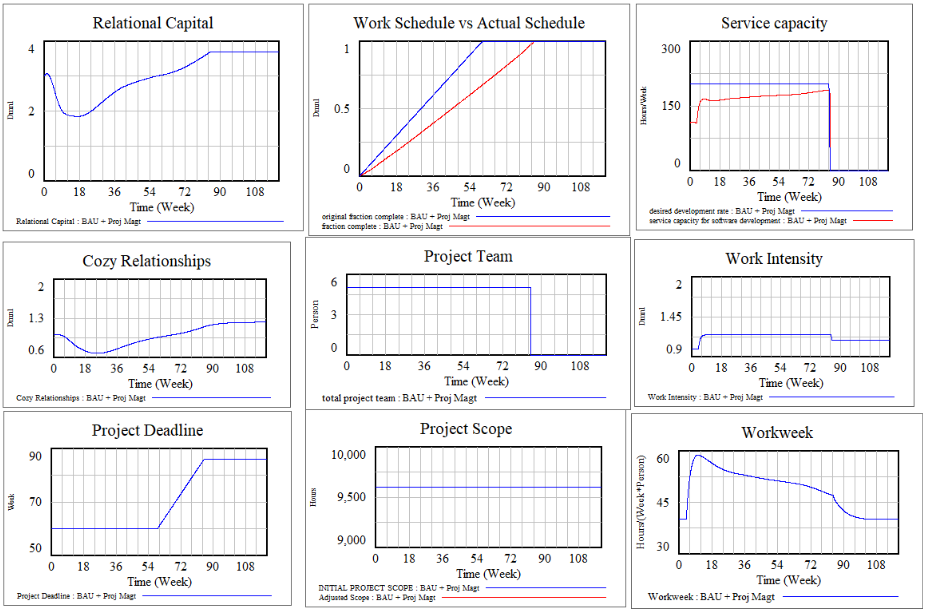

Figure 127 – Summary of results from using external project management capacity

8.9.4.5 Policy 3.5 – Business-as-usual with increased monitoring

Policy 3.5 focuses on enhancing project monitoring through the implementation of formal processes. This aligns with the literature emphasizing the importance of control (Payne, Storbacka and Frow, 2008) and customer experiences (Vargo and Lusch, 2016), which are fundamental to value perception (Komulainen, 2014). By establishing clear benchmarks and regular monitoring, this policy aims to prevent the erosion of project goals. However, while Policy 3.5 shares similarities with Policy 3.1, it diverges from Policies 3.2 and 3.4. While the latter two policies promote collaboration and knowledge sharing to increase service capacity, Policy 3.5 focuses on preventing complacency and inefficiency.

Despite these efforts, Policy 3.5 yielded suboptimal results, with a 54.17% schedule overrun and an 8.37% cost overrun. This suggests that, while monitoring and control are essential, they may not be sufficient to address the complex challenges inherent in project management. A more holistic approach, incorporating elements of collaboration, knowledge sharing, and relationship building, is likely to yield better outcomes.

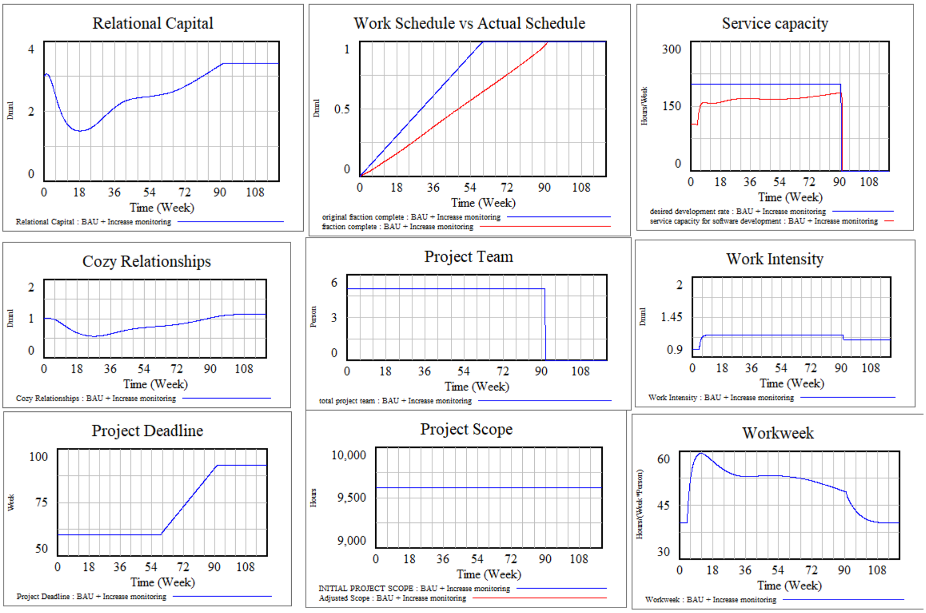

Figure 128 – Summary of results from increase in monitoring

8.9.5 Policy 4 – Combination of two different policies

This section (8.9.5) moves on to explore the combination of policies described earlier in Appendix 8. Table 21 summarizes the results from the combination of two policies.

Table 21 - Summary of the results from combining two different policies

Policy #	Simulation	Schedule		Cost	
		Weeks	% Overrun	Total Cost	% Overrun
Base Case	**Business as Usual With Automatic Adjustments**	**95,31**	**58,85%**	**€ 411.174**	**10,53%**
Policy 4.1	No understaffing with Improving feedback Mechanisms	65,5	9,17%	€ 407.529	9,55%
Policy 4.2	BAU + Improved feedback mechanisms + Postpone Schedule	91,08	51,80%	€ 392.107	5,41%
Policy 4.3	BAU + Hiring 50% rookies + Improving Feedback Mechanisms	64,25	7,08%	€ 482.149	29,61%
Policy 4.4	BAU + Hiring 80% Rookies + Improving Feedback Mechanisms	73,56	22,60%	€ 541.077	45,45%
Policy 4.5	BAU + Hiring 20% Rookies + Improving Feedback Mechanisms	61,25	2,08%	€ 439.631	18,18%
Policy 4.6	Improving feedback Mechanisms with Training	89,25	48,75%	€ 383.988	3,22%
Policy 4.7	Improving feedback mechanisms and Account Management	89,69	49,48%	€ 390.225	4,90%
Policy 4.8	Improving feedback mechanisms and Increase monitoring	89,56	49,27%	€ 389.819	4,79%
Policy 4.9	Improving feedback mechanisms and External Project Management Capacity	85,31	42,18%	€ 408.568	9,83%

8.9.5.1 Policy 4.1 – No understaffing with improving the feedback mechanisms

The first combined scenario investigates the synergistic effects of initiating a project with No Understaffing (Policy 1.1) while concurrently implementing Improved Feedback Mechanisms (Policy 3.1). This combination aims to capitalize on the benefits of adequate initial capacity (as observed in Policy 1.1) while actively mitigating potential complacency and enhancing quality control through stricter monitoring (a key outcome of Policy 3.1).

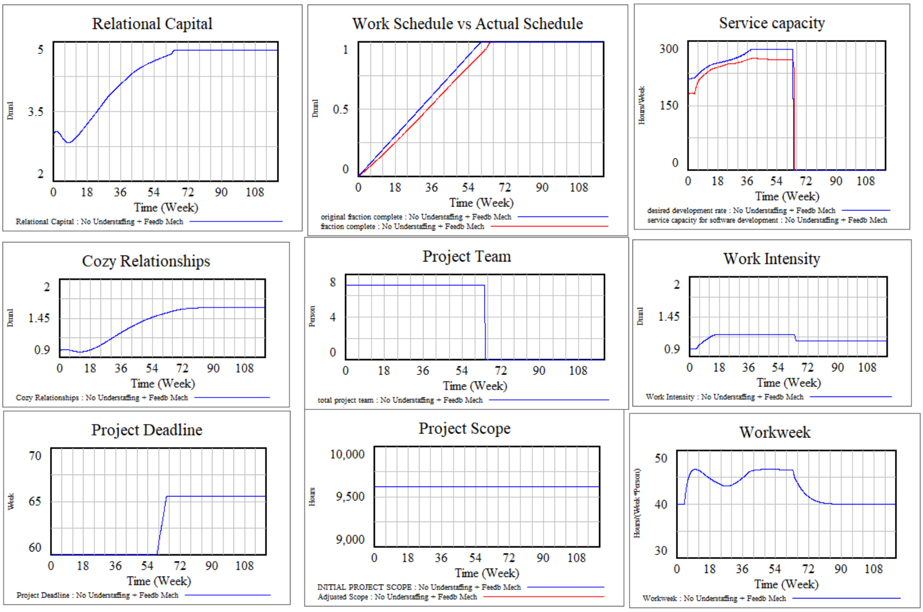

Figure 129 – Summary of results from no understaffing with improving feedback mechanisms

The results (Figure 129) for this combined approach demonstrate a notable improvement over either policy applied in isolation. The simulation yielded a schedule overrun of 9.17% and a cost overrun of 9.55%. Specifically, adding improved feedback mechanisms to a "no understaffing" scenario enhances Policy 1.1's individual performance by over one percentage point for both schedule (reducing it from 10.52% to 9.17%) and cost overrun (from 10.95% to 9.55%). This synergistic effect suggests that while adequate initial staffing creates a less pressured environment, coupling it with rigorous and expanded feedback loops effectively prevents the accumulation of errors and rework that might otherwise arise. Incorporating additional quality measurements strained the evaluation process, leading to a temporary dip in relational capital. While the addition of the RMCCV policy to improve monitoring to starting with sufficient service capacity demonstrably improved outcomes, the combined approach appears insufficient to fully address the emergence of 'cozy relationships' and their detrimental effects. This persistence might be attributable to a tolerance for lower quality due to generally acceptable overall results, potentially weakening the effectiveness of project responses.

Having demonstrated the positive outcomes achieved compared to the baseline scenario by adhering to project plans (avoiding understaffing) and enhancing

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feedback mechanisms, we must now evaluate the impact of additional policies on an understaffed baseline scenario.

8.9.5.2 Policy 4.2 – Business-as-usual, improving feedback mechanisms, and postponing schedule

Policy 4.2 investigates a complex combination of interventions within the BAU context of initial understaffing, integrating improving feedback mechanisms (as per Policy 3.1) with a strategy of postponing schedule. This latter component formalizes project managers' common response to increased workload by allowing for schedule adjustments (up to 50% of the project overrun, at 20-week intervals) with client agreement. The rationale for this inclusion was to potentially manage client expectations, alleviate immediate team pressure, and thereby weaken the persistent rework cycle, building upon the established benefits of enhanced feedback.

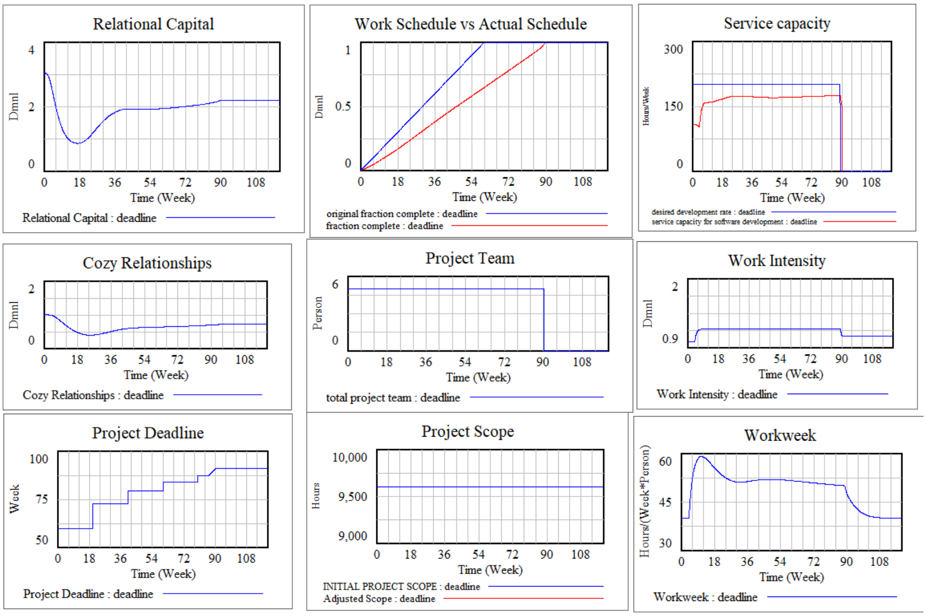

Figure 130 – Summary of results from improving feedback mechanisms and postponing deadlines

However, despite combining enhanced monitoring with this traditional response, the simulation yielded no significant improvements compared to the scenario where schedules were not postponed (i.e., Policy 3.1). Schedule overruns remained at 51.80%, cost overruns at 5.41%, and relational capital stayed low (Figure 130). This outcome aligns with expectations previously observed. Merely delaying the deadline without fundamentally addressing the chronic service capacity deficit and the initial understaffing provides minimal operational relief. Team pressure and the probability of error generation persist at high levels, indicating that simply formalizing schedule adjustments is insufficient to overcome the core operational challenges, even when coupled with improved feedback mechanisms. The sustained high pressure stemming from unaddressed capacity issues prevents the development of an environment conducive to relational capital growth.

8.9.5.3 Policy 4.3 – Business-as-usual, improving feedback mechanisms, hiring 50% of rookie employees

Policy 4.3 investigates a combined scenario within the BAU context of initial understaffing, integrating improved feedback mechanisms (from Policy 3.1) with a strategy of hiring 50% rookie employees (from Policy 1.2). In this scenario, the severe initial understaffing quickly forces the team to reach its maximum capacity of ten people (Figure 131). Consequently, the pressure to meet deadlines leads to persistently high work intensity and heavy utilization of overtime throughout the project.

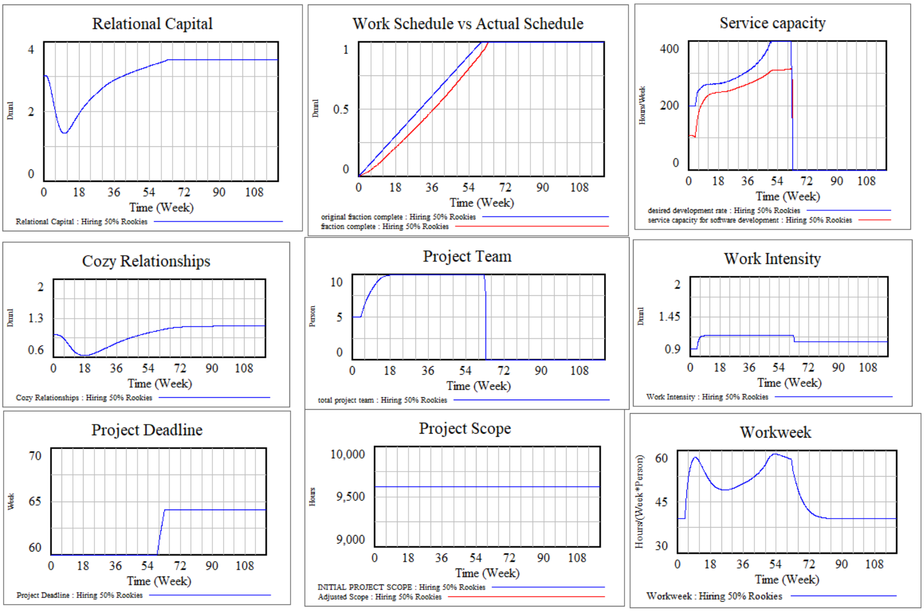

Figure 131 – Summary of the results from hiring 50% rookies and improving feedback mechanisms

Compared to Policy 1.2 (hiring 50% rookies without enhanced feedback), this combination demonstrates a notable improvement in schedule adherence. The project experiences a moderate schedule overrun of 7.08% (down from

8.95%) but a still significant cost overrun of 29.61% (down from 32.07%). While hiring additional staff clearly aids in meeting schedules in understaffed projects, the concurrent implementation of improved feedback mechanisms further enhances this effect by reducing error generation and subsequent rework, thereby contributing to both the schedule improvement and partially mitigating the cost. An important dynamic observed is that increasing service capacity allows relational capital to recover to normal levels by the project's end, while the additional feedback mechanisms inhibits the development of cozy relationships. Despite the positive impact on schedule and relational capital's normalization, the persistently high-cost overruns underscore the inherent challenges and inefficiencies of integrating a substantial proportion of inexperienced staff, even when coupled with enhanced monitoring. This suggests a need for further strategic reflection on optimizing team composition and process controls.

8.9.5.4 Policy 4.4 – Business-as-usual, improving feedback mechanisms, hiring 80% of rookie employees

Policy 4.4 combines the BAU context of initial understaffing with improved feedback mechanisms (from Policy 3.1) and a strategy of hiring 80% rookie employees (from Policy 1.3). While this policy enables staffing levels to quickly reach the project's maximum capacity, the resulting experience mix presents significant drawbacks. The substantial influx of inexperienced staff requires disproportionate training time from experienced team members, severely hindering their individual productivity. As illustrated in Figure 132, rookies' inherently lower productivity fundamentally limits the overall service capacity improvement, leading to a consequently higher error rate across the project.

The simulation results for this combination strikingly mirror the detrimental outcomes observed when hiring 80% rookies in isolation (Policy 1.3). The project experiences a significant schedule overrun of 22.6% and a substantial cost overrun of 45%. This indicates that the benefits of improved feedback mechanisms are largely overwhelmed by the profound inefficiencies associated with such a high proportion of inexperienced staff. The team is continuously forced to maintain high work intensity and utilize overtime extensively throughout the project, suggesting an unsustainable operational model with potential negative consequences for future projects and organizational well-being. Furthermore, relational capital only recovers to its initial value by the project's end, failing to achieve the growth observed in scenarios with more balanced team compositions. This suggests that the pervasive challenges of a high rookie ratio prevent the conditions necessary for RMCCV and the full benefits identified in the literature from materializing. These findings strongly underscore that a high rookie hiring ratio is generally not an effective strategy, particularly within a professional services environment.

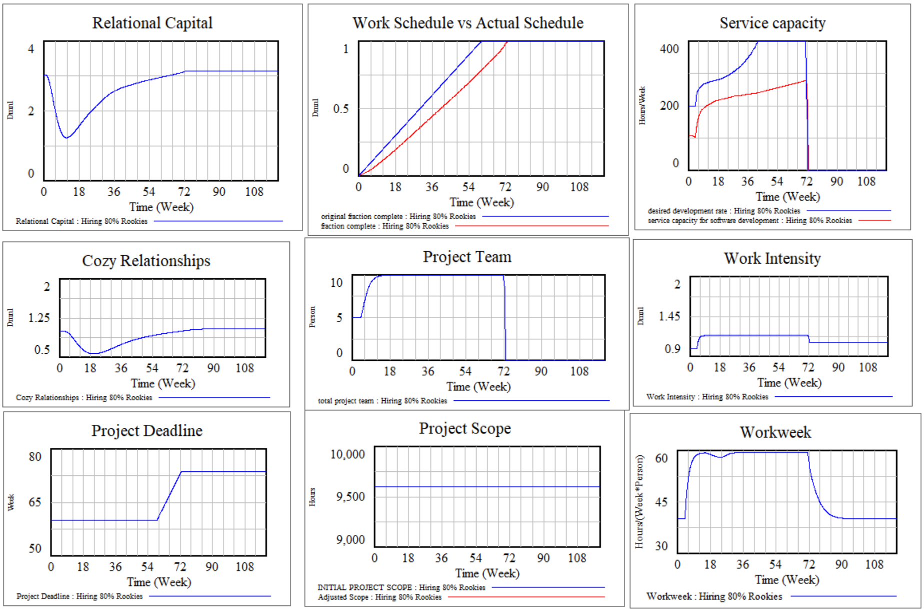

Figure 132 – Summary of the results from hiring 80% rookies and improving feedback mechanisms

8.9.5.5 Policy 4.5 – Business-as-usual, improving feedback mechanisms, hiring 20% of rookie employees

Policy 4.5 explores the combined impact of BAU initial understaffing, enhanced feedback mechanisms (from Policy 3.1), and the highly effective strategy of hiring only 20% rookie employees (from Policy 1.4). This combination, which prioritizes a majority of experienced staff, consistently yields the most positive results among all tested hiring scenarios until now.

The project achieves a remarkably minimal schedule overrun of 2.08% and the lowest cost overrun of 18.18% among all hiring strategies. This near-perfect adherence to schedule and significantly lower overall costs are directly attributable to the increased productivity of experienced staff (Figure 134). Their expertise leads to a much higher effective service capacity, even with a smaller overall team size (Figure 133). Furthermore, this approach minimizes overtime usage compared to all other hiring strategies, which contributes to reducing fatigue and errors. Crucially, relational capital recovers much faster than in other hiring policies. This rapid accumulation allows the team to fully leverage the potential of relational capital in increasing service capacity without the manifestation of negative effects such as complacency or "cozy relationships." Overall, combining robust feedback with a predominant investment in experienced staff proves to be the most effective strategy among the different hiring policies simulated.

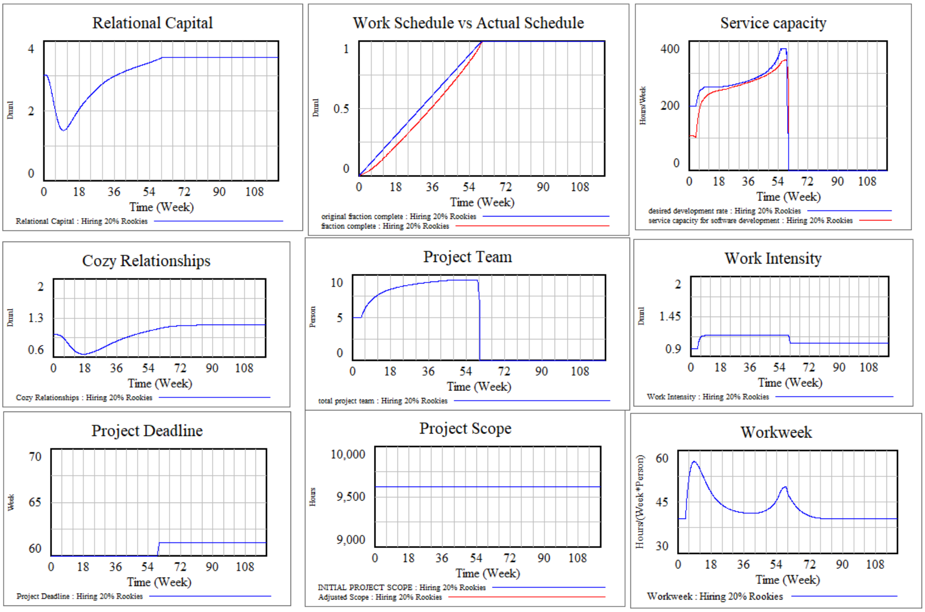

Figure 133 – Summary of the results from hiring 20% rookies

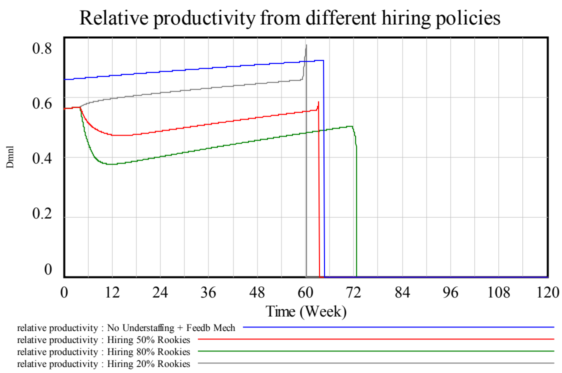

Figure 134 – Productivity comparison between different staffing policies

8.9.5.6 Policy 4.6 – Business-as-usual, improving feedback mechanisms, training the customer's team

Policy 4.6 investigates a key combination within the BAU context of initial understaffing, integrating enhanced feedback mechanisms (from Policy 3.1) with investing in customer team training and development (from Policy 3.2). This latter component aligns directly with the RMCCV research emphasis on co-creation.

While this combination of RMCCV-oriented policies doesn't entirely resolve the critical service capacity challenge inherent in the BAU scenario, it yields notable improvements. The project experiences a 48.75% schedule overrun, which, while still significant, marks a substantial decrease from the original BAU (58.85%). It also represents a good improvement compared to using client training in isolation (53.53% schedule overrun from Policy 3.2). Furthermore, the cost overrun is a very favorable 3.22%, representing nearly a halving of costs compared to Policy 3.1 (5.41% without training) and a drastic reduction from the BAU (10.53%). This demonstrates that combining a positive co-creation policy like client training with a controlling mechanism like enhanced feedback holds considerable potential. Despite the continued presence of a trade-off in team time for training, the significant improvements in both schedule and cost warrant further consideration of this synergistic approach.

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8.9.5.7 Policy 4.7 – Business-as-usual, improving feedback mechanisms, and introducing account management team

Policy 4.7 explores a combination within the BAU context of initial understaffing, integrating improved feedback mechanisms (from Policy 3.1) with the introduction of an account management team (from Policy 3.3). While both components are RMCCV-oriented policies aiming to enhance collaboration and oversight, this combination yields limited improvements in overall project outcomes compared to more effective strategies.

Schedule overruns stand at 49.48% and cost overruns at 4.90%. Notably, compared to Policy 4.6 (which combined feedback with client training), these results are considerably worse in terms of cost (4.90% vs 3.22%). This outcome aligns with expectations. The chronic service capacity deficit persists, and unlike training the client's team, the inclusion of account management doe not affect overall capacity, necessitating continued high work intensity and overtime. These pervasive operational pressures contribute to increased errors and lower scores across the five evaluated items, consequently hindering the desired growth of relational capital (as depicted in Figure 135). It is a significant observation that even with the implementation of two RMCCV-oriented policies, relational capital remains at low levels by project end. This suggests that while feedback mechanisms (Policy 3.1) can reduce errors, and account management (Policy 3.3) aims to foster better client relationships, their ability to drive genuine relational capital growth is severely constrained by fundamental, unaddressed capacity shortages. Furthermore, the inherent dampening effect of rigorous monitoring, which prevents the formation of overly "cozy relationships," also contributes to this limited relational capital accumulation. In this understaffed context, these combined policies primarily serve to control negative outcomes rather than proactively building robust positive relationships.

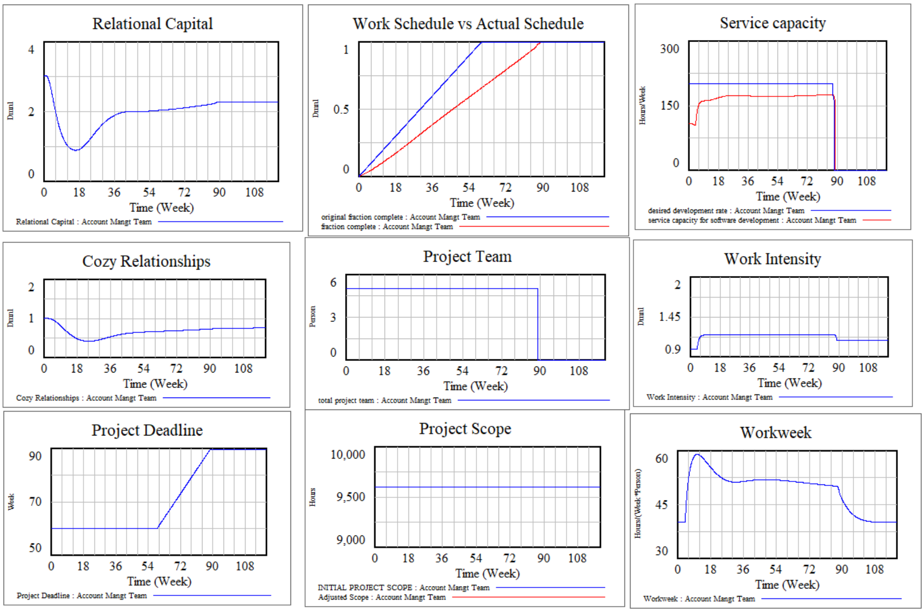

Figure 135 – Summary of results from improving feedback mechanisms and account management

8.9.5.8 Policy 4.8 – Business-as-usual, improve feedback mechanisms, introduce additional measures to increase monitoring and set rigid goals

This policy combination explores the impact of a highly rigorous control-oriented approach. It's important to articulate why, despite its strong theoretical basis, it yields limited results in the specific context of your simulation. Policy 4.8 builds upon the BAU context of initial understaffing by integrating improved feedback mechanisms (from Policy 3.1) with additional, rigid monitoring measures and goal setting. This strategy draws on the recognized importance of robust project monitoring, client relationships, and goal adherence (Mitręga and Zolkiewski, 2012), aiming to go beyond Company A's current KPI system. It proposes a more rigorous audit-team-like approach to decrease error generation, actively tracking initial project estimates as fixed goals and thereby mitigating "goal erosion". However, this intensive monitoring requires additional time investment from a separate team, inherently increasing project costs.

As Figure 136 illustrates, Policy 4.8 yields no significant improvement compared to other policies when applied in the context of severe initial understaffing. Despite high initial expectations for this control-focused approach, the project's overruns remain substantial, at 49.27% for schedule and 4.79% for cost. This outcome aligns with expectations: implementing stringent control measures in a severely understaffed project offers limited room for improvement. The persistent and significant service capacity gap fundamentally constrains the benefits that increased monitoring could otherwise provide. While Policy 4.8 is designed to mitigate the negative effects of "cozy relationships" in scenarios where relational capital is increasing, its impact is largely comparable to other tested policies in situations characterized by severe capacity deficits, offering only marginal improvement over the baseline.

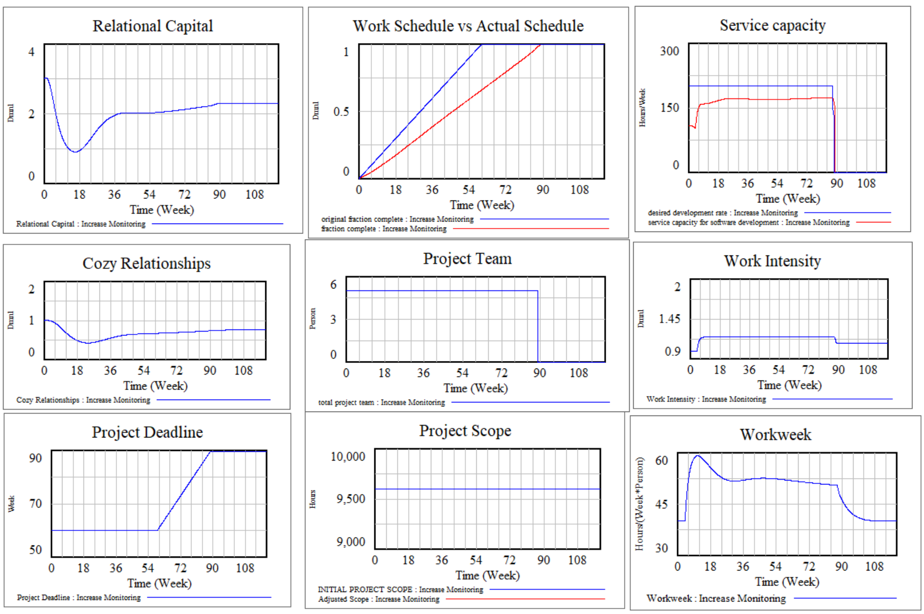

Figure 136 – Summary of results from improving feedback mechanisms and increasing monitoring

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8.9.5.9 Policy 4.9 – Business-as-usual, improving feedback mechanisms, adding external project management capacity

Policy 4.9 builds upon the BAU context of initial understaffing by integrating improved feedback mechanisms with the addition of external project management support. This strategy, commonly employed in software development projects and reflective of Company A's experience, involves hiring external resources. These external personnel are designed to act as independent and unbiased team members, bolstering coordination and planning capabilities while remaining immune to internal pressures and existing relationship dynamics.

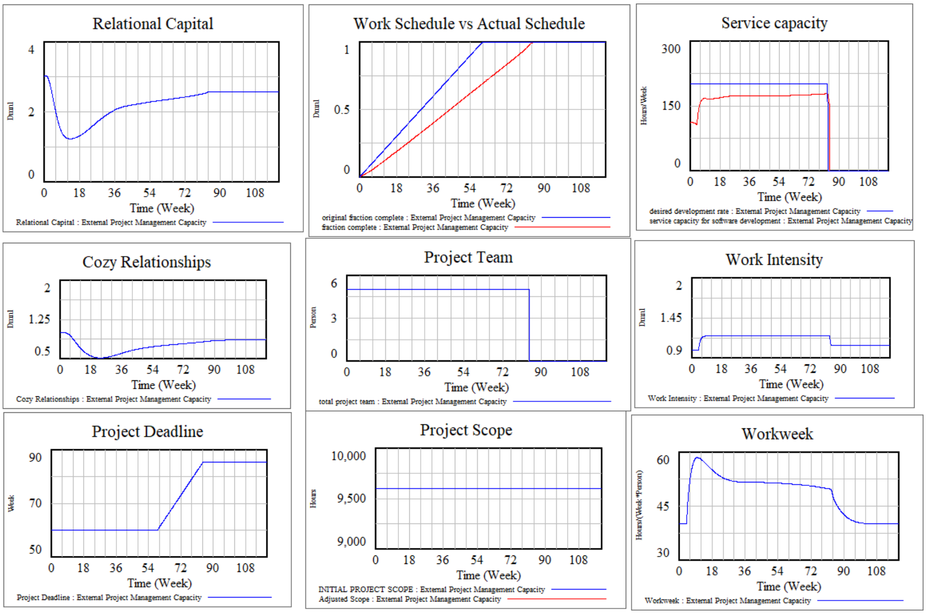

Figure 137 – Summary of the results from using external project management capacity

Leveraging external project management support in this combined scenario demonstrates encouraging results. Schedule overrun is significantly reduced to 42.18%, showing a slight improvement over Policy 3.4 (external PM support alone, at 43.23%), suggesting the added value of enhanced internal feedback. Cost overruns see a modest increase to 9.83% (a small reduction from Policy 3.4's 10.66%). Notably, this policy generates the fewest errors among all tested approaches (see blue line, Figure 138), likely contributing to the lowest accumulated workload observed across the simulations. Despite these operational efficiencies, relational capital fails to fully recover to its baseline level. This persistent suppression of relational capital, similar to observations in other control-focused policies (like 3.1 and 3.5), suggests that while external oversight and stringent monitoring are highly effective at reducing errors and improving schedule adherence, they do not inherently foster the conditions for robust relational capital growth. While promising, the policy's effectiveness seems contingent on larger teams with adequate service capacity, indicating that this control-oriented solution is most potent when fundamental capacity issues are less severe.

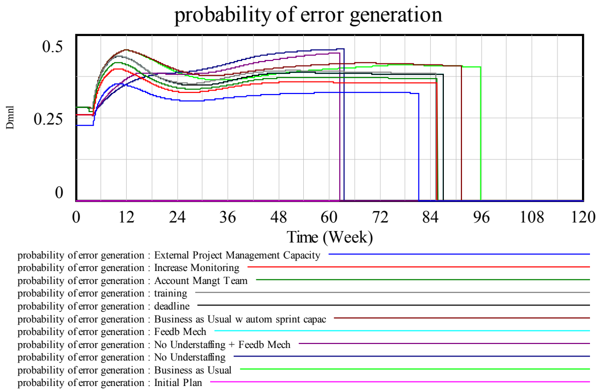

Figure 138 – PEG comparison between policies

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8.9.6 Policy 5 – Multiple combination of policies

This section (8.9.6) moves on to explore the combination of multiple policies described earlier in Appendix 8. Table 22 summarizes the results from the combination of two policies.

Table 22 - Summary of the results from combining multiple different policies

Policy #	Simulation	Schedule		Cost	
		Weeks	% Overrun	Total Cost	% Overrun
Base Case	**Business as Usual With Automatic Adjustments**	**95,31**	**58,85%**	**€ 411.174**	**10,53%**
Policy 5.1	No understaffing, Improving feedback mechanisms, with training	63,75	6,25%	€ 396.310	6,53%
Policy 5.2	No understaffing, Improving feedback mechanisms, with account management	64,12	6,87%	€ 400.948	7,78%
Policy 5.3	No understaffing, Improving feedback mechanisms with Increase monitoring	63,81	6,35%	€ 399.854	7,49%

Table 22 - Continued

Policy #	Simulation	Schedule		Cost	
		Weeks	**% Overrun**	**Total Cost**	**% Overrun**
Policy 5.4	No understaffing, Improving feedback mechanisms, with external PM support	61,62	2,70%	€ 413.042	11,03%
Policy 5.5	No understaffing, Improving feedback mechanisms, with training and Increase monitoring	62,5	4,17%	€ 391.380	5,21%
Policy 5.6	No understaffing + Improving feedback mechanisms + increase monitoring + training and external + PM support	61,37	2,28%	€ 411.317	10,57%
Policy 5.7	BAU + Improving feedback mechanisms + Inc Monit + Acc Managmt	88,06	46,77%	€ 387.227	4,09%
Policy 5.8	BAU + Hiring 50% + Improving feedback mechanisms + Inc Mon + Acc Managmt	62,25	3,75%	€ 467.420	25,65%
Policy 5.9	BAU + Hiring 50% + Improving feedback mechanisms + Inc Mon + Acc Managmt + Schedule	63,85	6,42%	€ 480.253	29,10%
Policy 5.10	BAU + Hiring 50% + Improving feedback mechanisms + Inc Mon + PM Support	61,12	1,87%	€ 475.960	27,95%
Policy 5.11	BAU+Hiring 50%+ Improving feedback mechanisms + Training+Mon+PM Support	60,6	1,00%	€ 458.746	23,32%

8.9.6.1 Policy 5.1 – No understaffing, improving feedback mechanisms, and training the customer's team

Policy 5.1 combines three impactful strategies: No Understaffing (Policy 1.1), Improving Feedback Mechanisms (Policy 3.1), and Training the Customer's Team (Policy 3.2). This multi-faceted approach aims to leverage initial capacity, enhanced monitoring, and co-creation to optimize project outcomes.

Compared to the foundational combination of "No Understaffing with Improving Feedback Mechanisms" (which yielded 9.17% schedule and 9.55% cost overruns), this expanded policy yields significantly improved results, demonstrating over a 30% gain in performance. Project outcomes show a moderate schedule overrun of 6.25% and a cost overrun of 6.53%. While these results are highly positive, they also reveal a critical dynamic: by fostering robust relational capital accumulation (a positive outcome of training and no understaffing), "cozy relationships" begin to emerge (Figure 139). Without complementary safeguards, this increase in cozy relationships can lead to a decline in goal focus, vigilance, and effective service capacity. This manifests as a higher probability of errors, increased error tolerance, lowered service capacity expectations, and extended deadline expectations. A key takeaway from this analysis is that policies promoting high relational capital growth must be accompanied by complementary policies designed to actively mitigate the potential drawbacks of overly close relationships, ensuring that collaboration remains productive and objective.

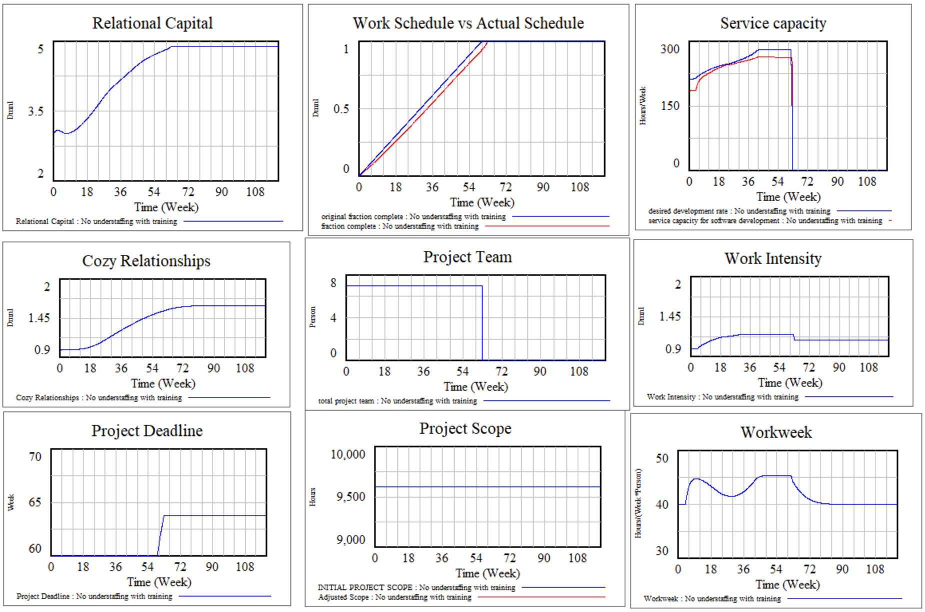

Figure 139 – Summary of results from no understaffing, improving feedback mechanisms, and training

8.9.6.2 Policy 5.2 – No understaffing, improving feedback mechanisms, and team account management

Policy 5.2 combines No Understaffing (Policy 1.1), Improving Feedback Mechanisms (Policy 3.1), and the inclusion of a Team Account Management structure (Policy 3.3). This scenario integrates an increasingly popular matrix organizational approach into the project's operational framework.

While not as effective as Policy 5.1 (which included customer team training), Policy 5.2 still delivers significant improvements compared to Policy 4.1 (the baseline with only no understaffing and improved feedback mechanisms, no dedicated account management). The project experiences a moderate schedule overrun of 6.87% and a cost overrun of 7.78%. As depicted in Figure 140, this combination also demonstrates dynamics similar to those discussed in Policy 5.1, where "cozy relationships" settle in. This highlights the need for ongoing vigilance and complementary policies to manage the potential downsides of overly strong internal relationships, even when starting with adequate staffing and enhanced feedback.

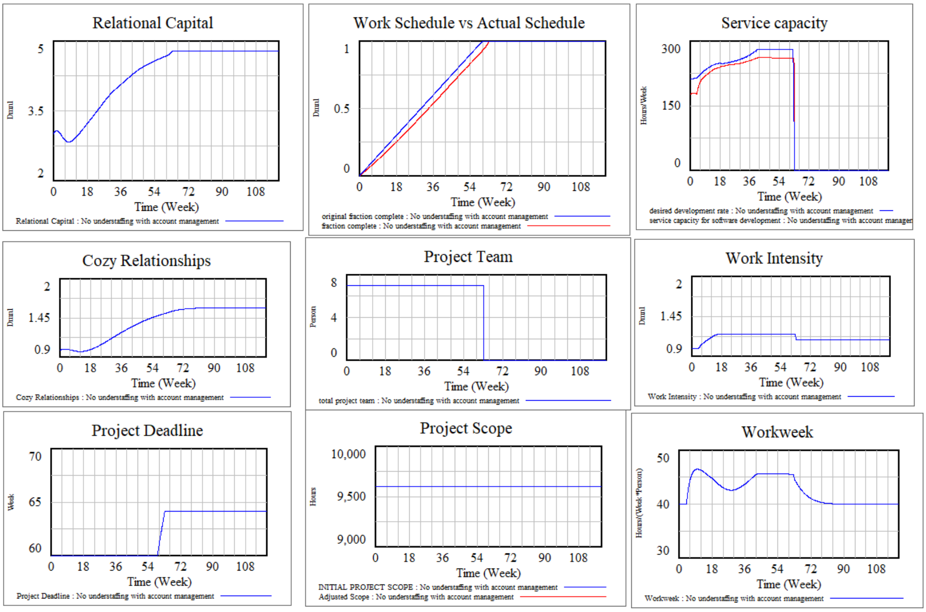

Figure 140 – Summary of results from the policy no understaffing with account management

8.9.6.3 Policy 5.3 – No understaffing, improving feedback mechanisms, and with improved monitoring

Policy 5.3 explores a comprehensive scenario combining No Understaffing (Policy 1.1), Improving Feedback Mechanisms (Policy 3.1), and an intensified focus on Improved Monitoring (drawing from Policy 3.5's approach to control). This policy specifically aims to establish robust measurement mechanisms designed to control the evolution of "cozy relationships," building upon the existing scenario of Policy 4.1 (no understaffing and improved feedback).

The simulation results indicate a schedule overrun of 6.35% and a cost overrun of 7.49%. While these overrun figures are similar to those observed in Policy 5.1 (client training) and Policy 5.2 (account management), the underlying dynamics regarding relational capital significantly differ. Policy 5.1, by investing in customer team training, represents a positively-oriented approach that promotes collaboration and knowledge transfer, thereby increasing service capacity and fostering robust relational capital accumulation, which, as previously noted, can lead to the emergence of "cozy relationships." In contrast, Policy 5.3 actively operates on controlling and monitoring behavior, explicitly trying to prevent the emergence of "cozy relationships" and to enhance efficiency. Although both approaches achieve similar moderate and balanced overruns when service capacity is close to desired values, they do so through fundamentally opposite mechanisms: one by promoting intense collaboration and knowledge transfer (potentially leading to higher relational capital and its downsides), and the other by reinforcing vigilance and control (tempering relational capital growth to prevent downsides). This juxtaposition highlights a key lesson: effective project management requires a nuanced balance between policies that foster relational capital growth and those that provide necessary controls.

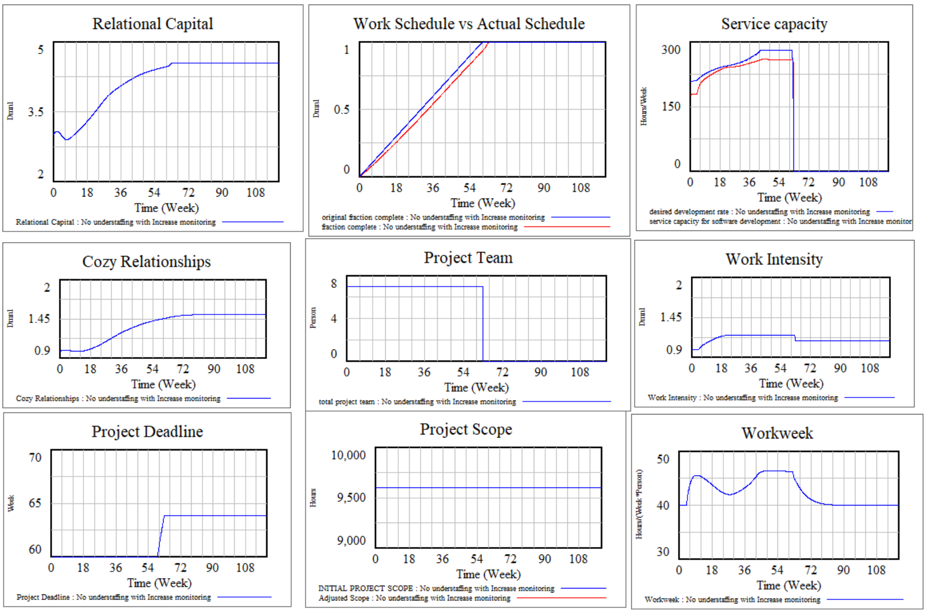

Figure 141 – Summary of results from the policy no understaffing with improved monitoring

8.9.6.4 Policy 5.4 – No understaffing , improving feedback mechanisms, and external project management support

Policy 5.4 represents a powerful combination of strategies, integrating No Understaffing (Policy 1.1) with Improving Feedback Mechanisms (Policy 3.1) and External Project Management Support (Policy 3.4). This multi-pronged approach capitalizes on optimal initial staffing alongside robust internal monitoring and independent external expertise to significantly enhance project performance.

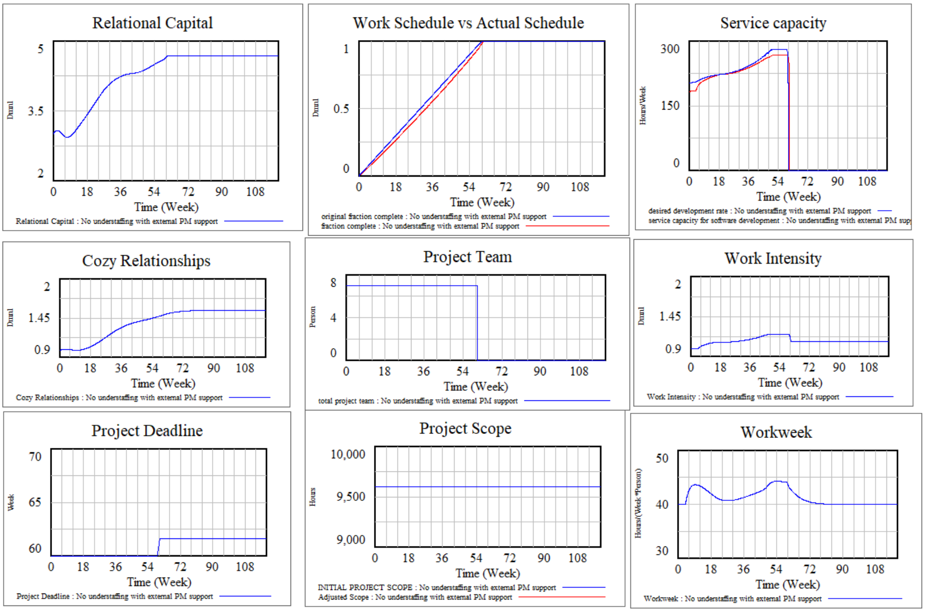

Figure 142 – Summary of results from the policy no understaffing with external PM support

This combination achieves impressive results, minimizing schedule overrun to a mere 2.70% while maintaining a controlled cost overrun at 11.03%. These figures represent a substantial improvement over Policy 4.1 (No Understaffing + feedback alone) and Policy 4.9 (BAU + feedback + external PM support), clearly demonstrating the critical advantage of initiating a project without understaffing. The benefits extend beyond immediate project outcomes: this approach significantly reduces reliance on overtime and work intensity (Figure 142), with the latter only escalating near project completion, indicating a much healthier and sustainable project environment. Consequently, it fosters a consistently lower probability of errors, leading to the lowest total accumulated workload observed across all "no understaffing" policy combinations. The synergy between adequate initial capacity, proactive error detection through feedback, and unbiased external coordination allows the project to operate with exceptional efficiency and control.

The results from Policies 5.1 – 5.4 (see Table 22) suggest that, although combining two policies with adequate staffing improved results, these can yet yield substantial improvements. This highlights the need to explore scenarios involving a broader range of policies that can enhance projects' results for those following the initial plan.

8.9.6.5 Policy 5.5 – No understaffing, improving feedback mechanisms, training, and increase monitoring

This comprehensive combination integrates four key strategies: No Understaffing (Policy 1.1), Improving Feedback Mechanisms (Policy 3.1), Training the Customer's Team (Policy 3.2), and Increased Monitoring (Policy 3.5). This approach aims to create an optimally robust project environment by combining foundational capacity, robust internal control, and external collaboration.

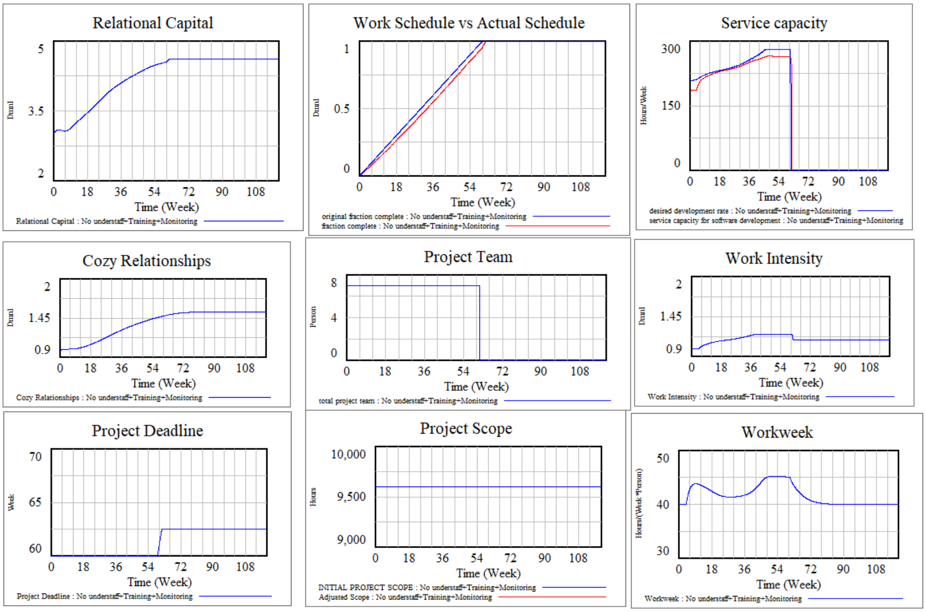

Figure 143 – Summary of policy 5.5's results

This multi-faceted policy delivers superior results compared to individual policies and many other combinations. It achieves a moderate schedule overrun of 4.17% and a controlled cost overrun of 5.21%. These figures represent a significant improvement over Policy 5.1 (No understaffing + feedback + training alone) and Policy 5.3 (No understaffing + feedback + monitoring alone), clearly indicating the synergistic benefits of a more holistic approach. Crucially, this policy successfully maintains high levels of relational capital. This is a particularly insightful finding: while customer training (Policy 3.2) fosters positive relational capital accumulation, the simultaneous presence of enhanced feedback and increased monitoring (Policies 3.1 and 3.5) acts as a vital safeguard. This allows the positive aspects of RMCCV (such as intensified collaboration and knowledge transfer) to flourish, leading to increased service capacity, without the manifestation of negative effects such as complacency or overly "cozy relationships". The robust control mechanisms ensure that the benefits of strong relationships are maintained without compromising goal adherence or efficiency, demonstrating the potential for an optimal balance between fostering collaboration and maintaining rigorous project oversight.

8.9.6.6 Policy 5.6 – No understaffing, improving feedback mechanisms, training, and using external project management support

Policy 5.6 represents a powerful four-fold combination, integrating No Understaffing (Policy 1.1), Improving Feedback Mechanisms (Policy 3.1), Training the Customer's Team (Policy 3.2), and External Project Management Support (Policy 3.4). This comprehensive approach aims to create a highly optimized project environment through a blend of foundational capacity, internal control, collaboration (RMCCV emphasis), and independent external oversight.

This policy delivers superior results compared to individual policies. It achieves a very small schedule overrun of 2.28% and a controlled cost overrun of 10.57%. When directly compared with Policy 5.5 (which included increased monitoring instead of external PM support), Policy 5.6 demonstrates better schedule performance (2.28% vs 4.17%) while exhibiting worse cost performance (10.57% vs 5.21%). This trade-off between superior schedule adherence and higher direct costs makes a straightforward choice between these two highly effective policies difficult.

However, the operational advantages of Policy 5.6 are compelling. It produces significantly lower work intensity and overtime (Figure 144), leading to a much lower probability of error generation (Figure 145). This culminates in a significantly lower accumulated total amount of work done (862 hours less), indicating exceptional efficiency in avoiding rework. Consequently, this environment of reduced pressure and errors naturally fosters a higher value for relational capital. The presence of external project management support, combined with effective internal feedback and client training, creates a project where collaboration thrives under disciplined execution, leading to superior efficiency and a healthier relational dynamic, albeit at a higher direct cost.

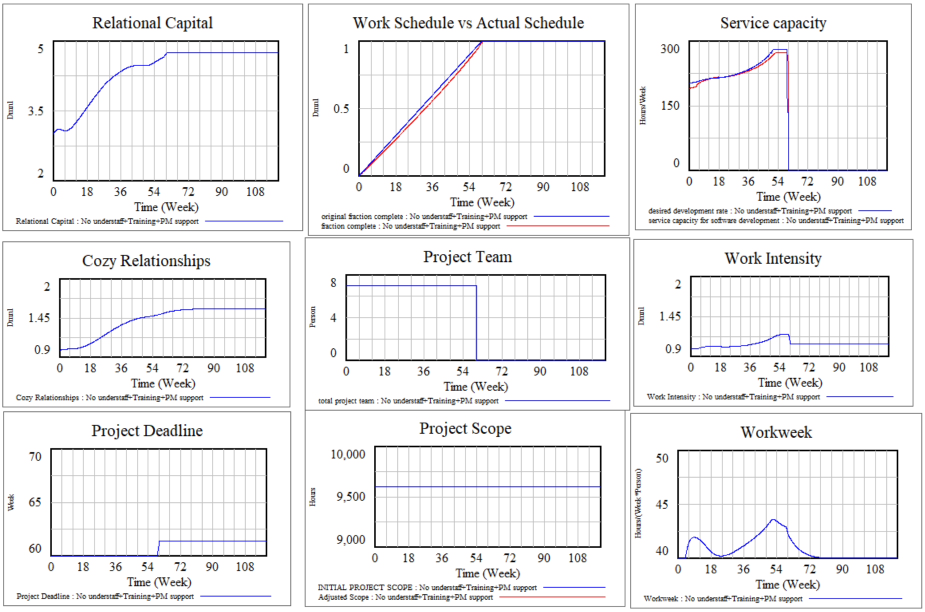

Figure 144 – Summary of policy 5.6's results

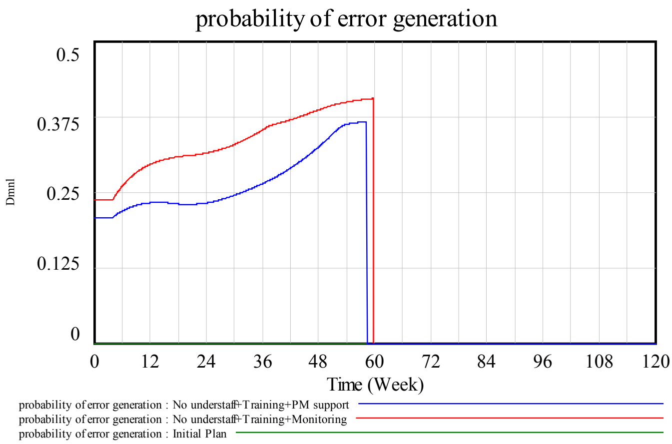

Figure 145 – Comparison for probability of error generation between Policies 5.5 and 5.6

8.9.6.7 Policy 5.7 – Business-as-usual, improving feedback mechanisms, using account management, and increasing monitoring

Having examined scenarios with adequate staffing, we now shift our focus to exploring approaches based on Company A's existing mental models and systems. Fortunately, Company A already possesses control mechanisms for implementing most of the proposed options. For instance, improving feedback mechanisms requires only efficient error tracking and utilizing regular meetings to leverage this information for enhanced expectation management and project control. Additionally, they have a dedicated planning and control department focused on implementing increased monitoring practices. Furthermore, a business development team is transitioning into relationship management with a holistic project oversight function. Finally, Company A has experience collaborating with external project management support teams.

Policy 5.7 investigates a scenario that combines an initial understaffing decision aligned with Company A's customary assumptions. This approach retains common practices like increased work intensity and overtime, supplemented by Company A's internal performance improvement structures. This includes leveraging the planning and control department for enhanced monitoring and the account management team for relationship management.

Despite the considerable improvement from the business-as-usual scenario (58,85% schedule overrun and 10,53% cost overrun), this scenario still results in a significant schedule overrun (46.77%) with a surprisingly low cost overrun (4.09%). As illustrated in Figure 146, service capacity falls considerably below desired levels, even with work intensity reaching its maximum almost from the outset and excessive overtime utilization. Unsurprisingly, the implemented RMCCV-oriented policies prove insufficient to counteract the negative impact on relational capital caused by the poor quality evaluations generated by the monitoring instruments. The low cost overrun is primarily achieved by overloading the project team and prioritizing schedule slippage.

The result from this scenario suggest that for understaffed projects aiming to balance schedule and cost overruns, adding capacity is a necessary intervention. Existing options without increased capacity lead to significant schedule overruns exceeding 45%. The applicability of these scenarios hinges on several factors. However, for service providers, the small cost overruns associated with these high schedule overruns may present an attractive option, contingent on client acceptance of extended timelines. Therefore, we will now explore scenarios that incorporate increased capacity.

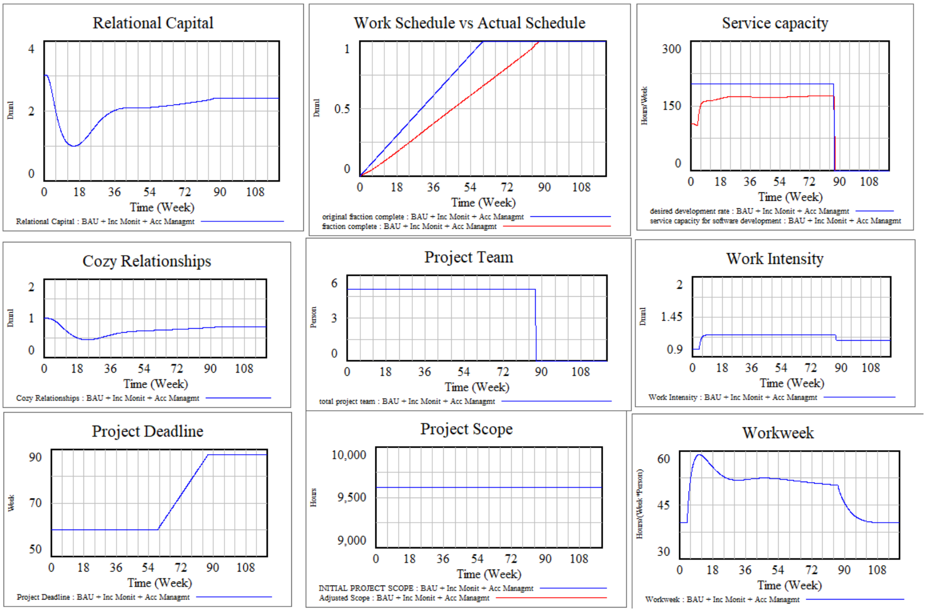

Figure 146 – Summary of results from understaffing, account management and increased monitoring

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8.9.6.8 Policy 5.8 – Business-as-usual, improving feedback mechanisms, allowing hiring (50% rookies), improving monitoring, and using account management

This policy represents a significant step by introducing controlled staffing increases into a complex combination of existing Company A practices. It aims to address the critical capacity deficit while maintaining various control and relationship-oriented mechanisms.

Policy 5.8 builds upon the foundation of Policy 5.7 (Business-as-Usual, improving feedback, account management, and increased monitoring) by adding the crucial element of allowing staff hiring under Company A's financial market goal of 50% rookie employees. This scenario aims to alleviate the severe understaffing seen in Policy 5.7 by strategically increasing capacity.

The simulation results show a schedule overrun of 3.75% and a cost overrun of 25.65%. These figures represent an improvement over Policy 4.3 (Business-as-usual, improving feedback, and hiring 50% rookies) in terms of both schedule and cost. However, as depicted in Figure 147, this scenario still exhibits very high usage of work intensity and overtime. This persistent pressure leads to an increased probability of error generation, highlighting that even with increased capacity, the compounded effects of understaffing, heavy monitoring, and the integration of new, inexperienced staff create a demanding environment. These findings suggest that while hiring helps, a strategy to further alleviate pressure, such as negotiating new schedule deadlines, might be necessary to mitigate the high work intensity and error rates, leading to healthier project execution.

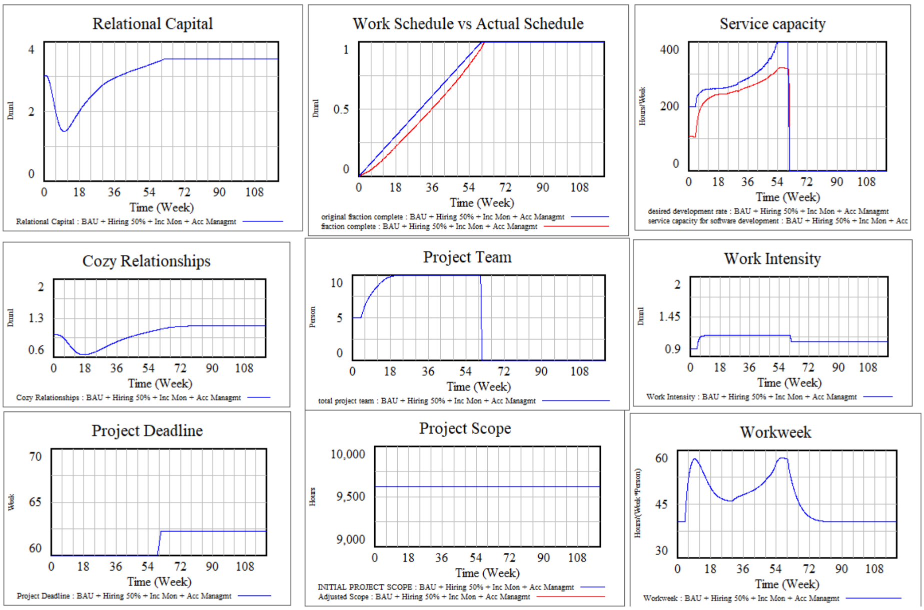

Figure 147 – Summary of results from Policy 5.8

8.9.6.9 Policy 5.9 – Business-as-usual, improving feedback mechanisms, allowing hiring (50% rookies), improving monitoring, using account management, and postponing schedules

This policy combination builds upon Policy 5.8 by introducing a pressure-relief mechanism: postponing schedules. The intent is to see if formalized deadline adjustments can further improve project outcomes, especially by alleviating the high work intensity and overtime observed in Policy 5.8.

Policy 5.9 integrates initial understaffing (BAU) with improving feedback mechanisms (Policy 3.1), allowing hiring of 50% rookie employees, improving monitoring (Policy 3.5), using account management (Policy 3.3), and finally, postponing schedules. The schedule postponement strategy reflects up to 50% of the anticipated schedule overrun into the project deadline, with adjustments occurring at 20-week intervals.

Surprisingly, despite this significant addition, the simulation results show a schedule overrun of 4.42% and a cost overrun of 29.02% (Figure 148). These figures are considerably worse than Policy 5.8's performance (3.75% schedule overrun and 25.65% cost overrun), marking a step backward. While the intent was to lessen schedule pressure, this adjustment did not significantly reduce reliance on work intensity and overtime, thus maintaining a high probability of error generation. Consequently, extending the deadline in this manner, using small schedule adjustments, failed to yield any substantial improvements compared to Policy 5.8. This outcome reinforces the understanding that shifting deadlines without addressing operational inefficiencies or capacity gaps is ineffective in complex, understaffed projects, even when combined with multiple control and relationship-oriented policies.

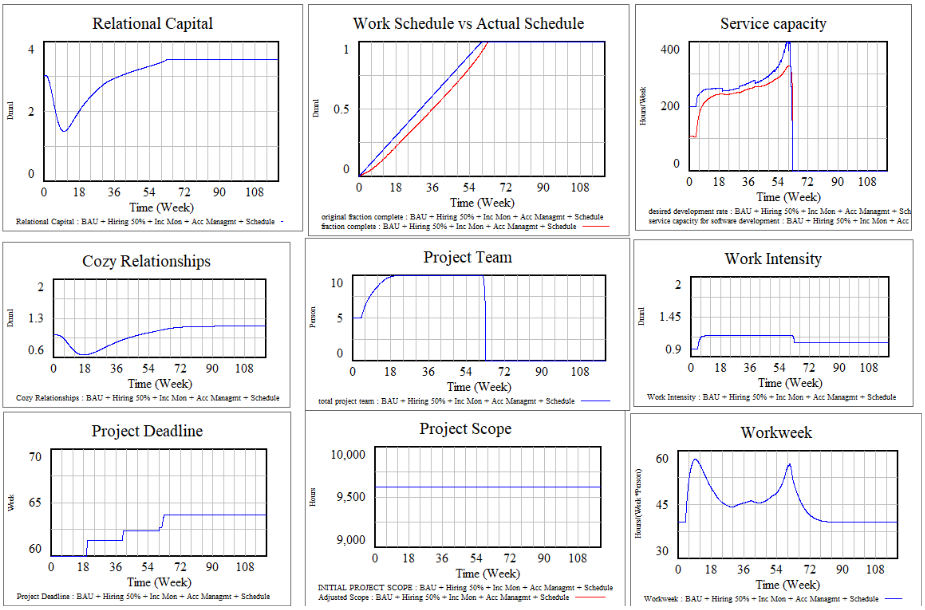

Figure 148 – Summary of results from Policy 5.9

8.9.6.10 Policy 5.10 – Business-as-usual, improving feedback mechanisms, with hiring 50% of rookie employees, increase monitoring, and external project management support

Policy 5.10 represents a comprehensive strategy within the Business-as-Usual (BAU) context of initial understaffing. This approach aims to address the chronic capacity shortage through targeted hiring, incorporating a 50% rookie recruitment strategy aligned with Company A's financial market goals. Simultaneously, it integrates robust control and support mechanisms: improving feedback mechanisms, increased monitoring, and external project management support.

The results, as depicted in Figure 149, demonstrate a significant improvement in achieving desired capacity levels. Consequently, the reliance on overtime diminishes, leading to a notably lower probability of error generation compared to both Policy 5.8 (which used account management instead of external PM support) and Policy 5.9 (which additionally involved postponing schedules).

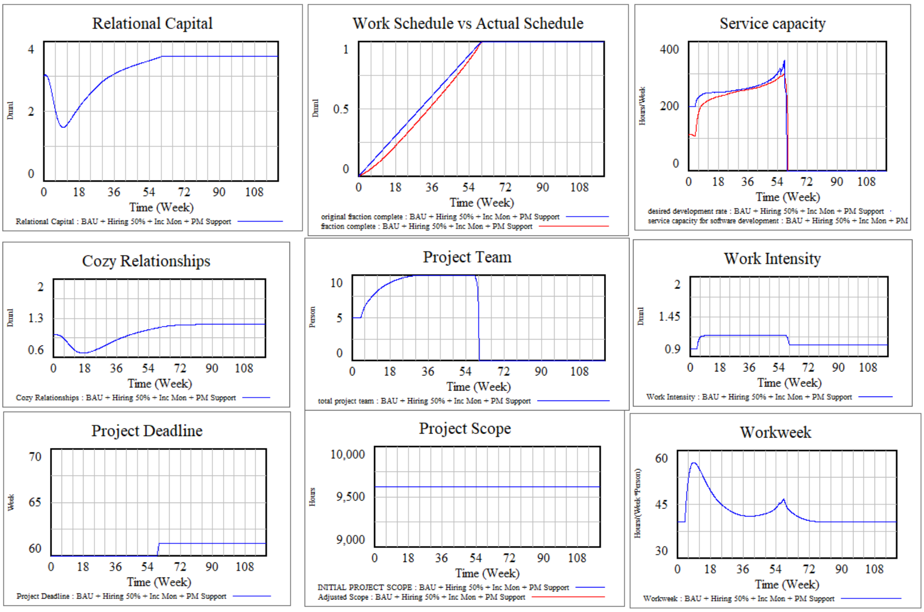

Figure 149 – Summary of results from Policy 5.10

While this scenario achieves a remarkably minimal schedule overrun of 1.87%, indicating exceptional control over project timelines, a notable cost overrun of 27.95% persists. This robust schedule performance comes at a higher cost compared to Policy 5.8 (25.65%), but it is justified by the significant gains in timely delivery and operational efficiency. However, when contrasted with policies prioritizing more experienced staff (e.g., Policy 4.5, which achieved 18.18% cost overrun with 20% rookie hiring and no external PM), the higher cost here reflects the expense associated with external project management support combined with the challenges of integrating a substantial proportion of rookie hires within an initially understaffed environment. Nevertheless, Policy 5.10 clearly demonstrates a powerful capability to control project schedules, even from a challenging BAU starting point.

8.9.6.11 Policy 5.11 – Business-as-usual, improving feedback mechanisms, with hiring 50% of rookie employees, increase monitoring, training the client's staff, and external project management support

Policy 5.11 builds upon the already robust framework of Policy 5.10 by incorporating a team training program for the client's staff. This policy represents the most comprehensive combination within the BAU category. It integrates initial understaffing, improving feedback mechanisms, hiring 50% rookie employees, increased monitoring, and external project management support, now explicitly augmented with client training. Consistent with previous findings, promoting employee and client development through training demonstrably improves project outcomes, yielding even more promising results for Policy 5.11. This policy achieves an exceptionally minimal schedule overrun of only 1.00%, demonstrating near-perfect control over project timelines. Furthermore, it maintains a moderate cost overrun of 23.32%, representing a substantial decrease compared to Policy 5.10 (which had a 27.95% cost overrun without client training).

The addition of client training in Policy 5.11 showcases its capacity to further optimize project efficiency and collaboration. While Policy 5.10 already excelled at schedule control, the incorporation of training (an RMCCV-oriented policy) contributes to a more integrated and capable project ecosystem. This likely leads to enhanced knowledge transfer, fewer misunderstandings, and more efficient resource utilization, thereby reducing overall workload and contributing to the significant cost reduction. Despite starting with a BAU understaffed condition and integrating 50% rookie hires, this comprehensive policy achieves an outstanding balance of schedule adherence and cost management, presenting a highly effective solution for project delivery.

8.9.7 Policy 6 – Combination of policies to cope with changes and new requirements

Building on the individual strategies outlined in Appendix 8, this section (8.9.7) introduces a new set of combined policies. These integrated approaches are specifically engineered to address the critical challenge of effectively managing new and changing project requirements. The comprehensive results from the testing of these policy combinations are summarized in Table 23.

Table 23 - Summary of the results from combining multiple different policies to respond to changes and new requirements

Policy #	Simulation	Schedule		Cost	
		Weeks	**% Overrun**	**Total Cost**	**% Overrun**
Base Case	**Business as Usual With Automatic Adjustments**	**95,31**	**58,85%**	**€ 411.174**	**10,53%**
Base Case	**BAU + new and changes in requirements**	**113,69**	**89,48%**	**€ 494.111**	**32,83%**
Policy 6.1	Req+No understaffing+ Improving feedback mechanisms + Mon+PM support	65,75	9,58%	€ 444.779	19,56%
Policy 6.2	Req+No understaffing+ Improving feedback mechanisms +Training+Mon+PM support	64,44	7,40%	€ 435.641	17,11%
Policy 6.3	Requirements + BAU + Hiring 50% + Improving feedback mechanisms + Inc Mon + PM Support	64,31	7,18%	€ 508.922	36,81%
Policy 6.4	Req+BAU+Hiring50% + Improving feedback mechanisms + Training + Mon + PM Support	64,06	6,77%	€ 502.085	34,97%
Policy 6.5	Req+BAU+Hiring20%+ Improving feedback mechanisms + Inc Mon + PM Support	61,62	2,70%	€ 458.735	23,32%
Policy 6.6	Req+BAU+Hiring20%+Improving feedback mechanisms + Training + Mon + PM Support	61,81	3,02%	€ 446.195	19,94%

8.9.7.1 Policy 6.1 - No understaffing, improving feedback mechanisms, increased monitoring, and using external project management support

Policy 6.1 initiates our exploration into policy combinations specifically designed to effectively manage changes and new requirements, a common and challenging aspect of real-world projects. This foundational policy in the “requirements” series combines an optimal starting condition of No Understaffing with robust control and support mechanisms: Improving

Feedback Mechanisms, Increased Monitoring, and Using External Project Management Support.

This combination of policies yields a schedule overrun of 9.58% and a cost overrun of 19.56%, with a drop to 14,79% cost overrun considering the additional billing from scope increase. While these results represent a significant improvement compared to the Business-as-Usual (BAU) scenario when facing new and changed requirements (which resulted in an 89.48% schedule overrun and 32.83% cost overrun), they also highlight the considerable impact of the "requirements change" challenge itself. For instance, Policy 5.4, which utilized the exact same set of interventions without new requirements, achieved a far superior 2.70% schedule overrun and 11.03% cost overrun. This direct comparison underscores the inherent difficulty and increased cost associated with integrating evolving requirements into a project, even when beginning with adequate staffing and comprehensive controls.

Despite these promising initial results in a challenging context, the analysis of Policy 6.1 reveals important opportunities for further improvement. Specifically, the findings suggest the significant potential of incorporating Relational Motive to Co-Create Value (RMCCV)-oriented policies, such as training initiatives. These policies, by directly promoting co-creation and enhancing service capacity, are anticipated to provide crucial additional leverage in managing the complexities introduced by requirement changes, as explored in subsequent policies.

8.9.7.2 Policy 6.2 – No understaffing, improving feedback mechanisms, increased monitoring, training the customer's team, and using external project management support

Policy 6.2 represents a robust, multi-faceted strategy specifically designed to accept and effectively cope with the additional work stemming from new and changed requirements. This combination integrates No Understaffing, Improving Feedback Mechanisms, Increased Monitoring, Training the Customer's Team, and External Project Management Support.

Despite the significant challenge posed by evolving requirements, this combination yielded encouraging results. The project was delivered within a moderate schedule overrun of 7.40% and a manageable gross cost overrun of 17.11%. These figures are particularly impressive when compared to the Business-as-Usual scenario accepting changes and new requirements, which resulted in an 89.48% schedule overrun and 32.83% cost overrun.

A key success factor for Policy 6.2 lies in its enhanced monitoring capabilities, facilitated by the combined policies. This enabled the project team to accurately identify and track additional work attributable to requirement changes (Figure 150, graph Project Scope). Consequently, this additional, out-of-scope work could be successfully billed to the client, effectively reducing the net cost overrun to a much more favorable 12.38%. Furthermore, Figure 150 depicts a continued positive relational capital development while maintaining controlled growth in "cozy relationships," indicating a successful balance of RMCCV benefits with necessary oversight. Additionally, despite a significant increase in total work due to new and changed requirements, a notably low reliance on overtime was observed.

These robust findings suggest that Policy 6.2 offers a compelling framework for companies to confidently consider accepting changes and additions to requirements, effectively mitigating the negative consequences often highlighted by project managers and transforming a potential liability into a manageable and even billable opportunity.

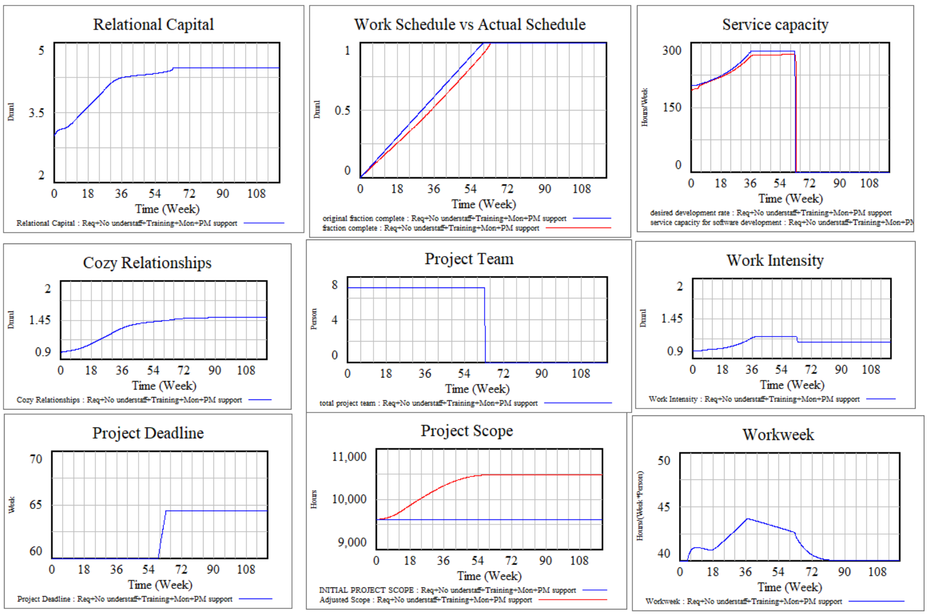

Figure 150 – Summary of results from Policy 6.2

8.9.7.3 Policy 6.3 – Business as Usual, Accepting changes and new requirements, , improving feedback mechanisms, allowing hiring (50% rookies), improve monitoring, and use external project management support

Policy 6.3 (Figure 151) tackles the challenge of accepting new requirements and changes within a Business-as-Usual (BAU) initial understaffing context. This policy combines improved feedback mechanisms, targeted hiring aligned with Company A's financial goals (allowing hiring of 50% rookies), enhanced monitoring, and external project management support. The simulation results show a moderate schedule overrun of 7.18%, representing a significant improvement compared to the BAU + Requirements baseline (89.48%). However, it comes with a significant gross cost overrun of 36.81%. While the policy's ability to track additional work arising from new requirements (amounting to 862 billable hours) successfully reduces the net cost overrun to 32.17%, this figure remains substantial.

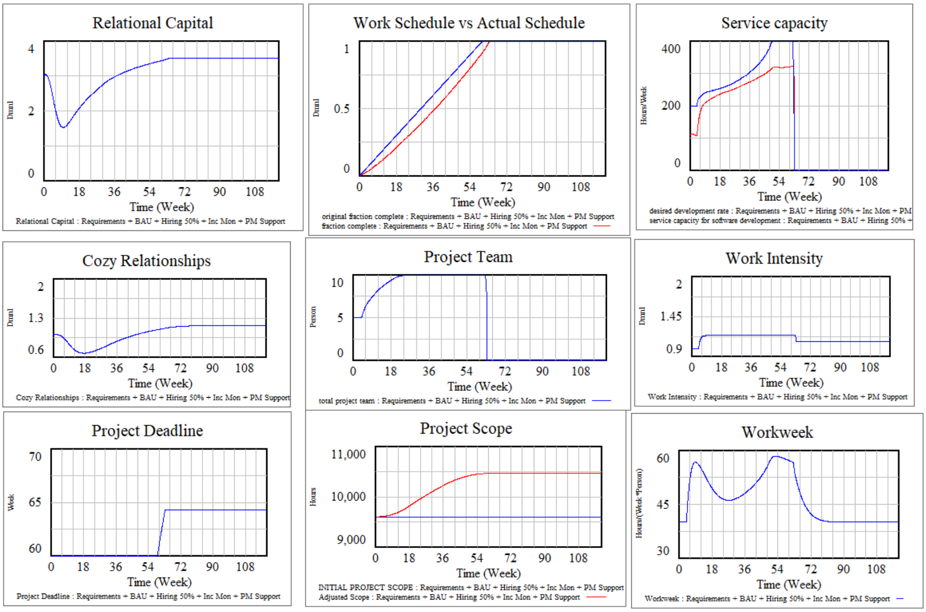

Figure 151 – Summary of results from Policy 6.3

Compared to Policy 6.2 (which started with no understaffing and included similar comprehensive controls), Policy 6.3 achieves a comparable schedule performance (7.18% vs 7.40%). However, it does so at a vastly higher cost (32.17% net vs 12.38% net in Policy 6.2) and a heavy reliance on work intensity and overtime. This sustained pressure, in turn, leads to a higher error rate, which introduces further stress on the project and may hinder the successful execution of longer projects or subsequent ones. The results highlight that while adding staff (even 50% rookies) and implementing robust controls can help manage schedule overruns in an understaffed environment facing scope changes, the fundamental cost of managing this high-pressure, under-resourced context remains prohibitively high, compromising project sustainability.

8.9.7.4 Policy 6.4 – Business as Usual, Accepting changes and new requirements, , improving feedback mechanisms, allowing hiring (50% rookies), training the customer's team, improve monitoring, and use external project management support

Policy 6.4 represents a strategy for managing new and changed requirements within a BAU initial understaffing context. Building upon Policy 6.3, this scenario incorporates a full suite of interventions: improving feedback mechanisms, allowing hiring of 50% rookie employees, training the customer's team, improving monitoring, and using external project management support.

As anticipated, incorporating the customer team training program into this already robust set of policies further improves project outcomes. Policy 6.4 successfully copes with the increasing work from requirements changes, achieving a schedule overrun of 6.77% and a gross cost overrun of 34.97%. Like in previous policies, the ability to bill for additional work due to new scope allows the net cost overrun to drop to 30.37%. When directly compared to Policy 6.3, the addition of customer training demonstrably improves both schedule (from 7.18% to 6.77%) and cost (gross from 36.81% to 34.97%; net from 32.17% to 30.37%). This underscores the value of RMCCV-oriented policies like client training, even in complex, initially understaffed environments. However, despite these improvements, the project still experiences significantly higher costs when compared to scenarios that begin with adequate staffing (e.g., Policy 6.2, which achieved a net cost of 12.38%). This reiterates that while comprehensive interventions can enhance performance, the fundamental cost burden associated with initially understaffed projects, even with partial capacity additions and multiple controls, remains a significant challenge.

8.9.7.5 Policy 6.5 – Accepting changes and new requirements, starting understaffed, improving feedback mechanisms, allowing hiring (20% rookies), improve monitoring, and use external project management support

Policy 6.5 represents a strategic refinement within the complex context of accepting new and changing requirements while starting understaffed (BAU).

This policy builds upon Policy 6.3 by adopting a more advantageous hiring strategy, targeting only 20% rookie employees (as opposed to 50%). This modification directly aligns with findings from earlier policies that consistently demonstrated superior project outcomes when incorporating a higher proportion of experienced staff. The policy also retains robust components, including improving feedback mechanisms, enhanced monitoring, and external project management support.

The results for Policy 6.5 are a dramatic improvement compared to the 50% rookie hiring strategy seen in Policy 6.3. It achieves a minimal schedule overrun of 2.70% and a gross cost overrun of 23.32%, which drops to a final net cost overrun of 18.50% after considering the billing of additional scope. This stands in stark contrast to Policy 6.3's 7.18% schedule overrun and 32.17% net cost overrun, unequivocally validating the profound benefit of prioritizing experienced hires.

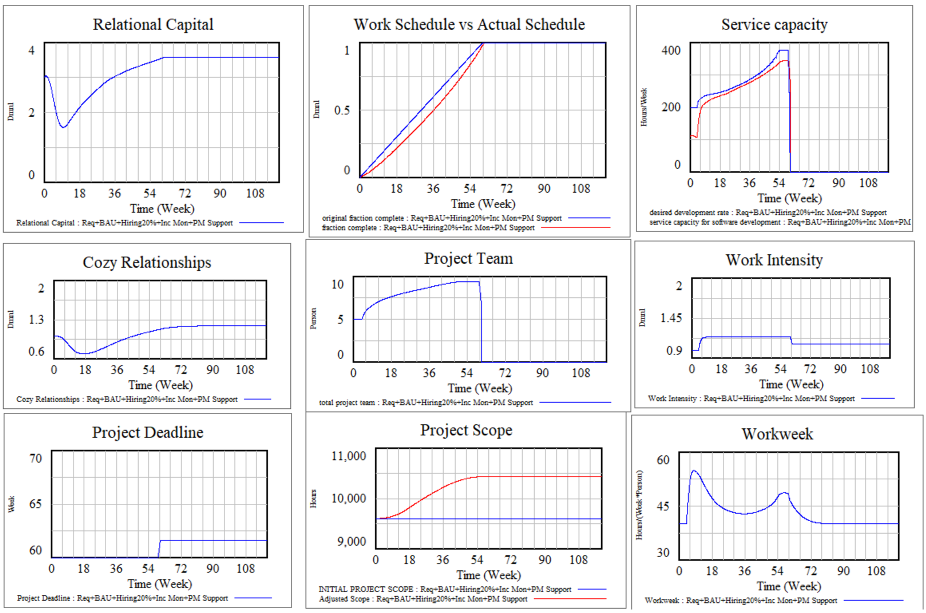

Figure 152 – Summary of results from Policy 6.5

Figure 152 further illustrates the impressive operational efficiencies. A significant improvement in service capacity allocation, a substantial decrease in overtime reliance, and an overall reduction in staffing requirements. These factors contribute significantly to the exceptional schedule performance. While

Policy 6.5 demonstrably improves relational capital compared to the project's outset, its full development remains hampered by the initial understaffing. This suggests that even with highly skilled new hires and comprehensive controls, the initial capacity deficit imposes a lasting constraint on relationship growth. Nevertheless, this policy highlights the immense strategic value of investing in experienced talent, even when initially understaffed and facing evolving requirements.

8.9.7.6 Policy 6.6 – Accepting changes and new requirements, starting understaffed, improving feedback mechanisms, allowing hiring (20% rookies), training, improve monitoring, and use external project management support

Building on the effective strategies established for improving understaffed projects, Policy 6.6 examines their applicability when faced with the common and critical challenge of accepting changes and additions to requirements in Agile and Hybrid environments. This policy represents the most comprehensive combination in this category, integrating Accepting Changes and New Requirements, Starting Understaffed, Improving Feedback Mechanisms, Allowing Hiring (20% Rookies), Training the Customer’s Team, Improving Monitoring, and Using External Project Management Support. It builds directly upon Policy 6.5 by incorporating client team training.

Figure 153 presents the outcomes of this robust approach. While the results are largely comparable to Policy 6.5, there are noteworthy distinctions. The schedule overrun experiences only a slight, almost negligible, increase to 3.02% (from 2.70% in Policy 6.5). However, a more significant improvement is observed in cost overruns:

- Without additional revenue from billable hours, the gross cost overrun decreases from 23.32% (Policy 6.5) to 19.94%.
- Considering revenue from billable hours, the net cost overrun remarkably improves from 18.50% (Policy 6.5) to 15.13%.

This substantial cost optimization appears directly attributable to a slight reduction in overall staffing requirements throughout the project, as illustrated in Figure 154. The incorporation of client training (an RMCCV-oriented policy) fosters more efficient collaboration and knowledge transfer, thereby allowing the project to manage its workload with fewer internal resources. Despite a minor schedule trade-off, Policy 6.6 demonstrates superior cost control and optimized resource utilization, providing a highly effective framework for navigating complex projects with evolving requirements, even when starting with an initial staffing deficit.

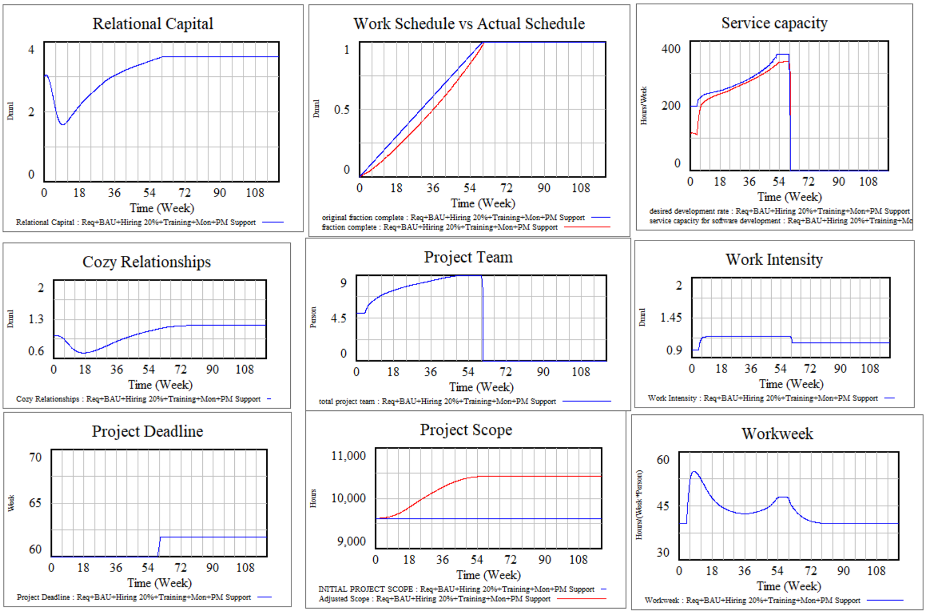

Figure 153 – Summary of results from Policy 6.6

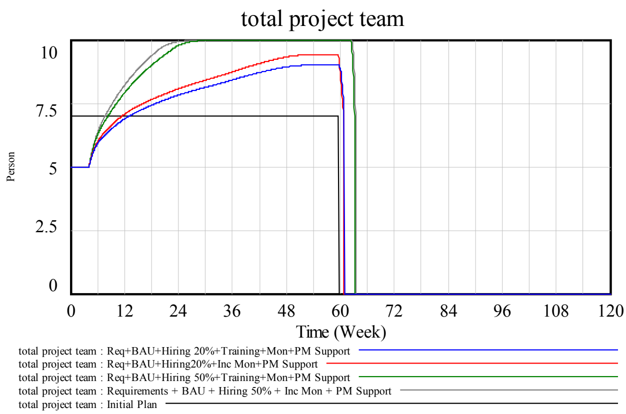

Figure 154 – Comparison between policies accepting changes in requirements

8.9.8 Summary of results from the policy analysis

Building upon the model validation presented earlier, this Appendix uses extensive simulation of different policies and their combinations to explore their effectiveness in improving project outcomes within a hypothetical scenario. This analysis aims to directly reflect on and validate the hypotheses described in Section 6.3. The initial project conditions mirror those established in the project plan at the beginning of Appendix 8 in Table 16. We established a baseline through two scenarios that replicate Company A's typical project decisions, ensuring the model accurately represents average behavior observed in real-world projects.

8.9.8.1 The Foundational Role of Initial Staffing and Capacity Management

Our simulations reveal that initial staffing levels serve as the paramount determinant of overall project success and sustainability. Projects starting with adequate staffing (e.g., Policy 1.1) demonstrate a balanced strategy, yielding moderate schedule and cost overruns of approximately 10% each. Furthermore, the integration of Relational Motive to Co-Create Value (RMCCV)-oriented policies within an adequately staffed environment consistently yields substantial improvements (Policies 5.1 to 5.6). In these scenarios, despite moderate project overruns, relational capital consistently grows throughout the project lifecycle.

Conversely, initiating projects with inadequate staffing consistently leads to poor performance. While individual RMCCV-oriented policies can help maintain low-cost overruns, they offer minimal schedule improvement, often resulting in staggering schedule overruns (e.g., Policy 5.7 with a 46.77% schedule overrun). For severely understaffed projects, combinations of policies that do not involve adding capacity yield only marginal improvements compared to using a single policy (e.g., Policy 5.7 versus Policies 4.6 to 4.9). This highlights a crucial insight: understaffing is the first overwhelming source of pressure for projects. Our findings confirm that significantly improving understaffed projects hinges on the ability to hire additional personnel, allowing the project team to grow to a level where substantial improvements can be achieved. This finding challenges a common project management mindset within the software development industry, where companies often favor staffing projects with less experienced staff in hopes of on-the-job training. Our analysis unequivocally demonstrates that hiring more experienced personnel (e.g., 20% rookies as in Policy 6.5 vs. 50% rookies as in Policy 6.3) dramatically reduces both schedule and cost overruns, even in initially understaffed contexts.

8.9.8.2 Validation of Hypotheses

Our extensive simulation results provide strong empirical evidence to validate the proposed hypotheses:

Hypothesis 1: Can effective capacity management strategies, including appropriate staffing and workload balancing, lead to improved project performance (e.g., lower costs, faster completion)?

This hypothesis is unequivocally confirmed by our simulations, directly addressing our first sub-research question regarding the sufficiency of staffing or scheduling alone. Policy 1.1 (adequate initial staffing) immediately demonstrated significant reductions in both schedule and cost overruns compared to the understaffed baseline. Furthermore, for initially understaffed projects, strategic capacity additions through hiring (e.g., Policies 5.10, 5.11, 6.5, 6.6) consistently led to substantial improvements in project performance, manifesting as drastically lower costs and faster completion times. The observed reduction in overtime reliance across numerous successful policies (e.g., 5.4, 5.5, 5.6, 5.10, 5.11, 6.2, 6.5, 6.6) serves as direct evidence of effective workload balancing contributing to these improved outcomes.

Hypothesis 2: Regular feedback and monitoring can identify and address issues early, leading to better project outcomes and efficient relationships.

The simulations consistently demonstrate that policies incorporating improved feedback mechanisms and increased monitoring (e.g., Policy 5.5, Policy 5.10, and across the entire 6.x series) are highly effective. This is evidenced by lower probabilities of error generation (e.g., Policy 5.6), and crucially, the ability to accurately identify and track additional work arising from new requirements, enabling successful billing to the client (as seen in Policies 6.2, 6.3, 6.4, 6.5, 6.6, where net cost overruns were significantly reduced). Furthermore, monitoring played a key role in controlling the potential downsides of "cozy relationships" while maintaining relational capital growth.

Hypothesis 3: Projects that prioritize relationship management, such as investing in client training, integrating account managers, or using benchmark goals, will achieve better outcomes (e.g., higher customer satisfaction, reduced rework).

The findings strongly support this hypothesis. Client training initiatives (e.g., Policies 5.1, 5.5, 5.6, 5.11, 6.2, 6.4, 6.6) consistently led to improved schedule and cost performance, often through reduced work intensity, lower overtime, and optimized overall staffing requirements (e.g., Policy 6.6 reducing staffing needs). This suggests enhanced collaboration and knowledge transfer, ultimately leading to more efficient project execution and likely higher client satisfaction. While some RMCCV-oriented policies (e.g., Policy 5.1 in isolation) could lead to "cozy relationships" without controls, when properly combined with monitoring, the benefits of relational capital were fully realized without negative impacts.

Hypothesis 4: Good feedback and monitoring practices, combined with strong relationships, can facilitate effective change management by fostering open communication, trust, and collaboration, thereby enabling efficient access to a wider range of beneficial policies.

This hypothesis is unequivocally confirmed by the performance of policies designed to handle new and changing requirements (the 6.x series). Combinations featuring robust feedback, increased monitoring, and relationship-building elements (like client training and external project management support) demonstrated remarkable effectiveness in managing scope changes. The ability to precisely track and bill for additional scope (a "beneficial policy" for the service provider) is a direct testament to the efficacy of these integrated practices in fostering clear communication and accountability amidst change. This allowed projects to maintain significantly lower schedule and cost overruns even under highly dynamic conditions (e.g., Policy 6.6 with 3.02% schedule and 15.13% net cost overrun, compared to the 89.48% schedule overrun of the BAU scenario with changes).

8.9.8.3 Synergistic Effects and Strategic Insights
Our analysis reveals that combining various policies, especially those fostering continuous relational capital growth in conjunction with enhanced feedback and monitoring, consistently yielded the most promising outcomes. Policies that integrated multiple interventions demonstrated superior performance compared to single interventions or less comprehensive combinations. For instance, Policy 5.11 achieved an exceptionally low schedule overrun of 1.00% while maintaining a moderate cost of 23.32%, by combining BAU understaffing with hiring 50% rookies, feedback, monitoring, client training, and external PM support. Similarly, Policy 5.6 (adequate staffing, feedback, training, external PM) yielded a minimal 2.28% schedule overrun, showcasing the power of comprehensive strategic alignment.

However, while external project management support consistently proved highly effective in controlling schedule overruns (as seen in Policies 5.4, 5.6, 5.10), it often came with a higher direct cost. The overall findings highlight critical trade-offs between schedule adherence and cost optimization, particularly when starting from an understaffed position. This research demonstrates that adequate service capacity is fundamental for fostering positive relationships, accumulating relational capital, and ultimately improving project outcomes. Without it, even RMCCV-oriented policies aimed at boosting relational capital yield limited benefits in knowledge transfer and learning, hindering capacity recovery. Conversely, strategic hiring of experienced staff coupled with comprehensive RMCCV-oriented policies can enable significantly understaffed projects to achieve high performance, leading to a virtuous cycle of improved relational capital and unlocking its full potential for achieving better project outcomes. This comprehensive approach empowers organizations to not only respond effectively to project challenges but also to strategically accept new opportunities, such as evolving client requirements, that were previously deemed too risky.

8.10 Appendix 10 – List of policies considered for the final model

The following tables present a list of policies considered for the final model, with the variables used, an explanation, and source for each of them.

Table 24 - Policies under the planning and controlling scope

#	Policy	Variable	Intended Policy	Source
1	Quality	Probability of error generation	Managing the probability of error generation is a critical project management task because it fuels the pervasive rework cycle. However, this task is often overlooked both for initial and recurring planning activities, introducing significant pressure to projects.	(Oliva and Sterman, 2010; Sterman, 2000; Jalili and Ford, 2016; Li *et al.*, 2018; Lyneis and Ford, 2007; Rebentisch *et al.*, 2018) Interviews
2	Plan	Adjust sprint capacity	Short feedback cycles are at the core of Agile and Hybrid practices. By revising sprint capacity at the end of each sprint, the project management can permanently adjust the plans for the next sprint.	(Sarangee *et al.*, 2022; Repenning, Kieffer and Repenning, 2017; Yahya and Maidin, 2023; Glaiel, Moulton and Madnick, 2014) Interviews
3	Plan	Add slack	Trying to compensate for the trend to underestimate requirements, project managers often add extra time to the initial plan.	(Austin, 2001; Abdel-Hamid and Madnick, 1989; Cao, 2022) Interviews
4	Control	Scope Increase to be sold	Allows project managers to decide what part of the additional work done in the project can be sold, improving the project financial results.	Interviews
5	Scope Management	Additional requirements per sprint	This can be used to limit the amount of additional requirements accepted in the project.	(Cao, Ramesh and Abdel-Hamid, 2010; Lyneis and Ford, 2007; Repenning, Kieffer and Repenning, 2017; Glaiel, Moulton and Madnick, 2014; Rebentisch *et al.*, 2018) Interviews
6	Scope Management	Scope decrease	This can be used to decrease the project scope to meet deadlines.	(Cao, Ramesh and Abdel-Hamid, 2010; Lyneis and Ford, 2007; Repenning, Kieffer and Repenning, 2017; Glaiel, Moulton and Madnick, 2014; Rebentisch *et al.*, 2018) Interviews
7	Scope Management	Average change in requirements per sprint	Allows to impose a limit to the change of requirements within the project.	(Cao, Ramesh and Abdel-Hamid, 2010; Lyneis and Ford, 2007; Repenning, Kieffer and Repenning, 2017; Glaiel, Moulton and Madnick, 2014; Rebentisch *et al.*, 2018) Interviews

Table 24 - Continued

#	Policy	Variable	Intended Policy	Source
8	Plan	Time to start using policies	Defines when to start using capacity correction policies.	Authors estimation according to interviews
9	Plan	Desired change in sprint duration	The decision to change sprint duration. This decision results from monitoring the adequacy of the capacity used and the work planned for each sprint.	(Sarangee *et al.*, 2022; Repenning, Kieffer and Repenning, 2017; Yahya and Maidin, 2023; Glaiel, Moulton and Madnick, 2014) Interviews
10	Plan	Time to start changing sprint duration	The decision when to start using the policy to change sprint duration.	Authors estimation according to interviews
11	Plan	Time to end changing sprint duration	The decision when to end using the policy to change sprint duration.	Authors estimation according to interviews
12	Plan	Switch manual sprint capacity	Decision between adjusting sprint capacity at the end of each sprint, or defining specific moments to do it.	Interviews
13	Plan	Sprint capacity change	The decision about how much to change sprint capacity.	(Sarangee *et al.*, 2022; Repenning, Kieffer and Repenning, 2017; Yahya and Maidin, 2023; Glaiel, Moulton and Madnick, 2014) Interviews
14	Plan	Time to change sprint capacity	The decision when to start using the policy to change sprint capacity	Authors estimation according to interviews
15	Plan	Time to end change sprint capacity	The decision when to end using the policy to change sprint capacity	Authors estimation according to interviews
16	Schedule	Percentage of deadline gap incorporation	A decision agreed with the client to postpone the project schedule and by how much.	(Sarangee *et al.*, 2022; Repenning, Kieffer and Repenning, 2017; Yahya and Maidin, 2023; Glaiel, Moulton and Madnick, 2014) Interviews

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Table 25 - Policies under the service capacity scope

#	Policy	Variable	Intended Policy	Source
17	Capacity	Maximum project workforce	Definition of the maximum number of people allowed to work on the project simultaneously.	Interviews (Sterman, 2000; Glaiel, Moulton and Madnick, 2014)
18	Understaffing	Initial number of rookies; Initial number of experienced	Understaffing is common in software projects as companies do not have the available resources to kick off projects at the right moment.	Interviews; (Lyneis and Ford, 2007; Glaiel, Moulton and Madnick, 2014)
19	Capacity	Percentage of gap to be filled by work intensity	Allows choosing how much of the policy of work intensity can be used.	(Ford, Lyneis and Taylor, 2007; Jalili and Ford, 2016; Li *et al.*, 2018) Interviews
20	Capacity	Percentage og gap to be filled by overtime	Allows choosing how much of the policy of overtime can be used.	(Ford, Lyneis and Taylor, 2007; Jalili and Ford, 2016; Li *et al.*, 2018) Interviews
21	Capacity	Percentage og gap to be filled by workforce	Allows choosing how much of the policy of hiring can be used.	(Ford, Lyneis and Taylor, 2007; Jalili and Ford, 2016; Li *et al.*, 2018) Interviews
22	Capacity	Reduction of work week by hiring	Establishes a goal for reducing overtime when hiring.	Authors estimation according to interviews
23	Capacity	Reduction of work intensity by hiring	Establishes a goal for reducing work intensity when hiring.	Authors estimation according to interviews
24	Capacity	Desired ratio of rookies	Project decision about the experience mix for new staff.	Interviews; (Ford, Lyneis and Taylor, 2007; Jalili and Ford, 2016; Li *et al.*, 2018; Nasirzadeh and Nojedehi, 2013; Kunc, 2008)
25	Capacity	Fraction of time for commercial activity	The decision to manage the amount of time experienced staff can use to participate in commercial activities outside the project's scope.	Authors estimation according to interviews

Table 25 - Continued

#	Policy	Variable	Intended Policy	Source
26	Capacity	Fraction of time to train rookies	The decision to manage the amount of time experienced uses to train the less experienced members of the project.	Authors estimation according to interviews (Oliva and Sterman, 2010; Sterman, 2000)
27	Capacity	Hours spent in daily meetings	The project manager can act on time management	Interviews
28	Capacity	Hours spent in sprint reviews	The project manager can act on time management	Interviews
29	Capacity	Hours spent in sprint planning	The project manager can act on time management	Interviews

Table 26 - Policies under the relationships management scope

#	Policy	Variable	Intended Policy	Source
30	Training	Hours spent training clients per week	Literature suggests that investing in training the client will improve his motivation to co-create and consequently improve overall productivity.	(Neghina *et al.*, 2015; Fatema and Sakib, 2018; Swart, Bond-Barnard and Chugh, 2022; Křivánková and Remta, 2023) Interviews
31	Improving Dialogue capability	Manage dialogue capability	Literature suggests that investing in promoting dialogue activities improves knowledge transfer, and will consequently improve overall productivity.	(Swart, Bond-Barnard and Chugh, 2022; Neghina *et al.*, 2015; Jaakkola and Alexander, 2014; Sarangee *et al.*, 2022) Interviews
32	Improving Feedback mechanisms	Measuring quality for errors, service capacity, schedule, and cost	Literature and interviews suggest that improving the metrics supporting project managers benefits the management of expectations and perceptions, which are critical for service quality.	Interviews (Abdel-Hamid and Madnick, 1989; Neghina *et al.*, 2017; Yahya and Maidin, 2023; Franck *et al.*, 2017)
33	Managing Cozy relationships	Cozy Relationships	Measuring Cozy relationships is critical to understand which policies work best to improve project results.	(Villena, Revilla and Choi, 2011; Rood *et al.*, 2018; Anderson and Jap, 2005; Villena, Choi and Revilla, 2021)
34	Managing Cozy relationships	Rotation of Staff	Several organizations already adopted the policy of limiting the time employees can work on projects within the same client to avoid the development of overly close relationships.	(Villena, Revilla and Choi, 2011; Rood *et al.*, 2018; Anderson and Jap, 2005; Villena, Choi and Revilla, 2021) Interviews
35	Managing Cozy relationships	Increase efficiency from external project management support	Hiring external project management support is a strategy that has been followed by software development companies and by their clients over the last decade, under the promise of relevant productivity gains.	Interviews; (Thite, 1999; Anantatmula, 2010; Meng and Boyd, 2017)
36	Managing Cozy relationships	Desired relational capital	Establishing a goal for relational capital opens an avenue of research for policies trying to standardize the processes adopted, but most importantly, to standardize and implement processes to manage daily interactions with clients, aiming at keeping relationships as professional and non-relationship-dependent as possible.	(Meng and Boyd, 2017; Neghina *et al.*, 2015; Neghina *et al.*, 2017)

Table 26 - Continued

#	Policy	Variable	Intended Policy	Source
37	Account Management	Decision to establish account management	Literature suggests that using matrix organizations within a project improves monitoring, quality control, and improves coordination.	Interviews (Grönroos, 2011; Autry and Golicic, 2010; Johnsen and Lacoste, 2016)
38	Goal setting	Erosion of goals	Managing the trend to eroding goals is regarded by literature as an important leverage	(Choi and Bae, 2009; Oliva and Sterman, 2010; Villena, Choi and Revilla, 2021)
39	Increase monitoring	Improvement from monitoring Policy	Literature suggests that improving monitoring mechanisms is important to manage the motivation to co-create. Additionally, project managers recognize in interviews that improving monitoring with the client helps manage expectations and quality perceptions.	Interviews (Villena, Revilla and Choi, 2011; Franck *et al.*, 2017; Villena, Choi and Revilla, 2021)
40	Increase monitoring	Switch to turn on monitoring policy	Decision point to start using the improvement of monitoring	Interviews (Villena, Revilla and Choi, 2011; Franck *et al.*, 2017; Villena, Choi and Revilla, 2021)
41	Quality	Maximum work intensity	Defines a maximum value allowed for work intensity. It can be the result of legal demands but also from the project manager's decision to overload the team.	Interviews, (Li *et al.*, 2018; Lyneis and Ford, 2007; Tripp and Armstrong, 2018; Oliva and Sterman, 2010)
42	Quality	Maximum work week	Defines a maximum value allowed for the number of working hours per week. It can be the result of legal demands but also from the project manager's decision to overload the team.	Interviews, (Li *et al.*, 2018; Lyneis and Ford, 2007; Tripp and Armstrong, 2018; Oliva and Sterman, 2010)

Table 27 - Summary of common combination of policies

#	Policy	Intended Policy	Source
43	No understaffing with training	This combination of policies combines using the initial staff plans, with investing in training the clients' staff, while considering th e decrease in time available to produce due to training.	The interviews with project managers over the course of the thesis emphasized the project managers' hopes to have access to the planned resources and their willingness to develop the skills of clients' staff.
44	No understaffing with account management	This combination of policies combines the project manager's hopes to access the planned resources with a common strategy used by software development companies that use the account management team as a source of additional control and risk mitigation.	The interviews with project managers revealed that using account management was a very common practice among software development companies.
45	No understaffing with Increase monitoring	This combination of policies combines the project manager's hopes to access the planned resources with the need to increase monitoring, which is highly praised by project management and System Dynamics literature.	The interviews with project managers revealed the preoccupation with improving monitoring and reporting systems as a way to improve results.
46	No understaffing with external PM support	This combination of policies combines the project manager's hopes to access the planned resources with an increasingly used strategy by clients in larger projects, using additional project management capacity from third parties.	The interviews with project managers revealed that the use of external project management support was a very common practice among the clients from software development companies.
47	No understaffing with training and Increase monitoring	This combination of policies combines the project manager's hopes to access the planned resources with training while trying to control the growth of relational capital by increasing monitoring. This policy represents a mix of policies resulting in large increases in relational capital with a policy aimed at controlling it.	Combination resulting from interviews

Table 27 - Continued

#	Policy	Intended Policy	Source
48	No understaffing with training and external PM support	This combination of policies combines the project manager's hopes to access the planned resources with training and additional project management capacity. Although they are capacity-oriented, using external project management capacity might slow down the growth of relational capital.	Combination resulting from interviews.
49	Changing ad adding Requirements +No understaffing +Increase monitoring +Project management support	This combination of policies introduces the challenge of changing and adding requirements to a scenario where the project manager accesses the planned resources, adds capacity through external project management, and tries to manage the growth of cozy relationships by improving monitoring.	Combination resulting from interviews.
50	Changing ad adding Requirements + No understaffing + Training + Increase monitoring + Project management support	This combination of policies expands the study of the responses to the challenge of changing and adding requirements by combining additional policies. We are testing starting with no underestimation and complementing it with training and adding project management capacity while trying to mitigate the development of cozy relationships through improving the monitoring systems.	Combination resulting from interviews.
51	Business as Usual + Increase monitoring + Account management	This combination of policies uses the business-as-usual scenario from company A, understaffing the project from the beginning, but introducing an increase in motoring and the account management team, to try to mitigate the development of cozy relationships.	Combination resulting from interviews.

Table 27 - Continued

#	Policy	Intended Policy	Source
52	Business as Usual + Hiring 50% of rookies + Increase monitoring + Account management	This combination of policies explores the addition of staff to work together with increasing monitoring and account management, hoping to control the accumulation of relational capital that might result from increasing capacity.	Combination resulting from interviews.
53	Business as Usual + Hiring 50% of rookies + Increase monitoring + Account management + Change schedule	This combination of policies adds the possibility of changing the schedule to the previous policy.	Combination resulting from interviews.
54	Business as Usual + Hiring 50% of rookies + Increase monitoring + Project management support	This combination of policies starts with the business-as-usual scenario but allows adding staff and external project management capacity while also increasing monitoring. Again, this policy includes two policies that might result in high increases in relational capital and one additional to control that increase.	Combination resulting from interviews.
55	Business as Usual + Hiring 50% of rookies + Increase monitoring + Project management support + Training	This combination of policies adds the possibility of training the client's staff to the previous policy.	Combination resulting from interviews.
56	Changing ad adding Requirements + Business as Usual + Hiring 50% of rookies + Increase monitoring + Project management support	This combination of policies tests the introduction of changes and new requirements to Policy 54.	Combination resulting from interviews.
57	Changing ad adding Requirements + Business as Usual + Hiring 50% of rookies + Increase monitoring + Project management support + Training	This combination of policies tests the introduction of changes and new requirements to Policy 55.	Combination resulting from interviews.

Table 27 - Continued

#	Policy	Intended Policy	Source
58	Changing ad adding Requirements + Business as Usual + Hiring 20% of rookies + Increase monitoring + Project management support	This combination of policies is policy 56 but allows only hiring 20% of rookies. This policy puts emphasis on hiring experienced staff.	Combination resulting from interviews.
59	Changing ad adding Requirements + Business as Usual + Hiring 20% of rookies + Increase monitoring + Project management support + Training	This combination of policies is policy 57 but allows only hiring 20% of rookies. This policy puts emphasis on hiring experienced staff with the additional concern of training the client's staff.	Combination resulting from interviews.
60	Changing ad adding Requirements + Business as Usual + Hiring 80% of rookies + Increase monitoring + Project management support	This combination of policies is policy 56 but allows only hiring 80% of rookies. This policy puts emphasis on costs.	Combination resulting from interviews.
61	Changing ad adding Requirements + Business as Usual + Hiring 80% of rookies + Increase monitoring + Project management support + Training	This combination of policies is policy 57 but allows only hiring 20% of rookies. This policy puts emphasis on costs with the additional concern of training the client's staff.	Combination resulting from interviews.

9. Curriculum vitae

Jorge Alberto Barra Cancela de Sousa was born in Vila Nova de Gaia, Portugal on the 21st of December 1975, and he graduated in Business Administration in Universidade Lusíada do Porto in the 5 year degree program pre Bologna. Jorge is a seasoned business leader with over 25 years of experience in information technology, finance, and strategy. His career path reflects a passion for continuous learning and a drive to leverage academic knowledge for practical applications.

Jorge's professional journey began in finance, holding a controller position at ASA Editores, a prominent Portuguese publishing house. He then transitioned to the IT sector, joining CPC Group, the second-largest IT firm in Portugal at the time. This shift ignited his interest in the research that would later form the foundation of his PhD thesis.

Following his tenure at CPC Group, Jorge led the financial market segment at INDRA Portugal for six years. Recognizing the need to address project management challenges, he pursued a Master's degree at the University of A Coruña, equipping him with expertise in simulation models for strategic and operational applications. Jorge subsequently embarked on a PhD program at the same university, ultimately pausing his studies to lead CPC Africa, one of Angola's largest IT companies.

As CEO of CPC Africa, Jorge oversaw a decade of growth, establishing himself as a board member for the company and several others. A conversation with Professor Etiënne Rouwette in 2017 rekindled his academic passion, leading him to take a career break between 2018 and 2019 to pursue his PhD studies. He completed coursework at Radboud University and delved deeper into System Dynamics.

In 2020, Jorge returned to the corporate world as Chief Strategy Officer at Armis Benelux. Here, he successfully balanced his professional responsibilities with his ongoing PhD studies, gaining firsthand experience in applying his research findings. This experience culminated in the establishment of his own company, Whatxnext, in 2024.

Whatxnext leverages Jorge's expertise in System Dynamics modeling to enhance decision support systems and share the valuable knowledge acquired throughout his diverse career path with a wider audience.

10. Nederlandse samenvatting (Dutch summary)

10.1 Probleem en Onderzoeksleemte

De software-industrie is een kritieke sector die voor grote uitdagingen staat. Projecten voor softwareontwikkeling worden geplaagd door hardnekkige overschrijdingen van tijdsplanning en budget, waarbij meer dan twee derde van de projecten te laat en te duur is. Hoewel de verschuiving van traditionele watervalmethodologieën naar Agile en Hybride benaderingen de betrokkenheid van de klant heeft vergroot, zien de bestaande raamwerken de gedragsdynamiek van persoonlijke relaties tussen klanten en dienstverleners grotendeels over het hoofd, als het gaat om het verbeteren van projectresultaten in termen van kosten en tijdsplanning. Deze thesis vult deze kritieke leemte door te onderzoeken hoe het Relational Motive to Co-Create Value (RMCCV) en Relational Capital de projectresultaten beïnvloeden. Het onderzoek wil twee belangrijke vragen beantwoorden:

1. Hoe beïnvloeden het RMCCV en relationeel kapitaal de projectresultaten in termen van kosten en schema?
2. Hoe kunnen dienstverleners het RMCCV en Relational Capital inzetten voor betere projectresultaten in termen van kosten en schema?

De studie gebruikt een interdisciplinaire benadering, waarbij concepten uit projectmanagement, marketing en Systeemdynamica worden gecombineerd om een simulatiemodel te bouwen en te valideren.

10.2 Het Relationele Motief om Waarde te Creëren

Hoofdstuk 2 introduceert het concept RMCCV en definieert het als een toekomstgerichte, actiegerichte intentie om relaties te verbeteren voor wederzijdse waardecreatie in kennisintensieve diensten. Met behulp van een exploratief Systeemdynamica-model onderzoekt dit hoofdstuk hoe een RMCCV in plaats van de verwachte stijging van servicekwaliteit, net tot een daling kan leiden. Het model toont aan dat een toename van RMCCV samenwerking intensiveert en vertrouwen laat toenemen, wat weer leidt tot minder dialoog en minder strenge kwaliteitscontroles. Uiteindelijk leidt dit tot lagere servicekwaliteit. Het hoofdstuk laat het belang van het beheren van RMCCV zien, waarbij het stellen van duidelijke kwaliteitsdoelen een bruikbare optie blijkt om deze achteruitgang te voorkomen.

10.3 Relaties in Informatietechnologieprojecten

Voortbouwend op het vorige hoofdstuk verdiept dit hoofdstuk de analyse door het RMCCV te onderzoeken in de context van softwareontwikkelingsprojecten. Het breidt het model uit naar een waterval projectworkflow en onderzoekt hoe relaties de projectdynamiek beïnvloeden, in termen van tijdsdruk, bereidheid om teamleden te wisselen en de acceptatie van ingrepen in kwaliteit. De bevindingen onderschrijven de conclusie dat relaties een kritische, vaak over het hoofd geziene vormen die projectresultaten sterk kunnen beïnvloeden, zowel in positieve als negatieve zin.

10.4 Relational Capital in Agile en Hybride Projecten

Dit hoofdstuk verbreedt de theoretische basis van het onderzoek door Relational Capital te introduceren, gedefinieerd als het geaccumuleerde reservoir van positieve relaties dat in de loop van de tijd is opgebouwd. Het hoofdstuk richt zich op de steeds populairder wordende Agile en Hybride methodologieën, waar intense samenwerking met klanten de relationele dynamiek nog kritischer maakt. Een uitgebreid literatuuronderzoek en interviews met 23 projectmanagers van zeven IT-bedrijven, vormt de basis voor een model dat zowel de positieve aspecten van Relational Capital (bijv. verbeterde communicatie) als de "duistere kant" ervan (bijv. zelfgenoegzaamheid leidend tot verminderde monitoring en doelerosie) belicht. Het model wordt gevalideerd met behulp van gegevens over real-world projecten, wat het belang van Relational Capital in projectoverschrijdingen onderschrijft.

10

10.5 Het Extended Thesis Model

Hoofdstuk 5 vormt de kern van het proefschrift, waarin alle voorgaande concepten worden geïntegreerd in één omvattend systeemdynamisch model. Het model brengt het RMCCV- en Relational Capital perspectief samen en past deze toe op hybride projectmethodologieën, die in de praktijk gebruikelijk zijn. Het model formaliseert de feedbackloops en causale relaties die in de voorgaande hoofdstukken zijn geïdentificeerd, die zowel personeelsbezetting, toewijzing van middelen, servicekwaliteit als de impact van relaties op planning en controle meenemen. Het model is grondig gevalideerd aan de hand van historische gegevens van vier praktijkprojecten voor een Portugees softwarebedrijf ("Bedrijf A"), waarbij de modelsimulaties het projectverloop over de tijd, inclusief plannings- en kostenoverschrijdingen, nauwkeurig reproduceren. Dit hoofdstuk toont aan dat het model een robuust instrument is om beleidsinterventies te verkennen en verborgen dynamieken te identificeren.

10.6 Beleidsanalyse en Strategieën

Met behulp van het gevalideerde model uit hoofdstuk 5 onderzoekt dit hoofdstuk de effectiviteit van verschillende opties voor projectmanagement. De analyse begint met een "business-as-usual"-scenario en test vervolgens een reeks beleidsopties die zijn afgeleid uit interviews en literatuur. De managementacties’zijn onderverdeeld in drie hoofdtypes:

- Personeelsbeleid: gericht op de samenstelling van het projectteam en de middelenallocatie, zoals het vermijden van aanvankelijke onderbezetting en het aannemen van meer ervaren personeel.
- Relationeel Beleid (gericht op het RMCCV): gericht op het bevorderen van een gezonde relatie, zoals het verbeteren van feedbackmechanismen, het trainen van het klantenteam en het implementeren van duidelijke projectgovernance.
- Combinatie van beleidslijnen: combineert verschillende individuele beleidslijnen, met aandacht voor waardecreatie in combinatie met de nodige controle om de ontwikkeling van al te nauwe relaties te voorkomen.

De belangrijkste bevinding is dat, hoewel afzonderlijke beleidsopties de resultaten kunnen verbeteren, de meest significante verbeteringen worden bereikt door het combineren van meerdere beleidslijnen. Het combineren van een personeelsbeleid (bijv. het vermijden van onderbezetting) met een relationeel beleid (bijv. het verbeteren van feedback) levert een veel beter resultaat op dan een van beide beleidslijnen afzonderlijk. Het hoofdstuk benadrukt ook de cruciale bevinding dat voldoende initiële capaciteit een voorwaarde is voor het succes van elke andere beleidsoptie.

10.7 Conclusies en Bijdragen

Dit laatste hoofdstuk integreert de onderzoeksbevindingen en geeft antwoorden op de twee onderzoeksvragen.

Antwoorden op de onderzoeksvragen:

1. Impact van RMCCV en Relational Capital: Het onderzoek toont aan dat het RMCCV en Relational Capital een sterke en dynamische impact hebben op projectresultaten. Het RMCCV, als motivatie voor waardecreatie, stimuleert de accumulatie van relationeel kapitaal, wat op zijn beurt de projectprestaties beïnvloedt. De thesis benadrukt een dubbel effect: positief relationeel kapitaal kan communicatie en productiviteit verbeteren, maar de "duistere kant" van relaties kan leiden tot zelfgenoegzaamheid, verminderde monitoring en uiteindelijk projectoverschrijdingen.
2. Benutting van relaties voor betere resultaten: De beleidsanalyse geeft een duidelijk antwoord op de vraag hoe deze dynamiek kan worden benut. De meest effectieve strategie is een veelzijdige aanpak die relationeel beleid combineert met robuuste controlemechanismen en voldoende personeelsbezetting vanaf de start van het project. De studie onderstreept dat relationeel beleid het meest effectief is wanneer een project niet ernstig onderbezet is.

Belangrijkste bijdragen:

- Theoretische bijdragen: De thesis slaat een nieuwe interdisciplinaire brug tussen projectmanagement en marketing door de wederkerige interactie van RMCCV en Relational Capital binnen een Systeemdynamica-raamwerk te formaliseren. Het introduceert een nieuwe "gedragsmatige en dynamische benadering" van projectmanagement die verder gaat dan traditionele, statische modellen door de invloed van relaties op projectresultaten centraal te stellen.
- Praktische implicaties: Het onderzoek biedt managers bruikbaar, empirisch onderbouwd handvaten om projectresultaten te verbeteren, waarbij het belang wordt benadrukt van actief relatiebeheer, samenwerkingsomgevingen en uitgebreide prestatiebewaking die verder gaat dan traditionele statistieken. Het biedt ook een raamwerk voor het begrijpen van de afwegingen tussen verschillende beleidscombinaties.
- Methodologische bijdragen: De thesis versterkt het gebruik van Systeemdynamica voor theorievorming door diverse kennisdomeinen te integreren en complexe, niet-lineaire relaties en feedbackloops te modelleren. Systeemdynamica ontpopt zich als een effectieve methode om vraagstukken uit marketing en projectmanagement in samenhang te bestuderen.
- Toekomstig onderzoek: De studie identificeert verschillende veelbelovende gebieden voor toekomstig onderzoek, waaronder het onderzoeken van de langetermijn, cumulatieve effecten van management over meerdere projecten, en het verkennen van "kantelpunten" waar projectrelaties verslechteren, wat kan leiden tot unsuccesvolle of gestopte projecten.

11. References

Aaltonen, K. and Turkulainen, V. (2018) 'Creating relational capital through socialization in project alliances', *International Journal of Operations & Production Management,* (38(6)), pp. 1387-1421.

Aarikka-Stenroos, L. and Jaakkola, E. (2012) 'Value co-creation in knowledge intensive business services: a dyadic perspective on the joint problem solving process.', *Industrial Marketing Management,* 41(1), pp. 15-26.

Abdel-Hamid, T. K. (1984) *The dynamics of software development project management: an integrative system dynamics perspective.* doctoral dissertation, Massachusetts Institute of Technology.

Abdel-Hamid, T. K. (1989) 'The dynamics of software project staffing: a system dynamics based simulation approach', *IEEE Transactions on Software engineering,* 15(2), pp. 109-119.

Abdel-Hamid, T. K. (1999) 'The impact of goals on software project management: an experimental investigation', *MIS Quarterly,* Vol. 23(No. 4), pp. 531-555.

Abdel-Hamid, T. K. and Madnick, S. E. (1989) 'Lessons learned from modeling the dynamics of software development', *Communications of the ACM,* 32(12), pp. 1426-1438.

Abdel-Hamid, T. K. and Madnick, S. E. (1991) *Software project dynamics: an integrated approach.* Prentice Hall Englewood Cliffs, NJ.

Abdel-Hamid, T. K. and Madnick, S. (1989) 'Software productivity: potential, actual, and perceived', *System Dynamics Review,* 5(2), pp. 93-113.

Aisyah, R. A., Sukoco, B. M. and Anshori, M. (2019) 'The effect of relational capital on performance: knowledge sharing as mediation variables in supplier and buyer relation', *International Journal of Logistics Systems and Management,* 34(2), pp. 211-232.

Amin, M., Shamim, A., Ghazali, Z. and Khan, I. (2021) 'Employee Motivation to Co-Create Value (EMCCV): Construction and Validation of Scale', *Journal of Retailing and Consumer Services,* 58, pp. 102334.

Anantatmula, V. S. (2010) 'Project manager leadership role in improving project performance', *Engineering Management Journal,* 22(1), pp. 13-22.

Anderson, E. and Jap, S. D. (2005) 'The dark side of close relationships', *MIT Sloan Management Review,* 46(3), pp. 75.

Austin, R. D. (2001) 'The effects of time pressure on quality in software development: An agency model', *Information Systems Research,* 12(2), pp. 195-207.

Autry, C. W. and Golicic, S. L. (2010) 'Evaluating buyer–supplier relationship–performance spirals: A longitudinal study', *Journal of Operations Management,* 28(2), pp. 87-100.

Bagdoniene, L. and Valkauskiene, G. (2018) 'Working together: Understanding value co-creation processes in professional service delivery', *Engineering Economics,* 29(1), pp. 101-114.

Bardhan, I. R., Demirkan, H., Kannan, P., Kauffman, R. J. and Sougstad, R. (2010) 'An interdisciplinary perspective on IT services management and service science', *Journal of Management Information Systems,* 26(4), pp. 13-64.

Barão, A. and da Silva, A. R. 'A model to evaluate the relational capital of organizations (SNARE RCO)'. *ENTERprise Information Systems: International Conference, CENTERIS 2011*, Vilamoura, Portugal,: Springer, 400-409.

Baumann, J., Le Meunier-FitzHugh, K. and Wilson, H. N. (2017) 'The challenge of communicating reciprocal value promises: Buyer-seller value proposition disparity in professional services', *Industrial Marketing Management,* 64, pp. 107-121.

Beck, K., Beedle, M., vn Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J. and Thomas, D. (2001) *Agile Manifesto*. Available at: Manifesto for Agile Software Development (agilemanifesto.org).

Bettencourt, L., Ostrom, A., Brown, S. and Roundtree, R. (2002) 'Client Co-Production in Knowledge-Intensive Business Services', *California Management Review,* 44(4), pp. 100-128.

Bettencourt, L. A., Lusch, R. F. and Vargo, S. L. (2014) 'A service lens on value creation: Marketing's role in achieving strategic advantage', *California Management Review,* 57(1), pp. 44-66.

Bhatti, W. A., Glowik, M. and Arslan, A. (2021) 'Knowledge sharing motives and value co-creation behavior of the consumers in physiotherapy services: a cross-cultural study', *Journal of Knowledge Management,* 25(5), pp. 1128-1145.

Buhalis, D. and Sinarta, Y. (2019) 'Real-time co-creation and nowness service: lessons from tourism and hospitality', *Journal of Travel & Tourism Marketing,* 36(5), pp. 563-582.

Cao, L. (2022) 'Estimating Efforts for Various Activities in Agile Software Development: An Empirical Study', *IEEE Access,* 10, pp. 83311-83321.

Cao, L., Ramesh, B. and Abdel-Hamid, T. (2010) 'Modeling dynamics in agile software development', *ACM Transactions on Management Information Systems (TMIS),* 1(1), pp. 1-26.

Chan, K. W., Yim, C. K. and Lam, S. S. (2010) 'Is customer participation in value creation a double-edged sword? Evidence from professional financial services across cultures', *Journal of Marketing,* 74(3), pp. 48-64.

Chichakly, K. 'Modeling Agile Development: When Is It Effective?'. *International System Dynamics Conference*, Boston.

Ching, P. and Mutuc, J. E. 'Modeling the dynamics of an Agile scrum team in the development of a single software project'. *2018 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*: IEEE, 386-390.

Choi, K. and Bae, D.-H. (2009) 'Dynamic project performance estimation by combining static estimation models with system dynamics', *Information and Software Technology,* 51(1), pp. 162-172.

CompTIA (2019) *IT Industry Outlook 2019*: CompTIA - Computing Technology Industry Association.

Conforto, E. C. and Amaral, D. C. (2016) 'Agile project management and stage-gate model—A hybrid framework for technology-based companies', *Journal of Engineering and Technology Management,* 40, pp. 1-14.

Conforto, E. C., Amaral, D. C., Da Silva, S. L., Di Felippo, A. and Kamikawachi, D. S. L. (2016) 'The agility construct on project management theory', *International Journal of Project Management,* 34(4), pp. 660-674.

Cooper, R. G. and Sommer, A. F. (2018) 'Agile–Stage-Gate for Manufacturers: Changing the Way New Products Are Developed Integrating Agile project management methods into a Stage-Gate system offers both opportunities and challenges', *Research-Technology Management,* 61(2), pp. 17-26.

Crielaard, L., Uleman, J. F., Châtel, B. D., Epskamp, S., Sloot, P. and Quax, R. (2024) 'Refining the causal loop diagram: A tutorial for maximizing the contribution of domain expertise in computational system dynamics modeling', *Psychological Methods,* 29(1), pp. 169.

Cronin Jr, J. J. and Taylor, S. A. (1992) 'Measuring service quality: a reexamination and extension', *Journal of Marketing,* 56(3), pp. 55-68.

Cummings, J. and Dennis, A. R. (2018) 'Virtual first impressions matter: the effect of enterprise social networking sites on impression formation in virtual teams', *MIS Quarterly,* 42(3), pp. 697-718.

De Gooyert, V., Rouwette, E., Van Kranenburg, H. and Freeman, E. (2017) 'Reviewing the role of stakeholders in operational research: A stakeholder theory perspective', *European Journal of Operational Research,* 262(2), pp. 402-410.

Deloitte 2019. 2019 Technology Industry Outlook.

Ellram, L. M. and Murfield, M. L. U. (2019) 'Supply chain management in industrial marketing–Relationships matter', *Industrial Marketing Management,* 79, pp. 36-45.

F. Tripp, J. and Armstrong, D. J. (2018) 'Agile methodologies: organizational adoption motives, tailoring, and performance', *Journal of Computer Information Systems,* 58(2), pp. 170-179.

Fatema, I. and Sakib, K. (2018) 'Using qualitative system dynamics in the development of an agile teamwork productivity model', *International Journal on Advances in Software,* 11(12), pp. 170-185.

Fernandes, T. and Remelhe, P. (2016) 'How to engage customers in co-creation: customers' motivations for collaborative innovation', *Journal of Strategic Marketing,* 24(3-4), pp. 311-326.

Ford, D. N. (1995) *The dynamics of project management : an investigation of the impacts of project process and coordination on performance.* Doctoral Dissertation, Massachusetts Institute of Technology, Cambridge, Mass.

Ford, D. N., Lyneis, J. M. and Taylor, T. 'Project controls to minimize cost and schedule overruns: A model, research agenda, and initial results'. *2007 International System Dynamics Conference*: Citeseer, 23-27.

Ford, D. N. and Sterman, J. D. (2003a) 'Overcoming the 90% syndrome: Iteration management in concurrent development projects', *Concurrent Engineering,* 11(3), pp. 177-186.

Ford, D. N. and Sterman, J. D. (2003b) 'The Liar's Club: concealing rework in concurrent development', *Concurrent Engineering,* 11(3), pp. 211-219.

Franck, R., Hildebrandt, G., Pickar, C. and Udis, B. 'Realistic acquisition schedule estimates: A follow-on inquiry'. *Fourteenth Annual Acquisition Research Symposium*, Monterey, California.

Frow, P., McColl-Kennedy, J. R. and Payne, A. (2016) 'Co-creation practices: Their role in shaping a health care ecosystem', *Industrial Marketing Management,* 56, pp. 24-39.

GAO, G. A. O. W. D. (2020) 'Agile Assessment Guide: Best Practices for Agile Adoption and Implementation'.

Gao, J. and Zhang, T. (2022) 'Effects of public funding on the commercial diffusion of on-site hydrogen production technology: A system dynamics perspective', *Technological Forecasting and Social Change,* 175, pp. 121380.

Georgantzas, N. C. and Katsamakas, E. G. (2008) 'Information systems research with system dynamics', *System Dynamics Review: The Journal of the System Dynamics Society,* 24(3), pp. 247-264.

Glaiel, F. S., Moulton, A. and Madnick, S. E. (2014) 'Agile project dynamics: A system dynamics investigation of agile software development methods', *Massachusetts Institute of Technology Engineering Systems Division,* Working Paper Series.

Gligor, D. M. and Holcomb, M. (2013) 'The role of personal relationships in supply chains: An exploration of buyers and suppliers of logistics services', *The International Journal of Logistics Management,* 24, pp. 338-355.

Godlewski, E., Lee, G. and Cooper, K. (2012) 'System dynamics transforms Fluor project and change management', *Interfaces,* 42(1), pp. 17-32.

Gronroos, C. (2007) *Service management and marketing: Customer management in service competition.* John Wiley & Sons.

Grönroos, C. (2011) 'A service perspective on business relationships: The value creation, interaction and marketing interface', *Industrial Marketing Management,* 40(2), pp. 240-247.

Grönroos, C. and Voima, P. (2013) 'Critical service logic: making sense of value creation and co-creation', *Journal of the Academy of Marketing Science,* 41(2), pp. 133-150.

Hanneman, R. A. (1988) *Computer-assisted theory building: Modeling dynamic social systems.* Sage Publications, Inc.

Hassani, R., El Bouzekri El Idrissi, Y. and Abouabdellah, A. 'Digital project management in the era of digital transformation: Hybrid method'. *Proceedings of the 2018 International Conference on Software Engineering and Information Management*, 98-103.

Hayata, T. and Han, J. 'A hybrid model for IT project with Scrum'. *Proceedings of 2011 IEEE International Conference on Service Operations, Logistics and Informatics*: IEEE, 285-290.

Homer, J. B. (1996) 'Why we iterate: scientific modeling in theory and practice', *System Dynamics Review: The Journal of the System Dynamics Society,* 12(1), pp. 1-19.

Imani, T., Nakano, M. and Anantatmula, V. (2017) 'Does a hybrid approach of agile and plan-driven methods work better for IT system development projects', *International journal of Engineering Research and Applications,* 1(2), pp. 3.

Jaakkola, E. and Alexander, M. (2014) 'The role of customer engagement behavior in value co-creation: a service system perspective', *Journal of Service Research,* 17(3), pp. 247-261.

Jain, S. K. and Gupta, G. (2004) 'Measuring Service Quality: SERVQUAL vs. SERVPERF Scales', *Vikalpa,* 29(2), pp. 25-37.

Jalili, Y. and Ford, D. N. (2016) 'Quantifying the impacts of rework, schedule pressure, and ripple effect loops on project schedule performance', *System Dynamics Review,* 32(1), pp. 82-96.

Johnsen, R. E. and Lacoste, S. (2016) 'An exploration of the 'dark side' associations of conflict, power and dependence in customer–supplier relationships', *Industrial Marketing Management,* 59, pp. 76-95.

Karpen, I., Bove, L. and Lukas, B. (2012) 'Linking service-dominant logic and strategic business practice: A conceptual model of a service-dominant orientation', *Journal of Service Research,* 15(1), pp. 21-38.

Komulainen, H. (2014) 'The role of learning in value co-creation in new technological B2B services', *Journal of Business & Industrial Marketing,* 29(3), pp. 238-252.

Kunc, M. (2008) 'Achieving a balanced organizational structure in professional services firms: some lessons from a modeling project', *System Dynamics Review,* 24(2), pp. 119-143.

Kuutila, M., Mäntylä, M., Farooq, U. and Claes, M. (2020) 'Time pressure in software engineering: A systematic review', *Information and Software Technology,* 121, pp. 106257.

Křivánková, M. and Remta, D. 'Real-Life Water-Scrum-Fall: Insights from Large Companies in Czech Republic'. *International Conference on Agile Software Development*: Springer, 183-192.

Lee, C.-H. and Ha, B.-C. (2018) 'The impact of buyer-supplier relationships' social capital on bi-directional information sharing in the supply chain', *Journal of Business & Industrial Marketing,* 33, pp. 325-336.

Li, Y., Jiang, L., Taylor, T. R. B. and Ford, D. N. (2018) 'Impact of Labour Controls on Tipping Point Dynamics in Large Complex Projects Impact of Project Labor Controls on Tipping Point Dynamics', *Systems Research and Behavioral Science,* 35(6), pp. 605-618.

Lovelock, C. and Gummesson, E. (2004) 'Whither services marketing? In search of a new paradigm and fresh perspectives', *Journal of Service Research,* 7(1), pp. 20-41.

Luna-Reyes, L. F., Black, L. J., Cresswell, A. M. and Pardo, T. A. (2008) 'Knowledge sharing and trust in collaborative requirements analysis', *System Dynamics Review,* 24(3), pp. 265-297.

Lusch, R. F., Vargo, S. L. and O'brien, M. (2007) 'Competing through service: Insights from service-dominant logic', *Journal of Retailing,* 83(1), pp. 5-18.

Lyneis, J. M., Cooper, K. G. and Els, S. A. (2001) 'Strategic management of complex projects: a case study using system dynamics', *System Dynamics Review,* 17(3), pp. 237-260.

Lyneis, J. M. and Ford, D. N. (2007) 'System Dynamics Applied to Project Management: a survey, assessment, and directions for future research', *System Dynamics Review,* 23(2/3), pp. 157-189.

Madhavaram, S., Appan, R., Manis, K. and Browne, G. J. (2023) 'Building capabilities for software development firm competitiveness: The role of intellectual capital and intra-firm relational capital', *Information & Management,* 60(2), pp. 103744.

Maglio, P. P. and Spohrer, J. (2008) 'Fundamentals of service science', *Journal of the Academy of Marketing Science,* 36(1), pp. 18-20.

Mandolfo, M., Chen, S. and Noci, G. (2020) 'Co-creation in new product development: Which drivers of consumer participation?', *International Journal of Engineering Business Management,* 12, pp. 1847979020913764.

Martins, A. L., Duarte, H. and Costa, D. (2018) 'Buyer–supplier relationships in IT outsourcing: consultants' perspective', *The International Journal of Logistics Management,* 29, pp. 1215-1236.

Mckinsey&Company (2018) 'Automation and the Future of the Workforce', Available at: Mckinsey Global Institute.

Meng, X. and Boyd, P. (2017) 'The role of the project manager in relationship management', *International Journal of Project Management,* 35(5), pp. 717-728.

Miles, M. B. and Huberman, A. M. (1994) *Qualitative data analysis: An expanded sourcebook.* Sage.

Mitręga, M. and Zolkiewski, J. (2012) 'Negative consequences of deep relationships with suppliers: An exploratory study in Poland', *Industrial Marketing Management,* 41(5), pp. 886-894.

Morrison, J. B. and Oliva, R. (2018) 'Integration of behavioral and operational elements through system dynamics', *The Handbook of Behavioral Operations*, pp. 8287.

Nasirzadeh, F. and Nojedehi, P. (2013) 'Dynamic modeling of labor productivity in construction projects', *International Journal of Project Management,* 31(6), pp. 903-911.

Neghina, C., Bloemer, J., van Birgelen, M. and Caniëls, M. C. J. (2017) 'Consumer motives and willingness to co-create in professional and generic services', *Journal of Service Management,* 28(1), pp. 157-181.

Neghina, C., Caniëls, M. C., Bloemer, J. M. and Birgelen, M. J. v. (2015) 'Value Co-creation in Service Interactions Dimensions and Antecedents', *Marketing Theory,* 15(2), pp. 221-242.

Noordhoff, C. S., Kyriakopoulos, K., Moorman, C., Pauwels, P. and Dellaert, B. G. (2011) 'The bright side and dark side of embedded ties in business-to-business innovation', *Journal of Marketing,* 75(5), pp. 34-52.

Nordin, F. and Kowalkowski, C. (2010) 'Solutions offerings: a critical review and reconceptualisation', *Journal of Service Management,* 21(4), pp. 441-459.

Oliva, R. (1996) *A dynamic theory of service delivery : implications for managing service quality.* Doctoral Dissertation, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Oliva, R. and Sterman, J. D. (2001) 'Cutting Corners and Working Overtime: Quality erosion in the service industry', *Management Science,* 47(7), pp. 894-914.

Oliva, R. and Sterman, J. D. (2010) 'Death Spirals and Virtuous Cycles Human Resource Dynamics in Knowledge-Based Services', *Handbook of Service Science. P. P. Maglio, C. A. Kieliszewski and J. C. Spohrer (eds)*, pp. 321-358.

Parasuraman, A., Berry, L. L. and Zeithaml, V. A. (1991) 'Refinement and reassessment of the SERVQUAL scale', *Journal of Retailing,* 67(4), pp. 420.

Parasuraman, A., Zeithaml, V. A. and Berry, L. L. (1985) 'A Conceptual Model of Service Quality and Its Implications for Future Research', *The Journal of Marketing,* 49(4), pp. 41-50.

Parasuraman, A., Zeithaml, V. A. and Berry, L. L. (1988) 'Servqual: A multiple-item scale for measuring consumer perc', *Journal of Retailing,* 64(1), pp. 12.

Patel, S. (2021) *Dynamic modeling of the effectiveness of software development methods on DoD programs.* The George Washington University.

Payne, A. F., Storbacka, K. and Frow, P. (2008) 'Managing the co-creation of value', *Journal of the Academy of Marketing Science,* 36(1), pp. 83-96.

Pera, R., Occhiocupo, N. and Clarke, J. (2016) 'Motives and resources for value co-creation in a multi-stakeholder ecosystem: A managerial perspective', *Journal of Business Research,* 69(10), pp. 4033-4041.

Pillai, K. G., Hodgkinson, G. P., Kalyanaram, G. and Nair, S. R. (2017) 'The negative effects of social capital in organizations: A review and extension', *International Journal of Management Reviews,* 19(1), pp. 97-124.

Rahmandad, H. and Hu, K. (2010) 'Modeling the rework cycle: capturing multiple defects per task', *System Dynamics Review,* 26(4), pp. 291-215.

Rahmandad, H. and Sterman, J. D. (2012) 'Reporting guidelines for simulation-based research in social sciences', *System Dynamics Review,* 28(4), pp. 396-411.

Rahmandad, H. and Weiss, D. M. (2009) 'Dynamics of concurrent software development', *System Dynamics Review: The Journal of the System Dynamics Society,* 25(3), pp. 224-249.

Rebentisch, E., Conforto, E. C., Schuh, G., Riesener, M., Kantelberg, J., Amaral, D. C. and Januszek, S. 'Agility factors and their impact on product development performance'. *DESIGN 2018 15th International Design Conference*, Dubrovnik, Croatia, 893-904.

Reiff, J. and Schlegel, D. (2022) 'Hybrid project management–a systematic literature review', *International Journal of Information Systems and Project Management,* 10(2), pp. 45-63.

Repenning, J., Kieffer, D. and Repenning, N. (2017) 'Agile for Everyone Else: Using Triggers and Checks to Create Agility Outside of Software Development'.

Roberts, D., Hughes, M. and Kertbo, K. (2014) 'Exploring consumers' motivations to engage in innovation through co-creation activities', *European Journal of Marketing,* 48(1/2), pp. 147-169.

Rood, C., Van den Berg, D., Niemann, W. and Meyer, A. (2018) 'The role of personal relationships in supply chain disruptions: Perspectives from buyers and suppliers of logistics services', *Acta Commercii,* 18(1), pp. 1-15.

Rouwette, E. A. 'System dynamics and power'. *Internacional System Dynamics Conference*, Frankfurt.

Ruiz, M., Ramos, I. and Toro, M. (2001) 'A simplified model of software project dynamics', *Journal of Systems and Software,* 59(3), pp. 299-309.

Saad Andaleeb, S. and Conway, C. J. J. o. s. m. (2006) 'Customer satisfaction in the restaurant industry: an examination of the transaction-specific model', 20(1), pp. 3-11.

Sarangee, K., Schmidt, J. B., Srinath, P. B. and Wallace, A. (2022) 'Agile transformation in dynamic, high-technology markets: Drivers, inhibitors, and execution', *Industrial Marketing Management,* 102, pp. 24-34.

Satzger, G., Kühl, N., Schüritz, R. and Baier, L. (2020) 'Will the customers be happy? Identifying unsatisfied customers from service encounter data', *Journal of Service Management,* 32(2), pp. 265-288.

Schüler, M., Fee Maier, M. and Liljedal, K. T. (2020) 'Motives and barriers affecting consumers' co-creation in the physical store', *The International Review of Retail, Distribution and Consumer Research,* 30(3), pp. 289-310.

Schwaninger, M. and Grösser, S. (2008) 'System dynamics as model-based theory building', *Systems Research and Behavioral Science: The Official Journal of the International Federation for Systems Research,* 25(4), pp. 447-465.

Sengupta, K., Abdel-Hamid, T. K. and Bosley, M. (1999) 'Coping with Staffing Delays in Software Project Management: An Experimental Investigation', *IEEE Transactions on Systems Man and Cybernetics Part A Systems and Humans,* 29(1), pp. 77-91.

Spohrer, J. and Maglio, P. P. (2008) 'The emergence of service science: Toward systematic service innovations to accelerate co-creation of value', *Production and Operations Management,* 17(3), pp. 238-246.

Sterman, J. (2000) *Business dynamics : systems thinking and modeling for a complex world.* Boston ; London: Irwin/McGraw-Hill.

Sterman, J., Oliva, R., Linderman, K. W. and Bendoly, E. (2015) 'System dynamics perspectives and modeling opportunities for research in operations management', *Journal of Operations Management,* 39, pp. 1-5.

Storbacka, K., Strandvik, T. and Grönroos, C. (1994) 'Managing customer relationships for profit: the dynamics of relationship quality', *International Journal of Service Industry Management,* 5(5), pp. 21-38.

Swart, K., Bond-Barnard, T. and Chugh, R. (2022) 'Challenges and critical success factors of digital communication, collaboration and knowledge sharing in project management virtual teams: a review', *International Journal of Information Systems and Project Management,* 10(4), pp. 84-103.

Taminiau, Y., Ferguson, J. and Moser, C. (2016) 'Instrumental client relationship development among top-ranking service professionals', *The Service Industries Journal,* 36(15-16), pp. 789-808.

Thite, M. 'Leadership: a critical success factor in IT project management', *Technology and Innovation Management. PICMET '99. Portland International Conference*, Portland, 298-303.

Tommasetti, A., Troisi, O. and Vesci, M. (2017) 'Measuring customer value co-creation behavior: Developing a conceptual model based on service-dominant logic', *Journal of Service Theory and Practice,* 27, pp. 930-950.

Tripp, J. and Armstrong, D. J. (2018) 'Agile methodologies: organizational adoption motives, tailoring, and performance', *Journal of Computer Information Systems,* 58(2), pp. 170-179.

Van Oorschot, K. E., Sengupta, K. and van Wassenhove, L. 'Dynamics of agile software development'. *International System Dynamics Society Conference*, Albuquerque.

van Oorschot, K. E., Sengupta, K. and Van Wassenhove, L. N. (2018) 'Under pressure: The effects of iteration lengths on agile software development performance', *Project Management Journal,* 49(6), pp. 78-102.

Vargo, S. and Lusch, R. (2004) 'Evolving to a new Dominant Logic for Marketing', *Journal of Marketing,* 68, pp. 1-17.

Vargo, S. L., Akaka, M. A. and Wieland, H. (2020) 'Rethinking the process of diffusion in innovation: A service-ecosystems and institutional perspective', *Journal of Business Research,* 116, pp. 526-534.

Vargo, S. L. and Lusch, R. F. (2016) 'Institutions and axioms: an extension and update of service-dominant logic', *Journal of the Academy of Marketing Science,* 44, pp. 5-23.

Vargo, S. L. and Lusch, R. F. (2017) 'Service-dominant logic 2025', *International Journal of Research in Marketing,* 34(1), pp. 46-67.

Vargo, S. L., Maglio, P. P. and Akaka, M. A. (2008) 'On value and value co-creation: A service systems and service logic perspective', *European Management Journal,* 26, pp. 145-152.

Vargo, S. L., Peters, L., Kjellberg, H., Koskela-Huotari, K., Nenonen, S., Polese, F., Sarno, D. and Vaughan, C. (2023) 'Emergence in marketing: an institutional and ecosystem framework', *Journal of the Academy of Marketing Science,* 51(1), pp. 2-22.

Villena, V. H., Choi, T. Y. and Revilla, E. (2019) 'Revisiting interorganizational trust: is more always better or could more be worse?', *Journal of Management,* 45(2), pp. 752-785.

Villena, V. H., Choi, T. Y. and Revilla, E. (2021) 'Mitigating Mechanisms for the Dark Side of Collaborative Buyer–Supplier Relationships: A Mixed-Method Study', *Journal of Supply Chain Management,* 57(4), pp. 86-116.

Villena, V. H., Revilla, E. and Choi, T. Y. (2011) 'The dark side of buyer–supplier relationships: A social capital perspective', *Journal of Operations Management,* 29(6), pp. 561-576.

West, D., Gilpin, M., Grant, T. and Anderson, A. (2011) 'Water-scrum-fall is the reality of agile for most organizations today', *Forrester Research,* 26(2011), pp. 1-17.

WorldBank (2019) *World Development Report 2019: The Changing Nature of Work*: World Bank Group.

Xu, T., Yang, J., Zhang, F. and Guo, W. (2021) 'Interfirm coopetition, interfirm knowledge creation, and collaborative innovation performance: The moderating roles of environmental competitiveness and dysfunctional competition', *Industrial Marketing Management,* 99, pp. 123-135.

Yahya, N. and Maidin, S. S. (2023) 'Hybrid agile development phases: the practice in software projects as performed by software engineering team', *Indonesian Journal of Electrical Engineering and Computer Science,* 29(3), pp. 1738-1749.

Yeniaras, V., Di Benedetto, A. and Dayan, M. (2021) 'Effects of relational ties paradox on financial and non-financial consequences of servitization: Roles of organizational flexibility and improvisation', *Industrial Marketing Management,* 99, pp. 54-68.

Zardini, A., Ricciardi, F. and Rossignoli, C. (2015) 'The relational capital of the IT department: Measuring a key resource for creating strategic value', *Journal of Intellectual Capital,* 16(4), pp. 835-859.

Zeithaml, V. A., Berry, L. L. and Parasuraman, A. (1996) 'The behavioral consequences of service quality', *Journal of Marketing,* 60, pp. 31-46.

Zhu, L. and Cheung, S. O. (2023) 'Incentivizing Relationship Investment for Project Performance Improvement', *Project Management Journal,* 54(1), pp. 70-87.

Zimmermann, N. and Curran, K. (2023) 'Dynamics of interdisciplinarity: a microlevel analysis of communication and facilitation in a group model-building workshop', *System Dynamics Review,* 39(4), pp. 336-370.

In the modern organizational landscape, software is no longer a support function; it is the strategic engine of success.
As businesses demand greater flexibility and faster delivery, the industry has placed the client at the heart of the development process. Yet, while collaboration has intensified, our understanding of the underlying human dynamics remains a *"black box."*

This thesis explores the **relational motive to co-Create value** and the accumulation of **relational capital** as the missing links in project performance. By synthesizing marketing theory, project management, and system dynamics, this thesis reveals how relationships can be modeled, measured, and managed. This work provides a rigorous framework for transforming relational complexity into a strategic lever, mitigating overruns, boosting motivation, and securing project success in an increasingly volatile environment.

Jorge Sousa is the CEO and co-founder of Whatnext, bringing over 25 years of experience leading complex international programs across Africa, Europe, and the Middle East. With extensive experience in the information technology industry, he has dedicated his career to bridging the gap between rigorous academic research and high-level executive practice. His work focuses on the application of System Dynamics to unravel the complexities of project management, sustainability, and regenerative business strategies.
Jorge is a passionate advocate for systemic decision-making, utilizing simulation to expose the counter-intuitive feedback loops and unforeseen long-term behaviors that often undermine organizational goals. Jorge is also advocating for the application of relational capital and co-creation strategies to build resilient, regenerative business models.

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