

Towards a Statistically Validated Model of Perceived Project Complexity

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Abstract

Project complexity is widely invoked to explain delivery difficulties, yet it is often used as a broad label rather than as a diagnostic construct that can be measured reliably and linked to organising responses. Existing frameworks propose multiple dimensions of complexity, but statistically validated survey measures remain limited, and there is continuing disagreement over whether emergent/dynamic complexity constitutes a distinct dimension or a temporal property of other forms of complexity.

This study provides an initial statistical validation of a survey-based measure of perceived project complexity derived from Maylor et al.'s (2013) Complexity Assessment Tool (CAT). We refined CAT-based items for survey use and collected responses from a large international sample of working project professionals recruited via Prolific. Using exploratory factor analysis followed by confirmatory factor analysis, we examined the underlying structure of the instrument, removed weak-performing items, and assessed the fit and reliability of the resulting measurement model.

Results support a four-factor structure that is interpretable in practitioner terms: (1) Organisation and Management, capturing the extent to which the project is set up for effective delivery (e.g., clarity, governance, resourcing, reporting, stakeholder alignment); (2) Institutional Environment, capturing the coordination demands associated with international dispersion (e.g., differences in location, language, time zone and currency); (3) Organisational Change, capturing the scale and significance of organisational and cultural change surrounding the project; and (4) Emergent, capturing anticipated change in project conditions over a six-month horizon. Notably, the Emergent items form a coherent factor rather than mirroring their current-state counterparts, providing empirical traction on the status of emergence within project complexity.

The study contributes a survey-based measurement model that both aligns with and recombines established complexity typologies in ways that reflect practitioner experience. It also strengthens the practical implications of complexity assessment by supporting a context-specific view of project organising: different configurations of complexity appear to call for different emphases in managerial discipline, coordination planning, change leadership, and adaptive response.

Keywords: project complexity model; project complexity; scale development

1. Introduction

Projects are increasingly delivered in environments marked by tight deadlines, shifting priorities, distributed teams and heightened scrutiny from multiple stakeholder groups. In many organisations, “project complexity” has become the default explanation for why delivery is difficult, yet it is often used as a broad label rather than as a practical diagnostic. The result is familiar: teams may sense that a project is “complex” but still lack a clear basis for identifying

what is driving that complexity and what additional organising responses are needed (e.g. stronger governance, additional coordination effort, different leadership behaviours, or greater adaptive capacity).

This gap is consequential for both research and practice. For researchers, complexity is frequently invoked as an explanatory variable, but inconsistent measurement makes it difficult to compare findings across studies or build cumulative knowledge about which forms of complexity matter for which outcomes. For practitioners, weak measurement limits the usefulness of complexity assessment for portfolio decision-making and project set-up: if complexity cannot be measured reliably and interpreted consistently, it cannot easily be linked to governance intensity, resourcing decisions, assurance processes, or capability planning. In sum, the field needs a measurement approach that is both practically meaningful and academically defensible.

A range of frameworks and assessment tools have attempted to respond to this need by offering structured prompts that help managers surface sources of difficulty and tailor their approach. Yet many instruments function better as conversation aids than as statistically validated measures. There remains limited empirical clarity about whether the commonly discussed “dimensions” of complexity are experienced as distinct constructs by practitioners or whether they blend into broader patterns that reflect how work is organised and managed. This issue is especially salient for emergence. Anticipated change and instability are widely recognised as central features of complex projects, but there is continuing disagreement about whether emergent/dynamic aspects of complexity should be treated as a stand-alone dimension or as a time-based property that sits “on top of” other sources of difficulty. Although several frameworks and tools are available, including those termed “Complexity Assessment Tool”, or “CAT”, statistically validated survey measures remain limited. This study offers an initial statistical validation of a measure derived from Maylor et al.’s (2013) CAT using exploratory

and confirmatory factor analysis (EFA, CFA) and provides a foundation for further validation and refinement.

Our aim is to develop and test a survey-based model of perceived project complexity that captures how project professionals group and interpret complexity-related conditions in practice. Treating complexity as a perceptual phenomenon is appropriate because what matters for organising and management is often not only objective project characteristics, but how difficult the work is experienced to be, and therefore what responses are seen as necessary, feasible, or justified.

Methodologically, the study follows a standard scale-development logic. We draw on an established practitioner-facing instrument as the starting point for item development, refine the wording for survey use, and then apply exploratory factor analysis (EFA) to identify the underlying structure of responses and reduce the instrument where items do not perform well statistically or conceptually. We then use confirmatory factor analysis (CFA) to assess the fit of the resulting measurement model. This two-stage approach enables us to move beyond face-valid groupings toward a model that is empirically grounded and can be tested and reused in future studies.

The paper makes three contributions. First, it offers a survey-based measurement model that produces dimensions that are interpretable in managerial terms and usable in subsequent research. Second, it provides evidence relevant to long-standing conceptual disagreements – particularly around emergence – by testing how anticipated change behaves statistically in a paired-item design and by examining whether the resulting structure is robust. Finally, it strengthens the practical implications of complexity assessment. By clarifying which difficulties tend to cluster, the model supports a more context-specific approach to project organising: projects dominated by foundational set-up and coordination demands may call primarily for managerial discipline and deliberate planning; projects dominated by

organisational change may require stronger leadership for commitment and adaptation; and projects dominated by emergence may require a more adaptive, sensemaking-oriented stance as conditions evolve.

2. Literature Review

Conceptualisations of Project Complexity

There is no agreed-upon definition of project complexity in the literature; Browning (2023:26) states that it is a “catch-all descriptor for project challenges”. Broadly, project complexity refers to the perceived level of difficulty involved in shaping and delivering a project, which may involve for example challenges in practitioners’ ability to predict, control, coordinate, fully appreciate the context and environment of the project. From a systems perspective, project complexity is understood as the level of differentiation, interdependence, uncertainty and change in project organising (Baccarini, 1996; Williams, 1999; Williams, 2005).

Over the past 30 years, several authors have contributed to the development of our understanding of project complexity. This body of work has explored the concept (Baccarini, 1996) and dimensions of project complexity (Bakhshi et al., 2016; Chipulu et al., 2024; Geraldi et al., 2011), research approaches (Cicmil et al., 2009; Mikkelsen, 2020), developed frameworks (Mikkelsen et al., 2020; Xia & Lee, 2004;) and assessment tools (Bosch-Rekvelde et al., 2011; de Rezende & Blackwell, 2019; Maylor et al., 2013).

Synthesising prior reviews (Bakhshi et al., 2016; Morcov et al., 2020), Mikkelsen and Aaltonen outline four branches of project complexity research: descriptive, perceptual, system of system and theoretical.

The descriptive perspective focuses on defining and characterising project complexity in terms of dimensions such as structural complexity, uncertainty, pace, dynamic, and socio-political considerations, among others, from which models can be developed, e.g. Shenhar (2001) and

Shenhar & Dvir (2007). Research in this tradition proposes frameworks and assessment models designed to help practitioners make sense of project complexity and tailor responses. Although there is some convergence around core dimensions, there is still limited agreement regarding their number or the distinctiveness of constructs such as ‘emergence’ (see Bakhshi et al., 2016; Chipulu et al., 2024; de Rezende & Balckwell, 2019; Joseph & Marnewick, 2021; Maylor & Turner, 2017; Padalkar & Gopinath, 2016; Rolstadas & Schieflo, 2017; Shenhar, 2007; Xia & Lee, 2004).

The perceptual perspective focuses on project complexity as it is experienced and perceived by individuals and examines how practitioners interpret, cope with, navigate and respond to perceived complexity (e.g. Ackermann & Alexander, 2016; Mikkelsen, 2021). This research is often case- and narrative-based (Diorgenes & Meyer, 2020) and seeks to understand sensemaking and behavioural responses.

The system of system perspective focuses on the management challenges that arise when projects involve multiple independent or semi-autonomous systems and their interactions (e.g. Daniel & Daniel, 2018; Snowden & Boone, 2007).

The theoretical perspective examines projects through a more abstract lens, including complexity theory (e.g. Cooke-Davies et al., 2007). As Cicmil et al., (2009) note, this ‘*complexity in projects*’ approach, used to describe research that analyses projects through a complexity theory lens, differs from the approach that emphasises ‘*complexity of projects*’ which aligns more closely with the descriptive and perceptual branches as they focus on the characteristics of projects and how managers and teams perceive and respond to what they call complexity.

While these branches have developed in parallel, research that explicitly bridges the descriptive and perceptual perspectives remains limited.

Bridging descriptive and perceptual perspectives: The CAT

A notable integrative effort is the grounded study by Maylor et al. (2008), which identified dimensions of managerial complexity and an associated assessment and response model. Building on this, Geraldi et al., (2011), taking a descriptive perspective, offered a chronological review of how the concept of project complexity has evolved and proposed a five-dimensional complexity framework comprising: Socio-political, pace, dynamic, uncertainty and structural complexity. In this framework:

- *Structural complexity* refers to size, number, heterogeneity and interdependence of project elements;
- *Uncertainty* refers to perceived lack of knowledge or information about the future state of the elements and interactions of the socio-technical 'system' being managed;
- *Dynamics* captures the extent and nature of changes throughout the project lifecycle;
- *Pace* refers to the temporal characteristics of a project, the rate or speed at which a project should be delivered; and
- *Socio-political complexity* refers to the behaviours, interests and interactions of internal and external stakeholders.

Drawing on this work, Maylor et al., (2013) developed a complexity assessment tool (CAT) to facilitate the identification and discussion of project complexities in practice. The CAT consists of 32 statements that capture structural, and socio-political dimensions of complexity, repeated to ask about anticipated changes (i.e. emergent complexity), thereby giving 64 questions to answer. In operationalising the framework, the authors embed Geraldi et al.'s pace within structural complexity and combine uncertainty and dynamics within the overarching emergent dimension. The CAT provides a diagrammatic view of project practitioner's perceptions of project complexities and is used to encourage dialogue about how to proactively manage current and anticipated complexities. In this sense, the CAT is explicitly positioned at the intersection of descriptive and perceptual perspectives.

Maylor et al.'s (2013) CAT has now been used with several thousand managers across the public and private sectors and a wide range of industrial contexts, as part of postgraduate teaching and executive education. It provides a valuable way of thinking about work challenges, the distinction between the three dimensions of complexity help to structure discussion about the nature of the challenges (both current and anticipated) and supports constructive conversations among stakeholders. The categorisation of structural, socio-political and emergent complexity has been taken up in subsequent research into projects (Boonstra & Reezigt, 2023; Damayanti et al., 2021; Lock & Sergeenko, 2024; Maylor & Tuner, 2017), supply chains (Boehme et al., 2021, 2024; Turner et al., 2018), knowledge sharing (Cecchi et al., 2022; Gritzner & Kollnig, 2024), software development (Baxter & Turner, 2023), and healthcare (Greenhalgh et al., 2020; Sacchi et al., 2023).

Despite its widespread use and apparent face validity, the CAT has not yet been subject to full statistical validation as a measurement model of perceived project complexity. In particular, there is ongoing debate about whether emergent or dynamic aspects of complexity should be conceptualised as a distinct dimension or as a time-based property that modifies other forms of challenges. Existing instruments often function effectively as structured prompts or conversation aids, but less so as psychometrically robust scales.

We therefore aim to develop and test a survey-based model of perceived project complexity that captures how project professionals group and interpret complexity-related conditions in practice.

3. Methodology

Developing a robust statistical measure of project complexity requires multiple studies. Accordingly, this study builds on existing measures and reports the first steps in a wider validation programme. We structure our scale development process in line with established psychometric best practice, drawing on Irwing & Hughes' (2018) insights on test development,

and the foundational work by DeVellis (2017) on scale development. Psychometric tools are appropriate because we are measuring subjective perceptions of complexity, rather than objective characteristics such as frequency or quantity.

We began by developing a list of items to measure elements of project complexity and then conducted an exploratory factor analysis (EFA) to examine how the items correlate and how many factors might exist. To date, the factors have largely been theorised, with items developed qualitatively based on face validity. As there is no consensus on the number of dimensions or whether emergence constitutes a distinct factor, EFA provides an appropriate method for exploring the underlying structure of the items. This step therefore allows us to move beyond face validity towards construct validation.

The initial list of measures was based on Maylor et al.'s (2013) CAT, which was developed through a comprehensive review of the project complexity literature and qualitatively validated across a range of project settings. In this way, the CAT addresses aspects of rigour and relevance, which are widely recognised as important across project organising research (Pinto, 2022). The CAT includes 64 items intended to measure three aspects of project complexity: Structural Complexity, Socio-political Complexity, and Emergent Complexity.

A team of three experts (three of the co-authors), with academic backgrounds in project complexity and psychometrics, reviewed the initial list of items. We considered whether additional items from the literature were required but judged the CAT to be comprehensive and therefore did not add further items. The experts represented different national backgrounds (American, British, and Mexican), providing diverse perspectives on the use of the English language in project contexts. We aimed to remain as close as possible to the original wording to preserve the underlying theoretical constructs. However, items were revised, when necessary, in line with best practice in psychometric scale development, including avoiding double-barrelled questions, rephrasing items for Likert-scale measurement, and reverse-coding

selected items. Apart from these reverse-coded items, statements were framed positively to reflect conditions associated with lower perceived complexity. Respondents indicated their level of agreement using a 7-point Likert scale. These items formed Question List A, capturing current-state perceptions of project complexity (i.e. structural and socio-political complexity). Following Maylor et al.'s (2013) approach to measuring emergent complexity, we captured anticipated change for each item. The original CAT question ("Do you expect this situation to remain stable?") used a categorical response format (Yes/No). We revised this to a continuous response scale, asking: "How do you expect this to change in the next six months?", with a response scale from "much better" to "much worse" and a no-change option in the middle. The six-month time frame was chosen to focus respondents on near-term expectations rather than distant speculation, and its inclusion has been tested in workshops with project professionals facilitated by one co-author.

Each item in Question List A had a corresponding Question B item. Example items are shown in Table 1.

Table 1. Example items

Maylor et al. (2013)	Our items – Question A	Our items – Question B
The work has clear sponsorship consistent with its importance.	The project sponsorship provides appropriate support.	How do you expect this to change in the next six months?
Acceptance criteria for quality and regulatory requirements can be well defined.	Acceptance criteria for quality requirements are well defined.	How do you expect this to change in the next six months?
Acceptance criteria for quality and regulatory requirements can be well defined.	Regulatory requirements are well defined.	How do you expect this to change in the next six months?

The full list of items was subsequently reviewed by four additional experts, who provided feedback on clarity and wording. Minor revisions were made, and the instrument was finalised. The final survey contained 50 A items and 50 B items, yielding 100 items in total. A full list of Question A items is provided in Appendix A.

This list was used to develop an online survey. In keeping with best practice, questions were randomised where possible, and several questions were reverse-coded.

Data were gathered through Prolific. Comparative research suggests that Prolific produces survey data that is at least comparable to, and in some respects better than, common alternatives. Peer et al. (2017) report that Prolific participants are generally more naïve and less dishonest than those on MTurk, while delivering data quality comparable to MTurk and higher than some other crowdsourcing platforms. Peer et al. (2022) similarly find that Prolific performs strongly on key indicators including attention, comprehension, honesty and reliability. More recent cross-platform research also suggests that Prolific performs well on broader practical metrics, such as the proportion of high-quality respondents obtained per unit cost (Douglas et al., 2023). Taken together, this evidence supports the suitability of Prolific as a platform for collecting reliable self-report data from professional populations.

After cleaning the data, we used EFA to assess the initial factor structure. We then explored and reduced the scales, to improve the psychometric properties of each. Lastly, we confirmed the final factor structure using Confirmatory Factor Analysis (CFA).

4. Results

Sample

Using Prolific, we drew on a sample of project professionals who were currently working full-time on projects (sample participants can be pre-screened to ensure they meet specific demographic requirements). Respondents were paid GBP£2.50 for their participation. We collected 387 responses of which five were excluded due to implausible completion times, leaving 382 usable responses (53.7% female; $M_{\text{age}} = 39.38$, $SD = 11.13$). The number of years each participant had in leading or managing projects ranged from 1-38 years ($M_{\text{years}} = 6.96$, $SD = 6.49$). Participant nationalities were primarily British (26.9%), American (24.5%) South African (12.9%), and Canadian (5.7%). The remaining nationalities ranged from 0.3% to 2.6%

across 36 more countries, including Western Europe (e.g. Germany, Italy, Portugal), Eastern Europe (e.g. Czech Republic, Croatia, Estonia, Russia), the Middle East (e.g. Israel), South Asia (e.g. India), East/Southeast Asia (e.g. Philippines, South Korea, Vietnam), Africa (Nigeria, Zimbabwe), Latin America (Mexico, Argentina, Chile) and the Pacific region (e.g. New Zealand, Australia). Participants worked primarily in Information Technology (17.5%), Government (11.0%) and Construction (10.2%). The remaining industries ranged from 1.0% to 6.8% and included Education, Healthcare, Financial Services, and Manufacturing. Most participants held the title of Project Manager (51.6%), Team/Technical Lead (16.0%), Project Administrator/Coordinator (13.6%), or Programme Manager (7.1%). The remaining titles ranged from 0.8% to 6.0% and included roles such as Project Director, Director of Programme Management, and Project Sponsor.

Results

Data were analysed using SPSS 30. To conduct the exploratory factor analysis, we ran Principal Axis Analysis with Varimax (orthogonal) rotation. Orthogonal rotation was used, as the factors were theorised as conceptually distinct and not expected to correlate strongly. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy suggested adequate sampling for factor analysis (KMO=0.935, $p < .001$). 20 factors emerged with eigenvalues > 1.0 , representing 57.49% of the cumulative variance. The four-factor solution seemed most reasonable theoretically and statistically, although the total variance explained (TVE) was slightly low at 38.73%. We explored this solution further by removing items with which had low factor loadings $< .40$ (7 items) and cross-loadings > 0.3 (6 items), then ran an EFA with four factors with this solution. As expected, KMO (KMO=0.941, $p < .001$) and TVE both improved, with TVE results within more acceptable levels of 43.31%.

Based on the content of the items and the theoretical underpinning, we have labelled the four derived factors as Emergent Complexity, Organisation and Management, Institutional

Environment, and Organisational Change. The four factors and some example items are listed in Table 2.

Table 2. The four derived factors and example items

Factor No.	Factor Name	Example items
1	Emergent Complexity	Clarity on regulatory requirements will change in the next 6 months. The ability of the core team to make decisions will change in the next 6 months.
2	Organisation and Management	The scope is well defined. The benefits of the project are clearly understood.
3	Institutional Environment	Differences in spoken languages create challenges for this project. Differences in time zones create challenges for this project.
4	Organisational Change	The project is affected by significant organisational change. The project involved no significant organisational culture change.

We also examined the internal reliabilities of the derived factors by calculating Cronbach's alpha. Alpha reliability for the four derived factors all showed acceptable estimates (Table 3).

Table 3. Alpha reliabilities for the 4 derived factors.

Factor No.	Factor Name	Cronbach's α	No. of items
1	Emergent Complexity	0.974	46
2	Organisation and Management	0.932	33
3	Institutional Environment	0.767	4
4	Organisational Change	0.774	4

We ran a CFA of this solution in AMOS 30. Model fit was evaluated based on Root Mean Square Error of Approximation (RMSEA), the Standardized Root Mean Square Residual (SRMR), the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI). Based on recommendations derived from Monte Carlo simulations, Browne and Cudeck (1993) consider an RMSEA less than 0.08 to be adequate, but values less than 0.06 to be best. A value of <0.05

would be considered an excellent fit for SRMR, but values up to <0.08 are still considered good (Hu & Bentler, 1995). Hu and Bentler (1998) recommended that values for the CFI and TLI greater than 0.90 to be adequate, but values above 0.95 are preferred.

The model produced an excellent fit based on the RMSEA (0.055) and the SRMR (0.064), however the CFI (0.78) and TLI (0.77) were both slightly lower than adequate. Multiple indices are used in model evaluation, because they provide different information about the fit. Generally, a model is considered to demonstrate acceptable fit when multiple indices meet recommended thresholds.

Based on these results, we further explored the model. We noticed that Factor 1-Emergent Complexity was almost entirely composed of “B” questions. Moreover, the B questions did not load onto any other factor, except for a few cross loadings that were all < 0.4 . This raised concerns that Factor 1 might be a methodological artefact. Common method bias may exist if a single dominant factor accounts for a majority of the covariance in the variables (Urbach and Ahlemann, 2010), which may threaten the internal validity of the constructs. Harman’s one-factor test is recommended to analyse this further (Podsakoff et al., 2003). This test involves variance extraction with no rotation which we conducted using principal axis extraction in SPSS. The maximum variance explained by Factor 1 was 25.61%, and there were 20 factors with eigenvalues > 1.0 , therefore suggesting the absence of common method bias.

Thus we conclude the four-factor solution is a reasonable fit to the data. The four factors, their identified items and corresponding factor loadings are shown in Appendix B.

5. Discussion

The four factors emerging from the EFA – Organisation and Management, Institutional Environment, Organisational Change, and Emergent – map closely onto established dimensions of project complexity but also recombine them in ways that reflect how practitioners experience complexity in projects.

Organisation and Management brings together items relating to stakeholder support and understanding (SP14A–SP17A, SP19A), sponsorship and senior management backing (SP01A, SP04A), team motivation and cohesion (SP05A, SP06A), prior experience (SP07A, SP09A), and a broad set of ‘classic’ project management conditions: clear scope, vision, benefits, success measures and business case (ST01A–ST03A, SP02A, ST06A, ST07A); defined responsibilities and authority (ST11A, SP20A); resource sufficiency and controllability (ST17A, ST18A, ST20A, ST29A, ST28A); and the presence of reporting systems, tools, and regulatory clarity (ST08A, ST10A, ST12A–ST15A, SP03A).

This factor overlaps strongly with what the literature typically describes as structural complexity, based on the number and interdependence of elements such as resources, tasks, stakeholders, and organisational units (Baccarini, 1996). It also mirrors several elements of the MODeST model (Maylor et al., 2008): mission (clarity of goals and success criteria), organisation (fit with existing structures), delivery (processes, tools, reporting), stakeholders (support and alignment), and team (motivation, capability). At the same time, the Organisation and Management factor in our data also includes aspects that Geraldi et al. (2011) treat as belonging to socio-political complexity – such as senior management support, stakeholder commitment, alignment and shared understanding – and draws on what they classify under uncertainty: namely the prior experience of managers, teams and organisations with similar projects. In other words, the factor is mainly about how far the project is under structural control, but combines structural, socio-political and capability-related indicators that existing typologies usually keep separate.

In this sense, Organisation and Management is a hybrid factor. Rather than isolating structure, stakeholders and team as separate axes, it reflects a practitioner view in which effective projects are those where structure, governance, resources, and key stakeholders are all in place. This does not contradict existing typologies, but it brings together several of their dimensions into

a single, management-oriented construct that is easier to operationalise. Substantively, this factor also reinforces a simple but important point: many of the drivers of perceived complexity relate to “getting the basics right”. In other words, projects are often not made complex solely by novel technology or turbulent environments, but by insufficient attention to foundational set-up conditions such as clarity of purpose, resourcing, governance, and stakeholder alignment.

The Institutional Environment factor – capturing challenges arising from cross-country locations, languages, time zones and currencies (ST22A–ST25A) – aligns closely with the environmental/geo-cultural dimensions discussed in the complexity literature. Environmental complexity in Bosch-Rekvelde et al.’s (2010) TOE framework includes the market, legal, political and physical context within which the project operates. Our factor focuses on a narrower but practically significant subset of that domain: the coordination difficulties associated with distributed, international work (location, time zone, language and monetary systems). Similar elements appear in Maylor et al.’s (2008) work (multiple time zones, locations, languages) under organisational complexity. The contribution here is to isolate these ‘globalisation’ aspects – a likely growing area of complexity for many project-based organisations – as a distinct dimension, rather than subsuming them under general organisational or stakeholder complexity. From a managerial standpoint, this suggests an additional layer of coordination needs to be explicitly recognised and planned for (e.g. synchronisation across time zones, translation and interpretation, and the administrative friction of working across monetary and contractual systems).

The Organisational Change factor, defined by items on organisational and cultural change (SP10A–SP13A), corresponds to what many authors describe as change- or transformation-related complexity (Xia and Lee, 2003). Projects that fundamentally alter structures, processes or culture are recognised as more complex to manage than business-as-usual initiatives.

Williams (1999), for example, distinguishes structural complexity from uncertainty in goals and methods, arguing that projects with evolving objectives or ways of working introduce additional dimensions of complexity beyond the quantity and interdependence of elements. Similarly, Maylor et al. (2008) include organisational restructuring and other organisational changes as dynamic sources of managerial complexity within the organisational dimension of their MODeST model. Our Organisational Change factor aligns with this literature, but it captures a more specific aspect of change-related complexity: not *what* is changing (e.g. which processes, structures or roles are being redesigned), but rather respondents' perceptions of the *scale* and *significance* of the organisational and cultural change surrounding the project. The factor therefore captures the *transformational intensity* of the project: the extent to which the project challenges existing organisational arrangements, cultural norms and ways of working. Practically, this implies that effective responses rely less on "better planning" alone and more on leadership behaviours that can build commitment, sustain support, and guide adaptation during change and build resilience.

Finally, the Emergent factor – comprising all the "B items" asking how respondents expect each aspect to change over the next six months – is closely related to what Geraldi et al. (2011) describe as dynamic complexity, and to more recent discussions of emergent complexity as the degree to which the project context is in flux (e.g. Maylor et al., 2013; Floricel et al., 2016). By pairing current-state items ("A") with expected-change items ("B"), the instrument goes beyond describing present conditions to capture the anticipated evolution of the project environment.

It could also be argued that our findings provide empirical support for treating emergence as a distinct aspect of project complexity. Although the literature is divided on whether dynamic or emergent complexity should stand alone or be subsumed within structural and socio-political aspects, our results show a clear statistical separation: the "B" items consistently load together

and do not align with their corresponding “A” items, suggesting that respondents perceive emergence as a unique aspect of complexity rather than merely a feature of other dimensions. However, because each “B” item is a follow-up to the “A” items, conceptually they behave like a time-based layer on top of the other three factors (as per Figure 1). Our results can be read as consistent with both positions.

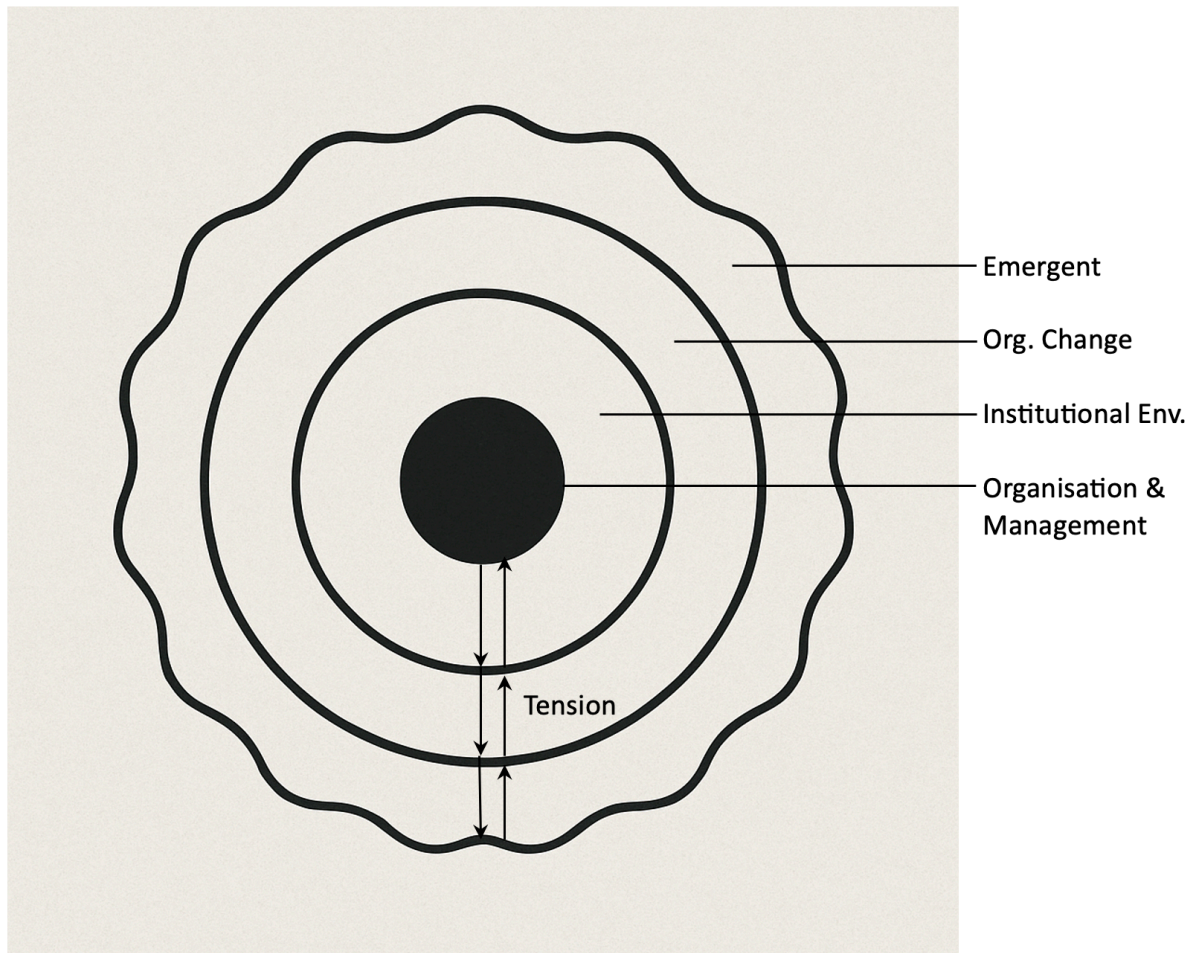


Figure 1. Nested factors

In summary, the four factors are consistent with existing frameworks but also simplify them. However, we do not interpret them as discrete or independent axes, as dimensions of complexity are often presented. Rather, they are ‘nested’, interdependent and mutually reinforcing, as illustrated in Figure 1. Organisation and Management sits closest to the project, capturing how structure, governance, resources and stakeholder alignment are experienced in a project team. This is embedded within the Institutional Environment, which constrains what

kinds of organisational arrangements, stakeholder networks and coordination mechanisms are possible (for example, through differences in location, language and time zone). Organisational Change cuts across these two levels: transformational projects are often driven by institutional pressures and, in turn, aim to reshape organisational structures, cultures and routines, changing the conditions reflected in Organisation and Management. Finally, Emergent complexity acts as a temporal layer across all three, capturing the extent to which these project, organisational and institutional conditions are expected to evolve over time.

These findings also help connect complexity to the range of managerial responses discussed by Maylor et al. (2013). In broad terms, Organisation and Management and Institutional Environment appear relatively “managerial” in nature: while they can be demanding, they are often at least partly addressable through strong fundamentals and deliberate coordination planning. Organisational Change aligns more closely with a “leader” response, where the core challenge is mobilising commitment and guiding adaptation. Emergent complexity, in contrast, points towards a more “entrepreneurial” stance: making sense of dynamism, acting under uncertainty, and adjusting course as conditions evolve. The key implication is therefore that the factor structure not only provides a more rigorous, survey-based picture of project professionals’ day-to-day challenges, but also helps explain why different projects call for different mixes of managerial discipline, leadership, and entrepreneurial action, rather than a single best approach to project management.

The contribution of this study is to turn this layered view into four empirically derived dimensions rooted in the existing literature. These dimensions remain practical for analysing how variations in complexity are linked to project outcomes and organisational responses. More broadly, the results support the view that “what makes a project complex” is closely tied to the kinds of responses available to practitioners: strengthening fundamentals where

complexity is managerial, leading change where complexity is transformational, and adopting more adaptive, sensemaking-oriented approaches where complexity is emergent.

Limitations

First, although Prolific allowed us to access working project professionals across multiple countries and sectors, the sample is not probability-based and is skewed towards Anglophone contexts (notably the UK and US), which may limit generalisability to non-English-speaking contexts and under-represented regions. Second, Emergent complexity is operationalised via paired A/B items with a six-month horizon; this design may encourage the B-items to cluster, so future work should test an “emergence-only” item set that does not rely on A/B pairing. Third, some factors show very high internal consistency (e.g. Emergent Complexity $\alpha = 0.974$), which may indicate item redundancy; scale shortening while preserving content coverage would improve practicality and may also strengthen model fit. Finally, although the CFA showed acceptable absolute fit (RMSEA = 0.055; SRMR = 0.064), incremental fit indices were below conventional thresholds (CFI = 0.78; TLI = 0.77), suggesting that further item refinement and alternative model specifications may be warranted. Accordingly, the four-factor solution should be treated as provisional pending replication and further validation.

Next Steps and Directions for Future Research

Building on these initial findings, several next steps would strengthen the measurement model and extend its contribution. First, further statistical validation should be undertaken using a new sample, including a confirmatory factor analysis (CFA) to test the stability of the four-factor structure and to evaluate alternative specifications. This phase should also assess discriminant validity and measurement stability across samples. It will be completed within the first quarter of 2026.

Second, the Emergent construct warrants targeted further development. A useful next step would be to redesign the emergence items so they can stand alone (i.e. without direct pairing to “A” statements), while retaining the core idea of anticipated change. This would also allow

clearer tests of whether emergence behaves as an independent dimension or as a temporal layer spanning other forms of complexity.

Looking beyond scale development, once validated, the four dimensions can be used as predictors in concurrent and longitudinal studies to examine their practical relevance. For example, this could be empirically examined by modelling the four factors as predictors of outcomes such as project performance, burnout, and team voice behaviour. Over time, this programme of research could translate the scale into more context-specific guidance: not only what makes a project complex, but what mix of managerial, leadership and adaptive approaches is most likely to be effective under different configurations of complexity.

6. Conclusion

This study set out to develop and provide an initial validation of a survey-based measurement model of perceived project complexity, grounded in Maylor et al.'s (2013) Complexity Assessment Tool (CAT) and informed by both descriptive and perceptual perspectives in the literature. Therefore, moving beyond face-valid groups. Using data from 382 project professionals across multiple sectors and countries, we identified a four-factor structure: organisation and management, institutional environment, organisational change and emergent complexity, that both aligns with established dimensions of project complexity and captures how practitioners experience complexity in practice.

The findings make three main contributions: First, they offer an empirically derived, psychometrically evaluated measurement model that goes beyond existing conversation aids and practitioner tools. The four dimensions are statistically defensible, interpretable in managerial terms, and suitable for use in subsequent quantitative research. Second, the results speak to long standing conceptual debates, particularly around emergence. The clustering of expected change items into a distinct factor suggest that practitioners experience emergent complexity as a separate, time-based aspect of difficulty, while its conceptual anchoring in

current state items supports viewing emergence as a temporal layer spanning other dimension. Third, the nested structure of the factors clarifies the links between sources of complexity and corresponding managerial responses. Organisation and management and institutional environment map onto more 'managerial' challenges, organisational change emphasises the need for leadership in transformation, and emergent complexity suggests more entrepreneurial, sensemaking orientated action under changing conditions. The model therefore supports a more context-specific view of how projects should be organised, as different complexity profiles require different responses. However, the study has limitations that underscore the provisional nature of the model. Future work will therefore focus on replication in new samples, refinement of the emergent complexity construct, and more extensive validation. Overall, the study advances efforts to measure project complexity in new ways that are both academically robust and practically meaningful. It provides a foundation for further research, more consistent complexity assessment on projects and more nuanced, context specific approaches to project organising.

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Appendix A – Final 50 items (A questions only) and their alignment with Maylor et al's (2013) items

Final 50 Items included in the Research Study	Maylor et al's (2013) items
<i>Items theorised as Structural Complexity</i>	
ST01 The vision for the project is clearly articulated.	1 The vision and benefits for the work can be clearly articulated.
ST02 The benefits of the project are clearly understood.	2 The vision and benefits for the work can be clearly articulated.
ST03 Success measures for the project are defined in agreement with the client.	2 Success measures for the work can be defined in agreement with the client.
ST04 The technology is not familiar to my project team. (-)	3 The technology is familiar to us.
ST05 The commercial arrangements are familiar to my project team.	4 The commercial arrangements are familiar to us.
ST06 The scope is well defined.	5 The scope can be well defined.
ST07 Acceptance criteria for quality requirements are well defined.	6 Acceptance criteria for quality and regulatory requirements can be well defined.
ST08 Regulatory requirements are well defined.	6 Acceptance criteria for quality and regulatory requirements can be well defined.
ST09 A schedule and resource plan are well defined.	7 A schedule and resource plan can be well defined.
ST10 The supply chain is in place.	8 The supply chain is in place.
ST11 Lines of responsibility for tasks and deliverables are defined.	9 Lines of responsibility for tasks and deliverables can be defined.
ST12 Accurate data reporting is not possible. (-)	10 Accurate, timely, and comprehensive data reporting is possible.
ST13 Timely data reporting is possible.	10 Accurate, timely, and comprehensive data reporting is possible.
ST14 Comprehensive data reporting is possible.	10 Accurate, timely, and comprehensive data reporting is possible.
ST15 Existing management tools can support the project.	11 Existing management tools can support the work.
ST16 Sufficient people with the right skills are available.	12 Sufficient people with the right skills are available.
ST17 Managers have adequate control of human resources.	13 Managers have adequate control of human resources (i.e., direct reporting).
ST18 Key people are wholly allocated to the project.	14 Key people are wholly allocated to the work.
ST19 Integration across multiple technical disciplines is required. (-)	15 Integration across multiple technical disciplines is not required.
ST20 The budget is not sufficient for the project. (-)	16 The budget is sufficient for the task.

Final 50 Items included in the Research Study	Maylor et al's (2013) items
ST21 The budget can be used flexibly.	17 The budget can be used flexibly.
ST22 Differences in country location create challenges for this project. (-)	18 The work will be carried out in a single country/time zone/language/currency.
ST23 Differences in time zones create challenges for this project. (-)	18 The work will be carried out in a single country/time zone/language/currency.
ST24 Differences in spoken languages create challenges for this project. (-)	18 The work will be carried out in a single country/time zone/language/currency.
ST25 Differences in monetary currencies create challenges for this project. (-)	18 The work will be carried out in a single country/time zone/language/currency.
ST26 The project is independent of other projects .	19 The work is independent of other projects and business-as-usual operations.
ST27 The project is independent of business-as-usual operations.	19 The work is independent of other projects and business-as-usual operations.
ST28 The schedule is not achievable. (-)	20 The pace is achievable.
ST29 The pace is achievable.	20 The pace is achievable.
ST30 Non-human resources (e.g. equipment, test facilities) are available when needed.	21 Resources (e.g., test facilities, equipment) will be available when needed.
<i>Items theorised as Socio-political Complexity</i>	
SP01 The project sponsorship provides appropriate support.	22 The work has clear sponsorship consistent with its importance.
SP02 The business case for the project is clear.	23 The business case for the work is clear.
SP03 The project's strategy aligns with the organization's strategy.	24 The goals for the work align with the organization's strategy.
SP04 Your own senior management actively supports the project.	25 Your own senior management supports the work.
SP05 Team members are motivated.	26 Team members are motivated and function well as a team.
SP06 Team members function well as a team.	26 Team members are motivated and function well as a team.
SP07 The team has experience with this kind of project.	27 Managers are experienced in this kind of work.
SP08 You have experience with this kind of project.	27 Managers are experienced in this kind of work.
SP09 Managers have experience with this kind of project	27 Managers are experienced in this kind of work.

Final 50 Items included in the Research Study	Maylor et al's (2013) items
SP10 The project involves no significant organizational change.	28 The work involves no significant organizational/cultural change.
SP11 The project involves no significant organizational culture change.	28 The work involves no significant organizational/cultural change.
SP12 The project is affected by significant organizational change. (-)	29 The work will be unaffected by significant organizational/cultural change.
SP13 The project is affected by significant organizational culture change. (-)	29 The work will be unaffected by significant organizational/cultural change.
SP14 The key external stakeholders are aligned to the project.	30 The external stakeholders (i.e., not immediate team members) are aligned, supportive, and committed to the project and have sufficient time for the work.
SP15 The key external stakeholders are supportive of the project.	30 The external stakeholders (i.e., not immediate team members) are aligned, supportive, and committed to the project and have sufficient time for the work.
SP16 The key external stakeholders are not committed to the project. (-)	30 The external stakeholders (i.e., not immediate team members) are aligned, supportive, and committed to the project and have sufficient time for the work.
SP17 The key external stakeholders have sufficient time for the project.	30 The external stakeholders (i.e., not immediate team members) are aligned, supportive, and committed to the project and have sufficient time for the work.
SP18 The key external stakeholders do not have a realistic understanding of the implications of the project. (-)	31 The external stakeholders (i.e., not immediate team members) have a realistic, shared understanding of the implications of the work.
SP19 The key external stakeholders have a shared understanding of the implications of the project.	31 The external stakeholders (i.e., not immediate team members) have a realistic, shared understanding of the implications of the work.
SP20 The core team has the authority to make decisions.	32 The core team has the authority to make decisions.

Note. (-) indicates items we intentionally reverse coded.

Appendix B – Final 4-Factor Solution with 87 items

Item	1.Emergent Complexity	2. Organisation and Management	3. Institutional Environment	4. Organisational Change
ST08B How do you expect this to change in the next 6 months? (Regulatory requirements are well defined)	0.762			
ST01B How do you expect this to change in the next 6 months? (The vision for the project is clearly articulated)	0.759			
SP20B How do you expect this to change in the next 6 months? (The core team has the authority to make decisions.)	0.757			
SP17B How do you expect this to change in the next 6 months? (The key external stakeholders have sufficient time for the project.)	0.744			
SP02B How do you expect this to change in the next 6 months? (The business case for the project is clear.)	0.742			
ST03B How do you expect this to change in the next 6 months? (Success measures for the project are defined in agreement with the client.)	0.741			
ST06B How do you expect this to change in the next 6 months? (The scope is well defined.)	0.726			
SP04B How do you expect this to change in the next 6 months? (Your own senior management actively supports the project.)	0.726			
SP14B How do you expect this to change in the next 6 months? (The key external stakeholders are aligned to the project.)	0.725			
ST16B How do you expect this to change in the next 6 months? (Sufficient people with the right skills are available.)	0.722			
ST11B How do you expect this to change in the next 6 months? (Lines of responsibility for tasks and deliverables are defined.)	0.721			
ST09B How do you expect this to change in the next 6 months? (A schedule and resource plan are well defined.)	0.717			
ST05B How do you expect this to change in the next 6 months? (The commercial arrangements are familiar to my project team.)	0.716			

Item	1.Emergent Complexity	2. Organisation and Management	3. Institutional Environment	4. Organisational Change
SP01B How do you expect this to change in the next 6 months? (The project sponsorship provides appropriate support.)	0.715			
ST21B How do you expect this to change in the next 6 months? (The budget can be used flexibly.)	0.714			
ST02B How do you expect this to change in the next 6 months? (The benefits of the project are clearly understood)	0.708			
SP03B How do you expect this to change in the next 6 months? (The project's strategy aligns with the organization's strategy.)	0.707			
ST18B How do you expect this to change in the next 6 months? (Key people are wholly allocated to the project.)	0.704			
ST10B How do you expect this to change in the next 6 months? (The supply chain is in place.)	0.697			
SP19B How do you expect this to change in the next 6 months? (The key external stakeholders have a shared understanding of the implications of the project.)	0.696			
SP15B How do you expect this to change in the next 6 months? (The key external stakeholders are supportive of the project.)	0.696			
ST07B How do you expect this to change in the next 6 months? (Acceptance criteria for quality requirements are well defined)	0.687			
SP05B How do you expect this to change in the next 6 months? (Team members are motivated.)	0.683			
ST29B How do you expect this to change in the next 6 months? (The pace is achievable.)	0.68			
ST26B How do you expect this to change in the next 6 months? (The project is independent of other projects)	0.679			
ST15B How do you expect this to change in the next 6 months? (Existing management tools can support the project.)	0.678			
ST30B How do you expect this to change in the next 6 months? (Non-human resources (e.g. equipment, test facilities) are available when needed.)	0.674			

Item	1.Emergent Complexity	2. Organisation and Management	3. Institutional Environment	4. Organisational Change
ST17B How do you expect this to change in the next 6 months? (Managers have adequate control of human resources)	0.674			
SP07B How do you expect this to change in the next 6 months? (The team has experience with this kind of project)	0.670			
ST19B How do you expect this to change in the next 6 months? (Integration across multiple technical disciplines is required (-))	0.661			
ST27B How do you expect this to change in the next 6 months? (The project is independent of business-as-usual operations.)	0.653			
ST20B How do you expect this to change in the next 6 months? (The budget is not sufficient for the project. (-))	0.652			
SP06B How do you expect this to change in the next 6 months? (Team members function well as a team.)	0.643			
SP09B How do you expect this to change in the next 6 months? (Managers have experience with this kind of project.)	0.635			
ST12B How do you expect this to change in the next 6 months? (Accurate data reporting is not possible. (-))	0.629			
SP12B How do you expect this to change in the next 6 months? (The project is affected by significant organizational change. (-))	0.626			
SP13B How do you expect this to change in the next 6 months? (The project is affected by significant organizational culture change.)	0.600			
ST25B How do you expect this to change in the next 6 months? (Differences in monetary currencies create challenges for this project.)	0.591			
ST14B How do you expect this to change in the next 6 months? (Comprehensive data reporting is possible.)	0.590			
ST24B How do you expect this to change in the next 6 months? (Differences in spoken languages create challenges for this project.)	0.588			
ST22B How do you expect this to change in the next 6 months? (Differences in country locations create challenges for this project.)	0.581			

Item	1.Emergent Complexity	2. Organisation and Management	3. Institutional Environment	4. Organisational Change
ST28B How do you expect this to change in the next 6 months? (The schedule is not achievable. (-))	0.581			
ST13B How do you expect this to change in the next 6 months? (Timely data reporting is possible.)	0.574			
SP16B How do you expect this to change in the next 6 months? (The key external stakeholders are not committed to the project.)	0.560			
SP18B How do you expect this to change in the next 6 months? (The key external stakeholders do not have a realistic understanding of the implications of the project.)	0.552			
SP10B How do you expect this to change in the next 6 months? (The project involves no significant organizational change.)	0.540			
ST23B How do you expect this to change in the next 6 months? (Differences in time zones create challenges for this project.)	0.532			
SP08B How do you expect this to change in the next 6 months? (You have experience with this kind of project.)	0.511			
SP11B How do you expect this to change in the next 6 months? (The project involves no significant organizational culture change.)	0.507			
ST04B How do you expect this to change in the next 6 months? (The technology is not familiar to my project team.)	0.450			
ST06A The scope is well defined.		0.765		
ST09A Both the schedule and resource plan are well defined.		0.741		
ST02A The benefits of the project are clearly understood.		0.703		
ST01A The vision for the project is clearly articulated.		0.701		
ST07A Acceptance criteria for quality requirements are well defined.		0.690		
SP02A The business case for the project is clear.		0.655		
ST11A Lines of responsibility for tasks and deliverables are defined.		0.645		
SP14A The key external stakeholders are aligned to the project.		0.643		

Item	1.Emergent Complexity	2. Organisation and Management	3. Institutional Environment	4. Organisational Change
SP19A The key external stakeholders have a shared understanding of the implications of the project. (-)		-0.62		
ST15A Existing management tools can support the project.		0.619		
ST16A Sufficient people with the right skills are available.		0.599		
SP15A The key external stakeholders are supportive of the project.		0.598		
ST17A Managers have adequate control of human resources.		0.588		
ST05A The commercial arrangements are familiar to my project team.		0.583		
SP01A The project sponsorship provides appropriate support.		0.573		
ST08A Regulatory requirements are well defined.		0.573		
SP05A Team members are motivated.		0.570		
ST14A Comprehensive data reporting is possible.		0.565		
SP09A Managers have experience with this kind of project.		0.555		
ST18A Key people are wholly allocated to the project.		0.544		
SP07A The team has experience with this kind of project.		0.539		
ST13A Timely data reporting is possible.		0.530		
ST29A The pace is achievable.		0.528		
SP04A Your own senior management actively supports the project.		0.526		
SP06A Team members function well as a team.		0.507		
SP17A The key external stakeholders have sufficient time for the project.		0.507		
ST03A Success measures for the project are defined in agreement with the client.		0.503		
ST10A The supply chain is in place.		0.502		
SP20A The core team has the authority to make decisions.		0.485		
ST12A Accurate data reporting is not possible. (-)		0.482		
SP03A The project's strategy aligns with the organization's strategy.		0.440		
ST20A The budget is not sufficient for the project.(-)		0.433		
ST28A The schedule is not achievable. (-)		0.427		

Item	1.Emergent Complexity	2. Organisation and Management	3. Institutional Environment	4. Organisational Change
SP16A The key external stakeholders are not committed to the project. (-)		0.406		
ST22A Differences in country locations create challenges for this project. (-)			0.705	
ST24A Differences in spoken languages create challenges for this project. (-)			0.675	
ST23A Differences in time zones create challenges for this project. (-)			0.547	
ST25A Differences in monetary currencies create challenges for this project. (-)			0.487	
SP13A The project is affected by significant organizational culture change. (-)				0.668
SP10A The project involves no significant organizational change.				0.600
SP12A The project is affected by significant organizational change. (-)				0.599
SP11A The project involves no significant organizational culture change.				0.592

Note. (-) indicates reverse coded items. "B" items are shown with the text of their corresponding "A" items for clarity.



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Towards a statistically validated model of perceived project complexity

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