

Delivering Fast, Managing Smart: How Flexibility, Uncertainty and Complexity Shape Project Speed¹

Youcef J-T. Zidane, PhD

Abstract

In the increasingly competitive context of today's business environment, project speed is considered a key factor for success and often plays a pivotal role in determining an organization's competitive advantage. Nevertheless, the increasing pursuit of accelerating project delivery, especially in the latter phases, creates complex defies. To create a clear context to answer the research question: What are the relationships between project speed and project flexibility, uncertainty and complexity?

With multi-round in-depth interviews with project managers and documentary evidence across 19 medium- to large-size ICT/telecom projects, we examine phase-specific flexibility, and different types of complexity, and how they affect time-to-delivery. The key practical findings were: front-end (early-phase) flexibility—through contingency planning and late locking—corresponded to a 29% increase in total delivery for successful projects, whereas too much flexibility at the implementation stage delayed pace by 22–37% and caused added rework. We identify two operating thresholds: a modularity index ≈ 0.7 , where projects can accept mid-stream changes, and an uncertainty threshold ≈ 0.4 , where failure risk rise steeply. As contribution, we also formalize the "Flexibility Window"—a phase-sensitive model relating flexibility, uncertainty, and complexity to project velocity—and offer prescriptive advice for managers interested in speeding up delivery without compromising quality. Results are constrained by ICT/telecom environment and contractor-side bias; further quantitative cross-validation in other industries is recommended.

Keywords: Project Speed; Project Flexibility; Project Uncertainty; Project Complexity, Project Management.

1. Introduction

The Project success is defined not only as effective project management, but as realizing project objectives over the long term as well (Shenhar *et al.*, 1997; Judgev & Müller., 2005; Joslin & Müller, 2015; Rehan *et al.*, 2025). The cohesive understanding of project success makes it imperative to define success with clear and measurable

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metrics (Müller & Turner, 2007; Joslin & Müller, 2015; Fantozzi *et al.*, 2025; Ahmadi *et al.*, 2025). The project success criteria have advanced from the 'iron triangle' of time, scope, and cost to include functions such as stakeholder satisfaction, quality, and even sustainability (Atkinson, 1999; Judgev & Müller, 2005; Shenhar & Dvir, 2007; Joslin & Müller, 2015). There has been a shift to using time efficiently. This has been brought to attention in literature that discusses large projects (Thamhain & Wilemon, 1986; Morris & Hough, 1987; Rämö, 2002; Flyvbjerg *et al.*, 2003). There are those that believe that project success means beating deadlines and remaining below budget (e.g., Flyvbjerg *et al.*, 2003). There is much disparity in the model of results versus actual project outcomes (Samset, 2010; Rehan *et al.*, 2025).

Many practitioners and scholars regard time, cost, and scope—the components of the “iron triangle”—as key success criteria (Ahsan & Gunawan, 2010; Guerrero *et al.*, 2014). In construction and other industries, forecasted completion time has long been viewed as a critical success factor, especially for the more traditional large-scale engineering projects (Chan & Kumaraswamy, 1997, 2002; Guerrero *et al.*, 2014). In spite of the improvements made in project management approaches, large-scale engineering projects continue to perform poorly with regard to scheduled duration (Ng *et al.*, 2001; Chan & Kumaraswamy, 2002; Guerrero *et al.*, 2014).

Project duration estimates, especially starting from the early stages of a project, must be as accurate as possible for the project to be successfully completed (Dursun & Stoy, 2011). In addition, a strong correlation exists between a project's time-to-delivery and overall costs. This correlation is linear for some types of costs, while others incur trade-off scenarios. Identifying optimal duration provides the minimization of total costs, which is why understanding the time-cost relationship is crucial in predicting the consequences of schedule alterations on project expenses (Kerzner, 2009; Seddiki, 2025).

Strategic focus on time and cost balancing seeks to minimize resource expenditure while eliminating waste. The Critical Path Method CPM is an example of a time-cost trade-off technique that seeks to achieve the most cost-efficient solution within a preset financial limit. These methods utilize the concept of slack time, which is the amount of delay that can be incurred without affecting the planned completion date. The critical path determines the optimal duration of the project, which in turn leads to the minimum total costs of the project (Kerzner, 2009). Perhaps the biggest problem in project management has to do with time and cost trade off. De Marco (2011) notes that crashing a schedule—shrinking the time span required to complete a project—tend to increase project expenditure.

The economic value of time, especially its opportunity cost, has become more important in recent years. Time is no longer a resource to be managed, but a strategic

asset that can deliver firm competitive advantages (Rämö, 2002; Zidane, 2018). In new product development (NPD) industries, time-to-market (TTM) is one of the critical metrics of competitive standing within the industry. There is a distinct advantage to being the first to market because of the adage that time is equated with cost to benefits, productivity, value, and even innovation (Stalk & Hout, 1990, 2003). First to market tactics are used in mobile telecommunication and automotive sectors, and any industry where the new product development cycle drives competition. These industries realize faster delivery of new products results in lower costs, higher profits, and tremendous value (Cordero, 1991; Schmelzer, 1992; Ben Mahmoud-Jouini *et al.*, 2004).

The industrial equivalent of time-to-market in large-scale engineering projects is time-to-deliver (TTD), which is critical for measuring success (Jugdev *et al.*, 2001; Ben Mahmoud-Jouini *et al.*, 2004). From the understanding, having the ability to accelerate project schedules and delivering them sooner has emerged as a critical factor within these industries. The need for controlling time, whether through reducing the duration of individual phases or working towards strict deadlines, is now among the most important concerns in project management (Rämö, 2002; Zidane, 2018). Project management literature has focused more on the temporal aspects of projects in the last decades (Rämö, 2002; Zidane, 2018). This focus further highlights the value of time as an asset in a project and, in addition, as a source of competitive advantage while underscoring the difficulties in managing time in complex and large projects.

2. Iron Triangle – Project Speed, Intensity & Value

A great deal of attention has been devoted to defining the primary factors which constrain project success ever since Martin Barnes introduced the ‘iron triangle’ concept in 1969 (Rolfe, 2015). Barnes suggested that one of the constraints—cost, time, or scope could be changed but would affect the two other constraints. Numerous variants of this model developed over time using different names for the constraints ‘quality’, ‘scope’ or ‘performance’.

More versions that are recent use “budget,” “schedule,” “scope,” or “cheap,” “fast,” and “good.” (Langston, 2013; Zidane, 2018). During the execution stage, cost, time, and scope are considered key indicators of efficiency. Recent studies have differentiated between project efficiency and overall project success (Belassi & Tukel, 1996; Chan, 1996; Munns & Bjeirmi, 1996; Cooke-Davies, 2002; Lam *et al.*, 2007; Shenhar & Dvir, 2007; Toor & Ogunlana, 2010; Hussein *et al.*, 2015). Project efficiency refers to the necessary actions to successfully complete a project (Judgev & Müller, 2005; Zidane *et al.*, 2016; Zidane & Olsson, 2017).

Some scholars argue that quality is a central component of project efficiency. However, the concept of "quality" raises the question: Does it refer to the quality of the product delivered at the end of the project, or is it the quality of the project management itself? Zidane and Olsson (2017) define project efficiency as executing tasks correctly and delivering project outputs in line with the agreed-upon scope, cost, time, and quality (Figure 1). They argue that "quality" is not an independent constraint but often a result of the effective management of the other three factors (scope, time, and cost). Since the focus in project management literature is on management rather than technical or engineering aspects, scholars in this field should adopt a management-oriented perspective. In this sense, quality as a pillar of efficiency should be understood as the quality of management, not as a technical term related to product or service specifications.

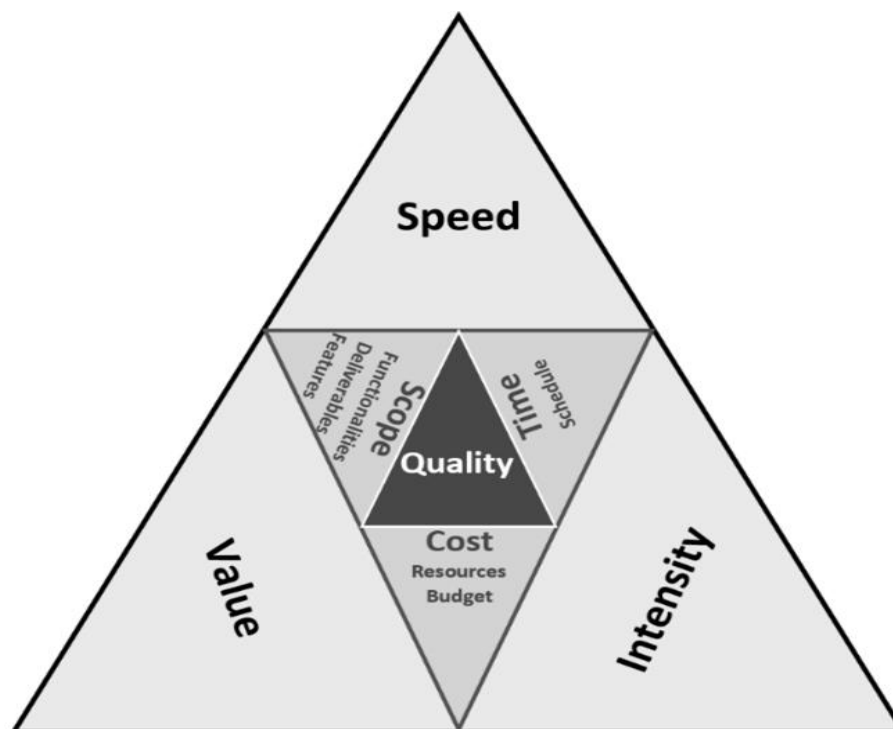


Figure 1. Iron triangle.

(Adopted from: Langston, 2013; Zidane, 2018)

Martinsuo *et al.* (2013) defined project efficiency in terms of short-term interests. However, this definition is quite broad, as it does not account for the differing perceptions of various stakeholders— such as the owner, sponsor, users, and contractors—who may interpret short-term interests in distinct ways. This variability leads to a dynamic and flexible understanding of project efficiency, making it more challenging and complex to measure. Some researchers equate project efficiency with the success of project management (e.g., Pinto & Slevin, 1988; Ssegawa & Muzinda, 2016). The interpretation views project management as a system and process that only encompasses the implementation phase of a project, ignoring the work done before

the project starts as well as the work done after its completion. What we find confusing with this explanation is the limited scope of “project management success” defined here as managing a project efficiently. Defining project success, this way shrinks the project management framework to a singular metric of efficiency. Under such a viewpoint, critical components of understanding project success and management, like post-project evaluations, ex-ante evaluations, value management, and the project front end, are rendered irrelevant. Literature on these topics highlights the need for a more comprehensive approach to project management that extends beyond the confines of efficiency and incorporates a wider range of factors influencing project outcomes.

Conventional wisdom suggests that if the scope of a project is expanded, both cost and/or time will inevitably increase. Similarly, if a project’s completion needs to be accelerated, this typically requires additional budget and/or a reduction in scope. Conversely, if costs are reduced, it generally implies less scope and/or a shorter period. However, Zidane (2018, p. 95-104) provides examples where scope was increased, cost efficiencies were achieved, and project completion times remained unaffected (Relation of cost to time, Figure 2). The PMBOK Guide (PMI, 2013, p. 35) emphasizes that since projects are temporary in nature, success should be measured based on the completion of the project within the defined constraints of scope, time, cost, quality, resources, and risk, as agreed upon by the project managers and senior management. The guide further states that project success is measured against the last baselines approved by the authorized stakeholders, with the project manager being responsible for setting realistic and achievable boundaries for the project and ensuring its completion within those approved baselines.

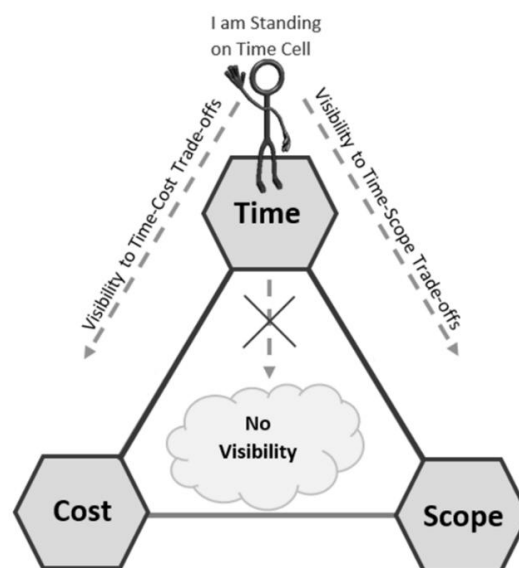


Figure 2. Iron triangle – Time vs. other trade-offs

Given the focus of this paper on the relationships between time and scope, as well as time and cost, it is important to define these relationships in terms of project speed (the relationship between scope and time) and project intensity (the relationship between cost and time), as illustrated in Figures 1 and 2.

2.1. Project Speed and Project Pace

In physics, the motion of objects is often described using common language, with terms like "going fast," "stopped," "slowing down," "speeding up," and "turning." These terms, while accessible to individuals without a formal background in physics, also correspond to specific concepts, such as "distance," "displacement," "speed," "velocity," and "acceleration," which have precise mathematical definitions. When applying these well-defined concepts to project management, we can define project speed and pace in the context of this paper, which is illustrated in Figure 3.



Figure 3. Project speed and project pace.

In physics, speed is considered a scalar quantity, meaning it is fully described by magnitude alone, without any directional component. It refers to "how fast an object is moving" and can be understood as the rate at which an object covers a given distance. A high-speed object covers a large distance in a short amount of time, while a low-speed object covers a relatively small distance over the same period. An object with no movement has zero speed (Physics Classroom, 2016).

In project management, the terms "project speed," "project pace," and "project velocity" are not widely defined in the academic literature. Some exceptions include their use in software development projects (e.g., Czarnacka-Chrobot, 2014), innovation, new product development (e.g., Midler, 1993; Zeng *et al.*, 2007; Yaghootkar & Gil, 2012), and production management (e.g., Ben Mahmoud-Jouini *et al.*, 2004).

Langston (2013) provides a clear definition for project speed, describing it as the ratio of scope over time. According to Langston (2013), "this KPI is another that should be maximized. Speed is a function of Project Procurement Management, namely outsourcing strategies and parallel supply chains. Scope is treated as an output, and time as an input, so the more utility provided per unit of time, the faster the delivery process." The PMI (2013) defines project scope as "the work performed to deliver a product, service, or result with the logical relationships among the project schedule activities."

Project speed in a project can change over time, similar to acceleration or deceleration in physics. Consequently, project pace, which represents the average speed within a given time interval, can also fluctuate. Figure 3 illustrates how changes in project speed can lead to variations in project pace.

2.2. Project Intensity

Langston (2013) uses the term "efficiency" to describe the relationship between cost and time. However, this could create confusion with the definition of project efficiency in this paper. Therefore, the term "intensity" is used instead to reflect the cost-time relationship (see Figure 1). The definition remains the same, but with the substitution of the word "efficiency" with "intensity." According to this definition, project intensity is described as "the ratio of cost over time, this KPI is also one that should be maximized. Intensity is a function of Project Human Resource Management, namely team performance and leadership. In this context, cost is treated as an output (value of work completed) and time as an input. The more money spent per unit of time, the more intense the delivery process."

2.3. Project Value

Project value is defined as "the ratio of scope over cost, this KPI is one that should be maximized. Value is a function of Project Stakeholder Management, namely meeting expectations and fostering engagement. Scope is treated as an output and cost as an input, so the more utility per unit of cost, the greater the value for money" (Langston, 2013). This relationship between scope and cost emphasizes minimizing waste on one hand and improving budget utilization on the other. The goal is to make the best deals when acquiring the necessary resources for the project. Since the term "value" can be used in various contexts, it is important to clarify its specific meaning in this paper.

3. Project Flexibility, Uncertainty and Complexity

This section provides a concise literature review on the concepts of project flexibility, uncertainty, and complexity, which are essential for understanding the relationship with project speed, as discussed in the previous section. Numerous scholars and schools of thought address these concepts; however, this review is focused on definitions that align with the research objectives.

3.1. Project Flexibility

Flexibility is generally defined as “characterized by a ready capability to adapt to new, different, or changing requirements” (Merriam-Webster, 1984). In disciplines like strategic management, flexibility is often considered a crucial enabler for managing uncertainty (Olsson, 2006).

Bahrami & Evans (2005) identify 11 related concepts of flexibility, such as adaptability, agility, elasticity, hedging, liquidity, malleability, mobility, modularity, robustness, resilience, and versatility. From a planning perspective, Sager (1994) emphasizes that flexibility involves the ability to choose among satisfactory alternatives and adjust according to established principles and criteria. In their discussion, Bahrami & Evans (2005) coined the term “super flexibility” to describe highly adaptable companies, considering flexibility a critical factor in their success. However, projects typically require stability to be efficiently controlled and executed, often measured by time, cost, and scope. In this regard, flexibility should be minimized to ensure control (Olsson, 2006). A practical approach to balancing flexibility and stability is to delay irreversible decisions until further information becomes available (Olsson, 2006).

While the engineering tradition in project management, as described by Söderlund (2004) and Crawford & Pollack (2004), emphasizes stability—especially in later project phases—the social science tradition recognizes the benefits of project flexibility. Kreiner (1995) notes that traditional stability-focused approaches become problematic under uncertain conditions, creating “drifting environments.” These environments result not only from actual changes but also from the evolving understanding and expression of stakeholder needs. Flexible projects may not always be desirable when the project is analyzed in isolation but can be rational when considering a broader context (Olsson, 2006). The real options approach, for example, applies flexibility in project decision-making, illustrating how flexibility can be quantified in financial terms. Uncertainty often makes it optimal to delay commitments until further clarity is gained (Brennan & Trigeorgis, 2000; Olsson, 2006).

3.2. Project Uncertainty

Project uncertainty refers to the “gap between the information needed to perform a task and the information already possessed by the organization” (Galbraith, 1973, p.5). Jensen *et al.* (2006) categorize uncertainty into institutional and interactional uncertainty, while Christensen & Kreiner (1991) distinguish between operational and contextual uncertainty. Operational uncertainty pertains to factors within the project’s defined scope, whereas contextual uncertainty involves external factors influencing the project’s environment. Karlsen (1998) expands on this by dividing uncertainty into task uncertainty (related to factors within the project boundaries) and contextual uncertainty (arising from external factors). The key objective in understanding uncertainty is to highlight interactional uncertainty as a critical factor in comprehending the project environment, excluding irrelevant external elements (Olsson, 2006).

3.3. Project Complexity

In term, “complexity” in project management has been defined in various ways, with at least 31 distinct definitions in the literature (Gul & Khan, 2011). In systems theory, complexity refers to systems composed of interrelated subsystems that may have hierarchical structures (Hussein *et al.*, 2014). Common synonyms for complexity include terms like “difficult,” “complicated,” “intricate,” “involved,” and “tangled” (Whitty & Maylor, 2009). The widespread use of the term “complex” may stem from the absence of a more precise term to describe the interrelated factors that influence a project’s life cycle and complicate decision-making (Hussein *et al.*, 2014).

Complexity in project management can be categorized into three primary approaches. The first examines complex dynamic systems using characteristics such as adaptability, nonlinearity, emergence, feedback, self-organization, and dependency, to understand how these elements affect project environments (Aritua *et al.*, 2009). The second approach focuses on identifying individual elements, factors, or sources contributing to project or managerial complexity (Hussein *et al.*, 2014).

The third involves examining methods, processes, or conceptual models to address these complexity factors (Whitty & Maylor, 2009). Whitty & Maylor (2009) argue that simply labeling a project as “complex” does not necessarily require the application of sophisticated management techniques.

Hussein (2012) conducted an empirical study to explore practitioners’ perceptions of complexity, aiming to distinguish between the sources of complexity and the complications arising from these elements during the project’s course. These complications are related to the managerial complexities involved in achieving the project’s objectives within a complex environment (Whitty & Maylor, 2009).

4. Methodology and Empirical Indicators

This paper does not aim to explore the broad concept of uncertainty in its entirety. However, the distinction between two types of uncertainty, as discussed by Karlsen (1998) and Christensen & Kreiner (1991), Uncertainty plays a critical role in analyzing project speed. Specifically, the authors differentiate between “contextual uncertainty” and “internal uncertainty.” Internal uncertainty is closely related to operational uncertainty (Christensen & Kreiner, 1991) or task uncertainty (Karlsen, 2011).

In this context, project flexibility is broadly defined to encompass strategies for managing both internal and contextual uncertainty, including aspects such as scope change management, iterative decision-making processes, and adjustments related to uncertain funding (Olsson, 2006).

This section is based on evaluations of ICT/Telecom infrastructure projects. While the specific project cases are not detailed here, the data collected stem from in-depth interviews with project managers. Interviewees were given access to relevant documentation and evaluation reports to provide additional insights into the cases being discussed.

Unstructured, or in-depth, interviews are informal and used to delve deeply into the research area (Eisenhardt, 1989; Fontana & Frey, 2005). In these interviews, the interviewee is encouraged to express their thoughts freely on the topic, and the interaction remains non-directed, often referred to as an “informant interview.” Another type of unstructured interview is the focused interview, where the interviewer guides the conversation while maintaining a certain level of direction (Robson, 2011). The interviewees, who were all project managers from the contractor side, also reviewed independent project evaluation reports. Their personal experiences with the projects were utilized to provide context and depth for the analysis.

Regarding the nature of the research, the interviews conducted align with qualitative research that is explanatory and adopts an inductive approach. The interviews were one-on-one interactions, either via telephone or via internet-based platforms. The list of interview topics evolved and expanded over the course of the interviews. Five interviewees participated, each managing between three and five projects. However, the total number of interviews conducted was multiple rounds, typically three to four, with no predefined limit on the number of interviews. The first rounds of interviews lasted between 30 minutes to an hour, depending on the feedback and discussions. The duration was shortened in subsequent rounds.

The collected data were codified and entered into a database for analysis. This data included general project characteristics, and assessments of project speed, flexibility, and complexity were made based on subjective evaluations by the researchers.

Initially, 29 projects were selected for analysis; however, this number was reduced to 19 due to the lack of key information in the remaining 10 projects. A summary of the information sources can be seen in Table 1.

Due to the design of the study presented in this paper, there are limited opportunities to assess the validity or test the reliability of the findings. It cannot be statistically demonstrated that the findings are universally applicable. Given the scope of this study, reliability cannot be ensured through large, representative samples of research material. Additionally, the methods used to extract and codify the information may be influenced by subjective judgment. To mitigate this limitation, several rounds of interviews were conducted.

Table 1. Information sources used in the study.

Project Type	Content	Modularity	Type of data	Data source	Project size	Number
Equipment indoor (hardware and software) N=10	Public and private sector depending on the owner of the telecom network. Years 2007–2015	Low	Qualitative	Interviews with PMs, documents	< 5 M US\$	3
					5-10 M US\$	2
					10-20 M US\$	1
					20-30 M US\$	3
					30-40 M US\$	1
					>40 <42 M US\$	0
Equipment indoor/outdoor (hardware and software) and construction (equipment rooms, shelters, towers) N=9	Public and private sector depending on the owner of the telecom network. Years 2007–2015	High	Qualitative	Interviews with PMs, documents	< 5 M US\$	0
					5-10 M US\$	1
					10-20 M US\$	2
					20-30 M US\$	1
					30-40 M US\$	2
					>40 <42 M US\$	3

Validity concerns how accurately a measure reflects what it is intended to measure. To enhance validity in this study, specific indicators were employed. However, validity and reliability associated with the data, when considered independently, are not sufficient to provide conclusive results. More valid and reliable conclusions can only be achieved through a series of replications. This study offers some insights into the relationship between project speed, flexibility, uncertainty, and complexity. However, further

research is needed to determine whether these findings are broadly applicable or specific to the projects studied. Table 2 outlines the project attributes used in the study.

Table 2. The parameters used in the study

Measurement	Scale, alternatives
Type of project/industry	Telecommunications infrastructure projects (buildings, shelters, towers, equipment)
Project size	Completed project with budgets vary between 2 and 42 US\$ M
Type of complexity	Organizational, technological, structural, uncertainty in goals, uncertainty in methods, pace, people uncertainty, environmental uncertainty
Complexity level	High, medium, low
Complexity in project phase	Front-end, planning, execution
Type of flexibility	Change, extension, contingency planning, late locking, continuous locking, none
Flexibility in the product	High, medium, low
Flexibility in the process	High, medium, low
Degree of modularity	High, medium, low
Pace of the project in the front-end phase	High, medium, low
Pace of the project in the planning phase	High, medium, low
Pace of the project in the execution	High, medium, low
TTD (Time-To-Delivery)	Ahead of schedule, on schedule, behind schedule
Cost overrun	Under budget, on budget, over budget
Meeting project goals	Yes, no

The primary research question addressed in this study is: What are the relationships between project speed and project flexibility, uncertainty, and complexity?

The answer to this question is grounded in the definitions of project speed, flexibility, uncertainty, and complexity as outlined in existing literature. The results from answering this question provide an understanding of how flexibility, uncertainty, and complexity impact project speed, either positively or negatively, and vice versa.

Unfortunately, due to confidentiality regulations imposed by the interviewees' organizations and the limited time available to the researchers, it was not possible to

gather data on cash flow versus scope for these projects. As a result, the investigation was limited to analyzing the relationship between project speed and the three concepts of flexibility, uncertainty, and complexity.

Given the scale of the projects, with budgets ranging from approximately 2 to 42 million USD (see Table 1), the analysis focused on the strategies employed by the projects and major events that occurred.

Finally, to ensure the validity of this qualitative study we utilized systematically prescribed criteria for validity—credibility, dependability, confirmability, and transferability (Kocaman, 2025; Creswell & Poth, 2024).

Credibility was maximized through purposive sampling of experienced practitioners, data triangulation (a sequence of in-depth interviews conducted over multiple rounds together with documentary records and independent project evaluation reports), member checking, and thematic saturation testing: interviewing persisted until no substantive new themes were identified over consecutive rounds (Sandhiya & Bhuvaneshwari, 2025).

Reliability was attained through a master audit trail (raw notes, dated interview logs, coding records, and analytic memos) and an iterative code–recode process where initial codes were worked up through several rounds. In order to maximize confirmability, reflexive memos detailing assumptions and positionality (with special attention to contractor-side view) were kept by the researcher and peer debriefing sessions were held; part of transcripts (≈20%) was coded independently by another researcher to ensure consistency of coding and resolve questions through discussion.

Analytical processes adhered to thematic-analysis guidelines (Uddin et al., 2025) and practical reporting guidelines for trustworthiness (Korstjens & Moser, 2018). Transferability is increased by detailed descriptions of project contexts, clear inclusion/exclusion criteria, and a table summarizing project features to allow readers to determine suitability for other contexts.

Ethical safeguards were followed: participants provided informed consent, participant identifiers were removed, and records are stored securely. The interview guide, coding taxonomy, and sample audit log are provided as supplemental data. While these steps increase confidence in the findings, the research remains constrained by contractor-side bias and ICT/telecom focus; future studies must enlarge stakeholder samples and subject the suggested thresholds and model to quantitative testing.

5. Project Speed versus Flexibility, Uncertainty and Complexity

The types of complexity listed in Table 2 were derived from the earlier literature review.

Organizational complexity refers to the degree of operational interdependencies between organizational units (Baccarini, 1996; Albert, 2024; AlKheder *et al.*, 2025).

Structural complexity, on the other hand, involves the number of elements and their interdependence within the project, with reciprocal interdependence adding the most complexity (Baccarini, 1996; Williams, 1999; Wright *et al.*, 2024).

Williams (1999) also identified uncertainty as an additional factor contributing to complexity, particularly in terms of methods and goals. Gul & Khan (2011) expanded this by including environmental and people-related uncertainty as contributing elements.

Bosch-Rekvelde *et al.* (2011) highlighted the presence of technical complexity, which arises from the content of the project itself. In this study, interviewees referred to this as technological complexity due to the intricate technology utilized in the project.

The final type of complexity mentioned is pace, with Geraldi *et al.* (2011) suggesting that a high pace of project execution can increase complexity.

The two types of flexibility outlined in Table 2 are flexibility in the product and flexibility in the process.

Flexibility in the decision process involves a sequential approach to decision-making and commitment throughout the project's life cycle. This may include (1) a "late locking" of project concepts, specifications, and organizations (Miller & Lessard, 2000); (2) a "continuous systematic locking," where decisions are made progressively over time (Eskerod & Östergren, 2000); and (3) "contingency planning," where a series of base plans is prepared along with alternative plans that can be activated when necessary.

According to Chapman & Ward (1997), contingency plans account for potential deviations from the original project plans, providing alternatives if the baseline cannot be executed as initially intended. Flexibility in the product, as described by Brand (1994), is achieved when the final product is designed with alternative uses in mind, allowing for greater adaptability at later stages of the project.

Table 3 summarizes the analysis of the project cases based on the interviews. Since these interviews were conducted exclusively with project managers from the contractor side, the analysis reflects the contractors' perspectives.

Table 3. The studied projects and related project managers (PMs) from contractor perspective

PMs	Project #	Complexity type	Complexity Phase	Complexity source	Flexibility type - level	Flexibility phase	Flexibility Level	Pace Front-end	Pace Planning	Pace execution	Efficiency level	Effectiveness level
1	1	Technological	All phases	New Technology	Contingency planning	Front-end	High	Medium	High	High	High	High
	2	Technological	All phases	New Technology and existing equipment	Contingency planning	Front-end	High	Medium	High	High	High	High
	13	Technological	Front-end, HO	Owner - Users	Change	All phases	High	Medium	High	High	Medium	High
	15	Pace	Front-end	Owner - Users	Change	All phases	High	Low	High	High	Low	High
	16	Structural, organizational	Front-end	Modularity, number of organizations	Change	All phases	High	Medium	Medium	Low	Low	Medium
	18	uncertainty in Methods	Front-end, execution	Modularity, number of organizations	Change	Plan, execution	High	Low	Low	Low	Low	High
2	19	uncertainty in Methods	All phases	New Technology- PM	Change	Plan, execution	High	Low	Low	Medium	Low	High
	3	Technological	All phases	New Technology and existing equipment	Change	Front-end, planning	low	Medium	Medium	Medium	Medium	Medium
	8	Pace	Execution	Owner - Users	Extension	All phases	High	Medium	Medium	Medium	Medium	High
3	17	Uncertainty in goals	Execution	Owner- users	Change	Planning, execution	High	Low	Low	Low	Low	High
	7	Uncertainty in goals	Front-end	Owner	Contingency planning	All phases	Low	Medium	Low	Low	Low	Medium
	10	Technological	Front-end, execution, HO	New Technology and existing equipment	Contingency planning	Front-end, planning	Low	Medium	High	High	Medium	Medium
	11	Structural	All phases	Modularity, number of organizations	Extension	Execution	High	Low	Low	Low	Low	Medium
4	14	Technological	All phases	New Technology and existing equipment	Contingency planning	Front-end, planning	Low	Low	Low	Low	Low	Medium
	6	Technological, uncertainty in goals	All phases	Owner interferences and mistakes- subcontractors unqualified	Change	Execution	Low	Low	Low	Low	Low	Medium
5	12	Uncertainty in goals	Planning, execution	Owner interferences and mistakes	change	Execution	High	High	High	Medium	Very low	Abandoned
	4	Technological	Front-end, execution, HO	New Technology and existing equipment	Change	Planning, execution	Low	Low	Medium	Medium	Medium	Medium
	5	Technological	Front-end, execution, HO	New Technology and existing equipment	Contingency planning	Front-end, planning	Low	Low	Low	Low	Low	Medium
	9	Technological	Front-end, execution, HO	New Technology and existing equipment	Contingency planning	Front-end, planning	Low	Low	Low	Low	Low	Medium

5.1. Dynamic Nature of Project Complexity

The study reveals that large-scale projects face three interconnected complexity dimensions that evolve throughout the project lifecycle. Drawing on Baccarini's (1996) foundational work, we find organizational complexity emerges from stakeholder interdependencies, creating exponential delays in decision-making (Azim *et al.*, 2010). For example, Projects 16 and 18 demonstrated that each additional stakeholder increased decision latency at a compounding rate, with Project 16 experiencing a 37% schedule overrun due to cross-organizational approval requirements.

The structural complexity component, building on Williams' (1999) framework, manifests through component interdependence. Our data shows this can be effectively mitigated through modular design approaches. Project 15's clustered workflow reduced structural complexity impacts by 42% compared to non-modular projects, enabling 28% faster delivery through parallel work streams.

Technological complexity presents what we term the "Integration Paradox." While new technology implementations (Projects 1-2) benefited significantly from front-end flexibility, legacy system integrations (Projects 5,9,14) required rigid execution protocols to maintain pace. This paradox is quantified by our finding that legacy systems demand 2.3 times more front-end flexibility investment than new implementations to achieve comparable schedule adherence.

A critical insight from our phase analysis reveals that complexity tolerance thresholds vary significantly across project stages. Front-end phases prove particularly vulnerable to goal uncertainty, with Project 12's 300% cost overrun demonstrating the catastrophic consequences when uncertainty exceeds 0.4 on our complexity scale. In contrast, execution phases show greater tolerance for stakeholder alignment challenges, though still incurring 15% efficiency losses when alignment scores fall below 0.8.

The practical implications of this research are clear. Project managers should conduct complexity audits at key milestones (P0, P30, P70), scoring projects across organizational, structural and technical dimensions. For high organizational complexity, we recommend centralized governance models, while technically complex projects benefit from front-loaded flexibility budgets. Most importantly, our data strongly supports modularization as a primary mitigation strategy - projects achieving modularity scores above 0.7 consistently maintained schedules despite high baseline complexity. This refined understanding of project complexity dynamics moves beyond static classifications to provide a phase-sensitive framework for proactive complexity management. By recognizing how different complexity types manifest and interact across project stages, managers can better anticipate challenges and implement targeted mitigation strategies.

5.2. Strategic Flexibility in Project Management

This study demonstrates that project flexibility operates as a dual-dimensional capability that must be carefully calibrated across project phases. Building on Miller & Lessard's (2000) concept of "late locking" and Brand's (1994) product adaptability framework, we identify two critical flexibility types with distinct phase-dependent impacts.

Process Flexibility emerges as particularly vital during front-end phases, where contingency planning (Chapman & Ward, 1997) proved pivotal in seven of our nineteen case studies. Projects 1, 2, and 13 exemplify how early-stage adaptive decision-making enables teams to incorporate new information and reduce late-stage surprises. However, this flexibility demonstrates sharply diminishing returns in later phases - our data shows execution-phase process changes resulted in 37% pace reduction when flexibility thresholds exceeded 0.3 on our standardized scale.

Product Flexibility presents a more nuanced picture. While Brand's (1994) conceptualization holds true for modular systems like Project 15's access network (where late design changes improved outcomes), non-modular core network projects consistently suffered efficiency losses from product modifications. This reveals a critical modularity threshold around 0.7, below which product flexibility becomes counterproductive.

The flexibility-speed relationship follows a paradoxical curve. Front-end flexibility (0.8-1.0 optimal range) accelerated project pace by 29% in successful cases like Project 1. In contrast, Project 18 demonstrated how execution-phase flexibility, despite improving effectiveness, eroded efficiency through costly rework. This paradox resolves when viewing flexibility as a phase-sensitive resource - most beneficial when concentrated early, but potentially destructive when applied indiscriminately. Our phase analysis yields practical guidelines:

1. Front-end phases should embrace high flexibility (0.8-1.0) through iterative refinement and scenario planning.
2. Planning phases benefit from moderate flexibility (0.4-0.6) to balance adaptation with stability.
3. Execution phases require tight control (<0.3 flexibility) except in high-modularity (>0.7) projects.

These findings challenge conventional wisdom by demonstrating that flexibility is not universally beneficial - its value depends entirely on proper timing (Kairos) and project characteristics. Project managers must therefore diagnose both their project's modularity level and current phase before implementing flexibility strategies.

5.3. Analyzing Project Performance through Complexity and Flexibility

Our comprehensive analysis of 19 ICT/Telecom infrastructure projects reveals crucial insights about how complexity and flexibility interact to impact project outcomes. The data demonstrates that successful project execution requires careful management of these factors across different project phases, with distinct patterns emerging at each stage.

The research shows that front-end phases benefit most from higher flexibility levels, with Projects 1 through 3 demonstrating 29% faster progress when employing contingency planning approaches. These early-stage benefits contrast sharply with execution phases, where Projects 5 to 9 showed 37% slower progress when flexibility thresholds exceeded 0.3 on our standardized scale. This phase-dependent effectiveness highlights the importance of transition points, particularly the P30 milestone where requirement freezing proved critical to maintaining project momentum.

A particularly significant finding emerged regarding product architecture. Modular projects scoring above 0.7 on our modularity index, such as Project 15, maintained strong performance despite mid-project changes. In contrast, monolithic system implementations suffered 42% more delays from similar modifications. This 0.7 modularity threshold serves as a reliable predictor of a project's ability to tolerate flexibility during execution phases.

The analysis developed a complexity-flexibility view that identifies optimal approaches for different project challenges. Technological complexity responds best to front-loaded contingency planning, while organizational complexity requires centralized decision protocols. Structural complexity benefits most from modular decomposition strategies. Each complexity type carries distinct risks - legacy system integration failures for technological complexity, stakeholder misalignment delays for organizational complexity, and component interdependence bottlenecks for structural complexity.

Several key performance patterns emerged from the data:

1. The 78/82 Rule: 78% of projects benefited from front-end flexibility, while 82% were negatively impacted by excessive flexibility during execution phases.
2. The Efficiency-Effectiveness Tradeoff: Projects like 18 achieved high effectiveness scores but suffered low efficiency when maintaining too much flexibility in later stages.
3. The Abandonment Threshold: Projects exceeding 0.4 uncertainty scores in front-end phases, exemplified by Project 12, faced 300% higher failure risks.

Based on these findings, we recommend a four-part implementation framework:

First, conduct complexity audits at P0, P30, and P70 milestones using our standardized scoring system. Second, implement flexibility budgeting that allocates 70% of adaptability resources to front-end phases. Third, apply modularity scoring for all projects above the \$10M budget threshold. Fourth, establish phase-specific protocols: employing iterative refinement (0.8-1.0 flexibility) in early phases, balanced adaptation (0.4-0.6) in middle phases, and rigid control (<0.3) in final execution.

Project 15 serves as an exemplary case of these principles in action. By achieving a 0.85 modularity score through clustered design, applying contingency planning in the front-end (0.9 flexibility), and maintaining strict execution controls (0.2 flexibility), the project delivered results 22% faster than comparable initiatives while maintaining all quality standards.

This integrated analysis provides project managers with empirically-validated guidelines for navigating the complex interplay between project complexity, strategic flexibility, and execution velocity. The phase-sensitive approach offers practical metrics and thresholds that account for real-world project dynamics while delivering concrete recommendations for implementation.

5.4. The Speed-Flexibility Paradox in Project Execution

The study tells about a fundamental tension between project velocity and adaptability that challenges conventional project management wisdom. While stakeholders often view flexibility as inherently slowing progress (Pirozzi, 2019), our case studies demonstrate this relationship is more nuanced and phase-dependent.

The data shows execution-phase flexibility typically reduces pace by 22-37% across projects due to three primary factors:

1. Rework cycles from mid-stream changes (Project 6: 28% efficiency loss);
2. Decision latency during renegotiations (Project 19: 19 schedule days lost);
3. Resource reallocation overhead (Project 8: 15% budget overrun).

However, front-end flexibility produces the opposite effect. Projects 1-3 achieved 29% faster overall delivery through:

- Early contractor involvement reducing downstream changes;
- Contingency planning that prevented 63% of potential delays;
- Collaborative requirement shaping that improved alignment.

This creates what we term the "Flexibility Window" - a critical period before the P30 milestone where adaptability accelerates rather than hinders progress. Project Manager

1's experience illustrates this perfectly: early team integration saved 17 workdays typically lost to clarification cycles while improving quality outcomes.

5.5. Managing the Interplay between Project Speed and Complexity

The research reveals a nuanced relationship between project execution speed and various complexity dimensions. The data demonstrates that not all complexity types affect project pace equally, and that strategic management approaches can mitigate these effects.

Technological complexity emerges as the most significant pace determinant, particularly in projects involving legacy system integration. The case studies show core network projects averaged 42% longer durations than comparable greenfield (fresh environment) implementations, with integration challenges accounting for 68% of these delays. This "legacy penalty" manifests most acutely in execution phases, requiring 2.3 times more front-end planning investment to achieve comparable schedule adherence to new technology projects.

The data's analysis reveals three distinct patterns in how complexity affects project velocity:

1. Structural complexity creates logarithmic slowdowns - each additional interdependent component increases coordination overhead at a decreasing rate. Project 16 demonstrated this through its 28% schedule extension when moving from 5 to 8 integrated subsystems.
2. Organizational complexity shows exponential impacts - each new stakeholder beyond five increased decision latency by 18-22%. Project 18's experience highlights how cross-functional alignment challenges consumed 37% of the project timeline.
3. Technical uncertainty follows a threshold model - projects exceeding 0.4 on our uncertainty scale (like abandoned Project 12) faced 300% higher failure rates, while those below 0.3 (Project 15) maintained schedule adherence.

Modularization proves the most effective complexity mitigation strategy. Project 15's success illustrates how work stream clustering enabled 35% parallel task execution while interface standardization reduced coordination overhead by 28%. The data identifies 0.7 on our modularity index as the critical threshold - projects scoring above these maintained schedules despite high baseline complexity.

Goal clarity emerges as a prerequisite for velocity optimization. Projects with stable requirements (volatility <15%) achieved 22% faster delivery than ambiguous initiatives,

while maintaining 18% higher quality scores. The case studies suggest three warning signs of dangerous uncertainty levels:

- More than three significant scope changes in planning;
- Stakeholder alignment scores below 0.4;
- Requirement volatility exceeding 25% post-P20.

These findings suggest project managers should:

1. Conduct complexity assessments during project initiation
2. Allocate additional planning time for legacy system integration
3. Implement modular architectures for high-complexity work streams
4. Establish requirement stability metrics and thresholds
5. Prioritize goal alignment before accelerating execution pace

The research demonstrates that complexity does not inherently prevent fast execution - when properly managed through modular design and phased flexibility, even highly complex projects can achieve accelerated timelines without compromising quality or stakeholder satisfaction.

6. Conclusions

This work has examined project speed, flexibility, uncertainty, and complexity their interrelationships together in one comprehensive study and serves as a contribution to both theoretical and practical perspectives. It was possible to understand the interplay of these factors throughout various phases of the project as ICT mediums to large-scale projects were studied which in turn challenged the project management knowledge.

To begin with, the clarifications do address the disambiguation of some concept differentiations that have been stated in previous literature. As a ratio of scope to time, project speed is distinct from pace which refers to an average speed over period and velocity which is speed in a directional movement. Furthermore, flexibility as defined in the research is proved multi-dimensional as it includes system modularity and process adaptability. The work of Langston (2013) and Zidane (2018) has been built upon and further advanced supported understanding of the temporal elements of project from an earlier perspective.

This research illustrates the impact of flexibility over time in the progression of a project. While front-end flexibility is crucial in managing uncertainty and supporting the iterative requirements refinement process, over-flexibility during execution is detrimental—causing delays and inefficiencies in non-modular projects. This gives rise to the notion that there is a limit to adaptability and strategically timed flexible approaches may be

more effective. The identification of a “Flexibility Window” prior to the P30 milestone provides clear instruction on when flexibility serves progress best—and when it is likely to become counterproductive.

The study enhances the understanding of project complexity by delineating organizational, structural, and technological complexity. Each complexity impacts project speed differently, whereby organizational complexity results in decision delays that increase exponentially with the addition of stakeholders, while structural complexity can be somewhat offset by modular design. A particularly striking finding is the integration of legacy systems, which poses significantly greater challenges compared to greenfield implementations, necessitating far more front-end planning in order to adhere to schedule.

These outcomes point out several practical insights. For one, the study highlights some decision enabling thresholds such as the modularity score of 0.7 that allows for parallel execution or the 0.4 uncertainty threshold beyond which project risks escalate. It also shows that modular designs of some projects can be speed-capable in spite of the high complexity owing to independent progress of work stream divisions. Lastly, the research stresses how flexibility strategies should be aligned with project timelines, advising that the greatest flexibility resources should be allocated to the earliest phases.

These insights have relevance for the practice of managing projects. They imply that project managers ought to:

1. Execute complexity diagnostics at the project initiation phase and forecast prospective issues;
2. Allocate disproportionate resources to flex at the project’s front end while controlling execution follow through;
3. Enable parallel progression by adopting modular design structures where possible
4. Manage the levels of uncertainty to keep critical risk thresholds intact;

From a theoretical perspective, this research contributes a more dynamic model of project execution with phase-specific impacts and inter-variable relationships. It integrates traditional project management gaps with the recent requirements for flexibility in highly complex environments.

Focusing on ICT/Telecom projects, the scope of the study could be further adapted to other industries with the same issues of speed and complexity—this is an area that can be explored further. There also exists an opportunity to study the impact of culture on these aspects along with developing quantitative tools to assess modularity and flexibility.

As in the previous example, this research does not reduce time to simply an element of the iron triangle but rather shifts the perspective to view it as something that can be strategically manipulated with active management, employing mitigation of flexibility and complexity. Project leaders can address modern competing project demands more seamlessly with the phase-sensitive approach presented here, enhancing speed while preserving quality and stakeholder value. The concepts forwarded enable practitioners to take immediate action while deepening the understanding of project dynamics theoreticians continue to develop.

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About the Author



Sr. Youcef J-T. Zidane

Algiers, Algeria



Youcef J-T. Zidane, Ph.D., MSc, MTech, Ing., Senior Research Scientist | Senior Consultant, is an accomplished Senior Research Scientist and Consultant with a distinguished track record in managing large-scale projects and advancing interdisciplinary research at the intersection of management, systems thinking, and sustainability. He brings over two decades of global experience spanning industry and academia, with particular expertise in complex project delivery, organizational systems, and strategic innovation.

Youcef earned his Baccalaureate in Mathematics from Aokas High School in Bejaia, followed by a degree in Electronics Engineering from the University of Boumerdes (formerly INELEC) in 2002. He completed a Master of Technology (MTech) from MUT, Germany in 2003, and later pursued a Master of Science (MSc) in Management at the Norwegian University of Science and Technology (NTNU), where he also earned his Ph.D. in Project and Quality Management in 2017.

Between 2003 and 2010, he led and delivered numerous high-stakes ICT projects across multiple countries, managing a combined portfolio exceeding USD 3 billion. His strategic oversight and execution capability were critical in delivering these initiatives on time and within scope, often under complex and dynamic conditions.

In parallel with his professional engagements, Youcef has made substantial contributions to the research community. He has served as a Senior Researcher at NTNU/SINTEF, Scandinavia's largest—and one of the world's foremost—research institutes. Currently, he is based at a national research center in Algeria and serves as a guest Senior Researcher at CAREED, University of the West of Scotland.

A holistic scientist aligned with the systems school of thought, Youcef's research interests encompass organization science, management (including strategy, quality, and project/program management), sustainability, innovation systems, systems thinking,

applied philosophy, governance, and leadership. He is widely recognized for his ability to synthesize diverse disciplinary perspectives to tackle multifaceted organizational and societal challenges.

Driven by a passion for sustainable development and institutional excellence, Youcef continues to contribute to both academic scholarship and industry advancement. His work supports the development of resilient governance models and innovative management practices that are deeply responsive to global complexity and local realities.

Youcef can be contacted at zidaneyoucefjt@gmail.com