Designing Integrated Multi-Role Survey Instruments for Systemic Risk Assessment Engineering Workplaces: A Framework for Branching-Logic Survey Development

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Abstract

Diverse, interdependent roles characterise engineering workplaces, creating complex pathways for risk propagation that are difficult to capture with standard safety climate surveys. Yet, many survey instruments treat the workforce as a homogeneous population or rely on siloed, role-specific tools. This paper presents a methodological framework for designing integrated multi-role survey instruments using a converge–diverge–reconverge architecture supported by branching logic.

The framework combines front-loaded universal modules to enable cross-role comparison, role-specific modules delivered through branching to capture functional depth and concluding universal modules to re-anchor responses at the organisational level. Survey architecture, sequencing decisions, and branching logic are documented as methodological contributions, with explicit attention to respondent burden, completion-time parity, and analytical integrity. The framework is demonstrated through the design and deployment of a global engineering workplace survey.

Rather than reporting empirical findings, the paper focuses on instrument design, transparency, and reusability. A validation pathway is outlined to support subsequent empirical analysis while maintaining a clear separation between design and results.

The framework provides practical guidance for researchers seeking to study systemic workplace phenomena across diverse engineering roles and is transferable to other complex, multi-role organisational contexts. Complete replication materials are provided to support methodological transparency and enable adaptation by different research teams.

Keywords: Sociotechnical Systems; Systemic Risk; Survey Methodology; Multi-Role Measurement; Branching Logic; Safety Culture Assessment; Converge-Diverge-Reconverge Design.

1. Introduction

1.1 The challenge of multi-role workplace research in engineering

Engineering work is inherently multi-role (Ayres et al., 2025a; Davies and Mackenzie, 2014; Winch, 2010). Design, construction, commissioning, operations, maintenance, planning, commercial, health and safety, and leadership functions each contribute distinct expertise to the delivery and operation of engineered systems (Davies and Mackenzie, 2014; Winch, 2010). While these roles are interdependent, they experience workplace pressures in markedly different ways, shaped by role-specific responsibilities, accountability structures, and temporal proximity to risk and consequence (Hollnagel, 2018; Weick and Sutcliffe, 2007; Woods, 2006).

Despite this diversity, much empirical research into engineering workplaces relies on instruments that treat the workforce as a homogeneous population (Ayres et al., 2025b; Fouad et al., 2017; Tynjälä, 2008). Generic workplace surveys can identify broad trends in job satisfaction, workload, or wellbeing, but frequently fail to capture the role-specific mechanisms through which organisational pressures are enacted in practice (Detert and Edmondson, 2011; Hussain et al., 2019; Nembhard and Edmondson, 2006). Conversely, highly targeted role-specific instruments—such as safety culture surveys, operational reliability assessments, or project management audits—provide depth within individual functions but prevent meaningful comparison across roles (Davies and Mackenzie, 2014; Haas et al., 2020; Swuste, 2010).

This methodological tension creates a persistent blind spot in engineering workplace research (Hood et al., 2004; Turner and Pidgeon, 1997). Organisational outcomes such as cost escalation, schedule delay, safety incidents, and workforce attrition are rarely attributable to a single role (Davies and Mackenzie, 2014; Weick and Sutcliffe, 2007; Winch, 2010). Instead, they emerge from interactions across roles, where pressures propagate, shift, and compound as work progresses through the project or asset lifecycle (Carlile, 2004; Hollnagel, 2018; Woods, 2006). Understanding these dynamics requires instruments capable of capturing both shared organisational conditions and their differentiated manifestation across roles (Carlile, 2004; Detert and Edmondson, 2011; Nembhard and Edmondson, 2006).

1.2 Systemic pressures and role-specific manifestations

Workplace pressure in engineering is best understood as a systemic phenomenon. Schedule pressure, for example, does not originate or terminate within a single function (Austin, 2025; Lant and Argote, 2000; Weick and Sutcliffe, 2007). The same organisational imperative to meet milestones may manifest as accelerated verification and acceptance during commissioning, deferred maintenance in operations, constrained risk tolerances in health and safety roles, or optimistic forecasting within planning and project controls (Anteby and Chan, 2018; Asdal, 2015; Leroy and Glomb, 2018; Woods, 2006). Each manifestation reflects local decision-making under pressure, yet all contribute to shared organisational outcomes (Akrich, 1992; Carlile, 2004).

Existing survey approaches struggle to represent this complexity. Instruments designed to measure universal constructs often lack the granularity required to detect how pressures are experienced and acted upon within specific roles. In contrast, role-specific surveys may capture detailed practices but isolate those practices from the broader organisational context in which they occur. As a result, researchers are frequently forced to choose between comparability and specificity.

An integrated approach is therefore required—one that recognises workplace pressure as a shared organisational condition while allowing for targeted measurement of role-specific experiences, behaviours, and consequences.

1.3 Limitations of existing survey approaches

The methodological limitations of existing engineering workplace surveys are well documented (Fouad et al., 2017; Tynjälä, 2008). Many instruments prioritise brevity and generalisability, resulting in role-blind measures that obscure important functional differences (Detert and Edmondson, 2011; Nembhard and Edmondson, 2006). Others adopt a siloed approach, focusing narrowly on individual disciplines or professional groups, which restricts cross-role analysis and limits organisational insight (Haas et al., 2020).

While branching logic and adaptive survey designs are well established in fields such as health and clinical research, their application within engineering workplace studies remains limited and inconsistently reported (Callegaro et al., 2015; Couper, 2011; Tourangeau et al., 2013). Where branching is used, it is often treated as a technical convenience rather than a deliberate methodological strategy, with little guidance provided on how such designs can preserve comparability while enabling depth (Callegaro et al., 2015; Couper, 2011; Tourangeau et al., 2013).

Consequently, there is a lack of validated, transparent frameworks to guide the design of multi-role survey instruments capable of capturing systemic workplace phenomena without fragmenting the dataset or overburdening respondents (Asdal, 2015; Carlile, 2004).

1.4 Purpose and contribution of this paper

This paper addresses this gap by presenting a structured methodological framework for designing integrated multi-role survey instruments in engineering contexts. Rather than reporting empirical findings, the paper focuses explicitly on instrument architecture, sequencing, and branching logic as methodological contributions.

The framework is demonstrated through the design and deployment of a global engineering workplace pressure survey incorporating universal core modules and role-specific branches. The instrument was intentionally structured to preserve cross-role comparability while enabling targeted exploration of role-dependent pressures and practices. At the time of submission, the survey was live and actively collecting responses.

The contributions of this paper are threefold. First, it provides a replicable design framework for researchers seeking to study systemic workplace phenomena across diverse engineering roles. Second, it documents practical design strategies—including sequencing and branching decisions—used to manage respondent burden while protecting analytical integrity. Third, it outlines a validation pathway to support subsequent empirical analysis without conflating design and results.

Consistent with established survey methodology, this paper deliberately separates instrument design from empirical validation, documenting the architecture before analysis to avoid post hoc modification of measurement tools (Callegaro et al., 2015; Tourangeau et al., 2013).

1.5 Paper structure

The remainder of the paper is structured as follows. Section 2 reviews existing approaches to workplace survey design in engineering and related fields, highlighting methodological challenges associated with role diversity and comparability. Section 3 details the instrument design methodology, including the theoretical framing, survey architecture, and branching-logic implementation. Section 4 outlines the planned validation approach and response quality considerations. Section 5 discusses the methodological implications and broader applicability of the framework, and Section 6 concludes by summarising the contribution and outlining future research directions.

2. Methodology

2.1 Workplace survey methods in engineering contexts

Survey-based research has long been used to investigate workplace conditions in engineering, including job satisfaction, organisational culture, safety climate, and psychological wellbeing (Fouad et al., 2017; Tynjälä, 2008). These instruments have provided valuable insights into broad trends affecting the engineering workforce, particularly regarding workload, safety performance, and retention (Detert and Edmondson, 2011; Nembhard and Edmondson, 2006).

However, many established workplace surveys adopt a role-agnostic approach, implicitly treating engineering organisations as homogeneous populations (Fouad et al., 2017; Tynjälä, 2008). While this enables large-scale comparison, it often obscures meaningful differences in how pressures are experienced and enacted across distinct functional roles. In engineering contexts—where responsibility, authority, and proximity to risk vary substantially by role—this limitation constrains the explanatory power of survey findings.

Conversely, role-specific instruments are commonly employed within subdomains such as safety culture, operational reliability, or project management (Haas et al., 2020; Swuste, 2010). These tools provide detailed insight into specific functions but are typically designed in isolation, limiting their ability to support cross-role comparisons or system-level analysis.

2.2 The importance of role in engineering workplace research

Role is a critical determinant of how organisational pressures are perceived, negotiated, and acted upon in engineering workplaces (Argyris, 1990; Argyris and Schön, 1978). Differences in decision authority, temporal exposure to risk, and accountability structures shape not only what pressures are experienced, but also how those pressures translate into practice (Hollnagel, 2018; Weick and Sutcliffe, 2007).

For example, schedule pressure may lead to accelerated verification and acceptance within commissioning roles, deferred maintenance decisions in operations, constrained risk tolerances in health and safety functions, or optimistic forecasting within planning and project controls (Leroy and Glomb, 2018; Woods, 2006). Each response reflects a localised adaptation to shared organisational demands, yet traditional survey approaches rarely capture these differentiated pathways within a single instrument.

Role-blind measurement risks flattening these dynamics, while siloed role-specific instruments fragment understanding across organisational boundaries. This tension highlights the need for methodological approaches that explicitly account for role diversity while preserving analytical coherence.

2.3 Branching logic and adaptive survey design

Branching logic, also referred to as adaptive or skip-logic survey design, has been widely adopted in fields such as health, clinical research, and social sciences to tailor question pathways based on respondent characteristics or prior responses (Couper, 2011; Tourangeau et al., 2013). These approaches are commonly used to reduce respondent burden, improve engagement, and enhance the relevance of survey content.

Within organisational research, branching logic has been applied selectively, often as a technical convenience rather than as a central methodological strategy (Couper, 2011). In many cases, branching is used to filter out inapplicable demographic questions or optional modules, with limited discussion of its implications for comparability, data structure, or analytical integrity.

In engineering workplace research, explicit methodological guidance on the use of branching logic remains limited. Where adaptive designs are employed, they are rarely documented in sufficient detail to support replication or reuse, and sequencing decisions are seldom justified in relation to fatigue, attrition, or comparative analysis.

2.4 Integrated multi-role measurement: current gaps

A small number of studies have attempted to capture multiple engineering roles within a single survey instrument; however, these efforts often rely on parallel role-specific surveys or post hoc role stratification during analysis (Fouad et al., 2017; Tynjälä, 2008). Such approaches can introduce measurement inconsistencies and limit the interpretability of cross-role comparisons.

Critically, there remains a lack of published frameworks that address how universal constructs and role-specific content can be integrated within a single instrument without compromising either depth or comparability (Asdal, 2015; Carlile, 2004). Existing literature provides limited guidance on sequencing, branching architecture, or strategies for managing respondent burden in multi-role engineering contexts.

This gap is methodological rather than theoretical (Argyris, 1990; Lant and Argote, 2000). While the importance of role diversity is widely acknowledged, practical approaches for designing instruments that operationalise this diversity in a transparent and replicable manner are underdeveloped.

2.4.1 Comparison with existing approaches

Table 1 summarises common approaches to multi-role measurement in engineering workplace research. Generic surveys achieve comparability by treating workforces as homogeneous but sacrifice role-specific depth. Role-specific instruments provide functional detail but fragment analysis. Parallel role surveys introduce comparability concerns due to differences in items. Post hoc role stratification preserves comparability but lacks targeted measurement of role-dependent phenomena. While adaptive designs using branching logic are used in health research, their use in engineering applications remains limited and inconsistently documented (Callegaro et al., 2015; Tourangeau et al., 2013). The present framework addresses this by providing explicit architectural documentation, treating design decisions as methodological contributions that require transparent reporting.

Table 1 Comparison of multi-role measurement approaches in workplace survey research

Approach	Role Handling	Branching Used?	Sequencing Documented?	Completion Parity Considered?	Replicability
Generic workplace surveys	Role-agnostic (homogeneous)	No	N/A	Yes (single path)	High (lacks depth)
Role-specific instruments	Siloed (separate by role)	No	N/A	N/A (separate surveys)	High within role (no cross-role)
Parallel role surveys	Multiple versions deployed	No (separate)	Rarely	No (different lengths)	Moderate (comparability issues)
Post hoc stratification	Universal + role as demographic	No	N/A	Yes (single path)	High (lacks depth)
Adaptive health surveys	Individual-level routing	Yes	Sometimes	Varies	Moderate-High (depends)
Present framework	Integrated universal + role-specific	Yes	Yes (explicit)	Yes (constraint)	High (documented)

Note: This comparison synthesises common approaches identified through review of engineering workplace survey literature (Section 2). Assessment reflects typical implementation patterns rather than individual studies.

2.5 Positioning the present study

This paper responds to documented gaps (Table 1) by focusing on survey architecture as a replicable contribution. While branching logic is established in health research, engineering workplace applications lack architectural transparency for replication (Callegaro et al., 2015; Tourangeau et al., 2013). Where role differentiation is attempted, sequencing decisions, branching rationale, and completion parity strategies are unreported or mentioned only in passing. The gap is not in the existence of branches but in the transparency of documentation. By documenting the rationale, structure, and implementation of an integrated multi-role instrument, this paper provides practical guidance for researchers studying systemic workplace phenomena. The following section details the instrument design methodology.

3. Instrument Design Methodology

3.1 Design principles

The survey instrument was designed around four explicit principles intended to balance analytical rigour, respondent burden, and practical deployability across diverse engineering roles.

First, a universal measurement foundation was established through a set of core constructs administered to all respondents. These constructs were selected to capture organisational conditions and experiences expected to be shared across roles, including workplace pressure, peer influence, organisational context, and psychological outcomes. This universal foundation enables direct comparison across roles and supports system-level analysis.

Second, role-specific depth was achieved through targeted modules delivered via branching logic. These modules were designed to capture pressures, practices, and decision contexts unique to particular engineering roles, without requiring respondents to engage with irrelevant questions outside their functional domain.

Third, comparative integrity was treated as a primary design constraint. Universal modules were deliberately positioned at the front of the instrument before any role-specific branching. This sequencing ensured that all respondents completed the core comparative measures, safeguarding cross-role analyses even in the event of partial completion or later-stage fatigue.

Finally, respondent burden control was embedded in the instrument's architecture. Branching logic was used to limit survey length and prevent exposure to irrelevant role-specific content (Callegaro et al., 2015; Tourangeau et al., 2013). Completion time parity across roles (approximately 10–15 minutes) was treated as an explicit design requirement rather than an incidental outcome.

3.2 Conceptual framing

The instrument is grounded in a systemic view of workplace pressure within engineering organisations (Hollnagel, 2018; Weick and Sutcliffe, 2007). Rather than treating pressure as an individual-level attribute, the design conceptualises it as an organisational condition that manifests differently across roles depending on proximity to risk, authority, and operational consequence (Rasmussen, 1997).

Peer influence and team norms are treated as cross-cutting mechanisms that mediate how organisational pressures are interpreted and acted upon (Edmondson, 1999). Organisational culture and leadership context provide a shared backdrop within which role-specific behaviours emerge (Perrow, 2011; Thorndike, 1995). Role, in this framework, functions as a moderator of experience rather than as a siloed category.

This framing informed both the selection of universal constructs and the development of role-specific modules, ensuring conceptual coherence across the instrument while allowing targeted exploration of localised pressures.

3.3 Instrument structure

The survey instrument comprises two primary components: (1) universal modules completed by all respondents, and (2) role-specific modules delivered through branching logic based on self-identified primary role.

3.3.1 Universal modules

All respondents completed a standard set of modules before any role-specific branching. These modules were positioned at the front of the instrument to preserve comparability and analytical integrity under partial completion conditions.

The universal modules included:

- **Demographics and work context**, capturing age range, gender, education level, country or region of work, discipline or functional area, industry sector, work setting, employment type, team size, and career intentions.
- **Workplace pressure** is measured using a five-item scale addressing unrealistic expectations, role expansion, peer judgment, treatment of mistakes, and pressure to work beyond contracted hours.
- **Delay and cost attribution**, capturing respondents' perceptions of which groups and systemic processes most commonly contribute to project delays or cost increases.
- **Psychological outcomes**, including perceived overwhelm, anxiety related to work expectations, autonomy, and overall well-being.
- **Peer influence and team culture**, measured through items assessing conformity pressure, behavioural influence of colleagues, hesitation to challenge decisions, and groupthink dynamics.
- **Peer pressure impacts on quality and delivery**, capturing self-reported experiences of quality compromise, process bypassing, informal scope changes, defect manipulation, risk acceptance, and rework.
- **Organisational context**, assessing leadership support, communication openness, treatment of mistakes, and encouragement of independence and initiative.

Likert-type response formats were used throughout, with scale anchors selected to balance sensitivity and respondent clarity. "Not applicable" options were included where appropriate to avoid forced responses.

3.3.2 Role-specific modules

After completing the universal modules, respondents were routed to role-specific question sets based on their self-identified primary role. Role identification was used exclusively as a routing mechanism rather than as a measured construct.

Seven role-specific modules were developed:

- **Commissioning and start-up**, focusing on schedule-driven verification pressure, defect severity downgrading, premature close-out, permit and authorisation bypassing, documentation incompleteness, out-of-sequence execution, risk acceptance, operational readiness concerns, and recognition of commissioning as a high-risk phase.

- **Operations and maintenance**, addressing pressure to operate with known defects, maintenance deferral, operation outside recommended limits, fast-tracking or skipping work, and incomplete sign-offs.
- **Planning, scheduling, and project controls**, examining forecast manipulation, external pressure on reporting, discouragement of delay disclosure, and prioritisation of milestones over realism.
- **Commercial, contracts, and procurement**, capturing the influence of contractual deadlines, milestone payments, documentation acceptance, variation suppression, and sources of commercial pressure.
- **Health, safety, and environment (HSE/WHS)**, focusing on premature sign-off, superficial risk assessment, pressure-driven risk acceptance, resistance to safety concerns, and exclusion from early planning.
- **Leadership and management**, capturing team size and supervisory scope to contextualise responses within the universal modules.
- **Other roles** (including design engineering, project management, technical specialists, and early-career roles) bypassed role-specific modules and proceeded directly to the universal sections.

The length of role-specific modules varied by role but was designed to align with the overall completion-time parity objective.

The overall survey architecture followed a converge–diverge–reconverge structure. All respondents first completed a set of universal modules designed to support cross-role comparison. Participants were then routed to role-specific modules via branching logic based on primary role. After completing role-specific content, all respondents were rerouted to a final set of universal questions before survey completion. These concluding items were designed to re-establish a shared organisational frame, capture overarching perceptions, and provide a consistent closing experience across roles.

Role identification was treated as a pragmatic routing variable rather than a latent construct, such that any misclassification affects role-specific depth rather than the integrity of cross-role comparative analyses.

3.3.3 Module length and role selection rationale

Seven role-specific modules were developed with varying question counts based on pressure complexity. Commissioning and start-up (20 items, Q21-40) received the most extensive module, reflecting high-risk, time-compressed commissioning work. Operations and maintenance (7 items, Q41-47) and HSE/WHS (7 items, Q58-64) addressed ongoing operational and safety oversight pressures. Planning and scheduling (5 items, Q48-52) and commercial roles (5 items, Q53-57) received shorter modules reflecting narrower pressure domains. Leadership roles (1 item, Q65) received only a supervisory scope question, as workplace pressures were captured through universal modules.

The overall survey architecture is conceptually represented in Figure 1. The structure follows a converge–diverge–reconverge pattern, analogous to a tree where universal modules form both the foundational roots and the encompassing canopy. At the same time, role-specific branches capture differentiated functional experiences.

All respondents begin with universal modules (the roots), which establish shared constructs and enable cross-role comparability. Participants then diverge into role-specific branches—Commissioning, Operations, Planning, HSE/WHS, and others—each capturing the functional depth and differentiated experiences unique to that role. Following role-specific content, all respondents reconverge to complete final universal modules (the canopy), which re-anchor responses at the organisational level through reflection on organisational context, peer influence, and workplace outcomes.

This architecture ensures that every respondent completes identical universal measures while experiencing only the role-specific content relevant to their function, balancing analytical integrity with control of respondent burden.

Specific roles—design engineering, project management, technical specialists, construction, trades, graduate engineers, and academic roles—were routing options without dedicated role-specific modules. These respondents proceeded directly from role selection (Q20) to universal reconverge modules (Q66-100). This reflected two considerations: substantial heterogeneity within categories made it difficult to identify relevant items consistently, and the primary research focus was on roles directly exposed to schedule-driven pressures during commissioning, operations, and delivery.

Role categories were informed by literature review, practitioner consultation, and the research team's professional experience. Categories align with standard functional divisions while maintaining granularity to capture distinct pressure pathways.

Despite variation in role-specific module length (0-20 items), completion time parity across pathways was maintained at approximately 10–15 minutes. Branching architecture ensured respondents with longer role-specific modules completed fewer non-applicable questions, while those with shorter or no role-specific modules moved quickly to reconverge. Completion time parity was an explicit design constraint, ensuring equitable respondent burden and minimising differential attrition by pathway.

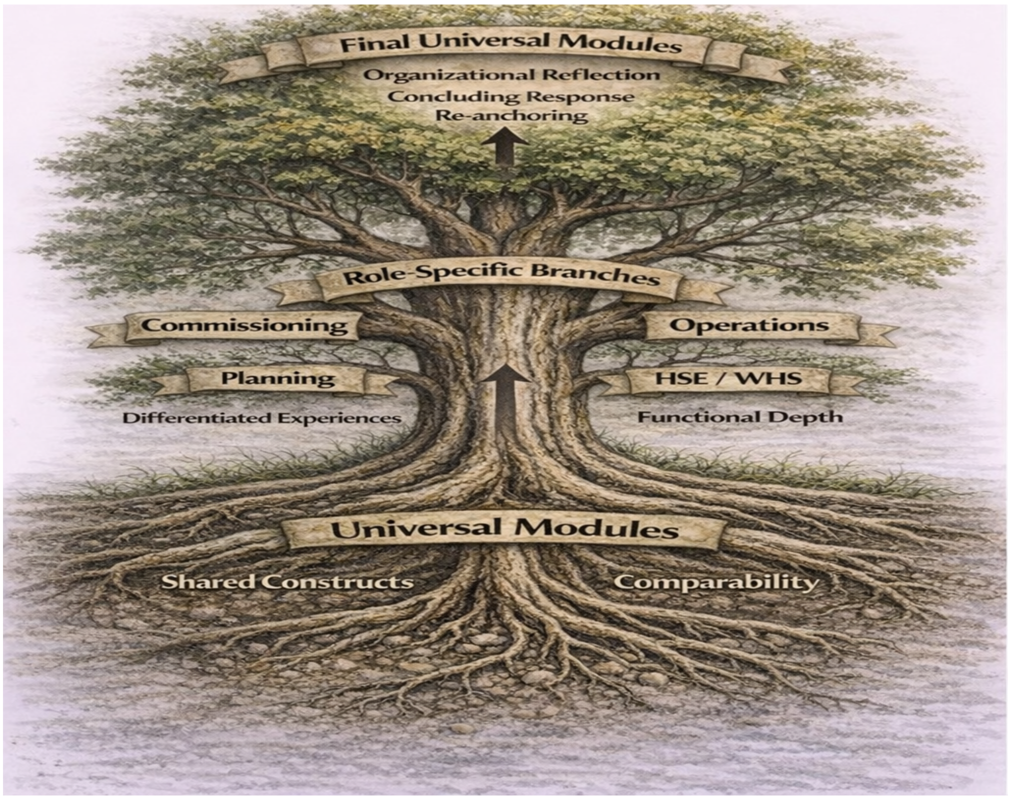


Figure 1. Conceptual representation of the converge–diverge–reconverge survey architecture

Universal modules (roots and canopy) provide a shared measurement foundation and organisational re-anchoring. Role-specific branches provide functional depth by exposing targeted modules via branching logic. All pathways maintain completion despite time parity through varying module lengths.

3.4 Branching logic implementation

The instrument was implemented using Google Forms, selected for its stable skip-logic functionality, device accessibility, and suitability for anonymous data collection in a global context. Role selection served as the sole branching variable, directing respondents to relevant role-specific modules after completion of the universal sections.

Primary comparative constructs were positioned exclusively within the front-loaded universal modules, thereby limiting any role-priming effects in cross-role analyses.

All branching paths were tested before deployment to ensure correct routing and to confirm that universal modules were consistently completed before any role-specific items were presented. This architecture ensured that no respondent was exposed to irrelevant role-specific questions, thereby substantially reducing respondent burden and minimising fatigue relative to flat, role-agnostic survey designs (Dillman et al., 2014; Krosnick, 1991).

The choice of survey platform does not affect the instrument's conceptual design, which is fully specified and transferable to alternative survey environments.

Table 2. Survey structure overview

Role-specific module	Primary focus areas	No. of items	Example themes
Commissioning & start-up	Schedule-driven verification pressure, defect handling, readiness risk, permit and documentation completeness	20	Premature testing, defect severity downgrading, out-of-sequence work, risk acceptance
Operations & maintenance	Asset reliability under pressure, maintenance deferral, operational risk trade-offs	7	Running with known defects, operating outside limits, fast-tracked work
Planning & scheduling / project controls	Forecast realism, reporting pressure, milestone dominance	5	Schedule manipulation, delay suppression, incomplete inputs
Commercial, contracts & procurement	Contractual pressure on technical decisions, milestone incentives	5	Incomplete documentation acceptance, variation suppression
Health, Safety & Environment (HSE/WHS)	Safety governance under delivery pressure, risk escalation	7	Premature sign-off, superficial risk assessment, safety pushback
Leadership / management	Supervisory scope and responsibility	1	Number of direct reports
Other roles (e.g. design, PM, SME, early career)	—	0	Respondents proceed directly to universal modules

Notes: Role-specific modules are delivered only to respondents who self-identify with the corresponding primary role. Role identification functions as a routing variable rather than a measured construct.

Table 3. Role-specific module content summary

Module	Respondents	Content focus	No. of items	Approx. completion time
Consent & eligibility	All	Eligibility screening and informed consent	3	<1 min
Universal modules (front-loaded)	All	Demographics, workplace pressure, peer influence, psychological outcomes, organisational context	~34	8–10 min
Role-specific modules	Role-dependent	Role-specific pressures and practices (see Table 2)	1–20	3–5 min
Final universal modules (re-convergence)	All	Overall perceptions, reflective and closing items	2–4	<1 min
Total (per respondent)	—	—	**~40–60**	**10–15 min**

Notes: Completion time reflects intentional design parity across roles achieved through branching logic. No respondent is exposed to all role-specific items.

Sequencing of universal and role-specific modules was carefully considered. Demographics and work context (Q5-19) were positioned first to establish a consistent foundation before role differentiation. Role-specific modules (Q21-65) followed immediately, capturing concrete practices while respondents were contextually anchored. Universal comparative constructs (Q66-100) were deliberately positioned after role-specific content.

This sequencing offers a methodological advantage: engaging with concrete, role-specific scenarios first positions respondents to provide contextually grounded judgments on abstract organisational constructs (Bradburn et al., 2004; Krosnick, 1991). A respondent reflecting on specific instances of schedule pressure provides more informed responses to universal items like ‘I feel pressure to meet unrealistic expectations’ than when presented without contextual priming. Role-specific questions address observable behaviours; universal constructs measure broader outcomes—the former grounds respondents; the latter benefits from this grounding.

Because all respondents complete identical universal modules in the same sequence, cross-role comparability is preserved. While sequencing may prime universal responses, this was judged acceptable for contextually informed judgments. Reconverge design ensures analytical integrity by guaranteeing core comparative measures are completed by all participants regardless of pathway.

3.5 Question development and scaling

Survey items were developed through an iterative process that combined a review of existing workplace and safety literature with practitioner-informed insights drawn from the research team’s professional experience across engineering, commissioning, operations, and project delivery contexts (Fouad et al., 2017; Haas et al., 2020).

Where possible, items were framed to reflect observable practices and experiences rather than abstract attitudes, reducing ambiguity and supporting consistent interpretation across roles (Dekker, 2017). Multi-item scales were used for latent constructs, while single-item measures were reserved for descriptive or concrete variables. Response scales were standardised across modules to ensure analytical consistency and reduce respondents' cognitive load.

Survey items addressing workplace pressures and practices were designed to capture experiences across respondents’ entire engineering careers rather than being limited to their current role or employer. Respondents were asked to report on both current experiences (e.g., ‘In your current role, how often…’) and career-wide patterns (e.g., ‘Throughout your career, have you ever experienced…’) where relevant. This dual framing served three purposes: enhancing anonymity by preventing attribution to specific organisations or projects, enabling comparison between current and accumulated career experiences, and capturing insights from respondents who had transitioned between functional roles. The approach prioritised respondent safety and analytical richness over time-bounded measurement, while still allowing respondents to distinguish between recent and historical experiences where this distinction was analytically meaningful.

3.6 Ethical considerations

Participation in the survey was voluntary and limited to individuals aged 18 or older who were currently working, or had worked in the past five years, in engineering, technical, industrial, manufacturing, or project-delivery environments. Eligible roles included direct engineering and technical positions, as well as operational, project support, commercial, supply chain, and administrative functions within these organisational contexts. The study received approval from the Human Research Ethics Committee of Universiti Malaysia Sarawak.

Informed consent was obtained through a structured multi-step process. The survey welcome page served as the Participant Information Sheet, providing comprehensive study details, including the purpose, eligibility, data handling, anonymity protections, and the researcher's contact information. Participants confirmed comprehension before proceeding, and automated routing ensured that those who had not yet read the information were returned to the welcome page (see Supplementary Material 1 for complete consent process documentation). Subsequent consent items confirmed age eligibility and voluntary participation.

No identifying information—including names, email addresses, organisational identifiers, or IP addresses—was collected. Google Forms settings were configured to disable login requirements and response tracking, ensuring complete participant anonymity. Survey data were stored in secure, access-controlled institutional accounts.

At the time of manuscript submission, the survey was live and actively collecting responses, with closure scheduled for 7th March 2026.

4. Validation Approach

4.1 Content validity

Content validity was supported through structured review and testing by practising engineers, with at least one individual representing each role-specific module completing the full survey before public deployment. Review participants were drawn from commissioning, operations, maintenance, planning, project delivery, commercial, and health and safety roles, ensuring coverage across all branched pathways within the instrument.

Reviewers were asked to assess the relevance of items to their role, the clarity of wording, the completeness of role-specific content, the appropriateness of response options, and the overall survey flow. Feedback was used to refine wording, ordering, and explanatory text to improve clarity and alignment with operational practice.

Feedback from this practitioner review led to targeted refinements in question wording, ordering, and response options to improve clarity and reduce ambiguity. Several items were rephrased to reflect better operational language used in practice, and explanatory text was added where reviewers identified potential for misinterpretation. No items were removed or added following this process; instead, refinements focused on improving alignment between constructs and real-world engineering experience.

This practitioner-informed review process ensured that the instrument reflected credible workplace scenarios and role-specific pressures, supporting content validity before large-scale deployment.

Initial testing of the survey instrument was conducted before formal ethics approval solely to verify branching logic, question sequencing, and technical functionality. Responses generated during this phase were not retained, analysed, or used for research purposes and were permanently deleted before public deployment of the survey. This can be independently verified through response timestamps, which show that all retained data were collected following ethics approval. Accordingly, practitioner feedback informed minor refinements to instrument wording and structure but did not contribute data to the study.

4.1.1 Technical validation: Week 0 pilot deployment

The survey instrument underwent technical validation through a controlled Week 0 pilot deployment conducted prior to full-scale data collection. The primary objective of this pilot was to verify that the branching logic functioned as designed and that respondents were correctly routed to role-specific modules based on their self-identified primary role.
The pilot was deployed to a small convenience sample (N = 52) with representation across target role categories: commissioning/start-up (n = 4), operations/maintenance (n = 2), design engineering (n = 7), planning/project controls (n = 1), leadership/management (n = 2), and other roles including project management, construction, trades/technicians, commercial, HSE/WHS, and technical specialists (n = 36). Geographic diversity was achieved with responses from Australia (n = 44), Malaysia (n = 3), the Philippines (n = 2), the United Kingdom (n = 1), and the United States (n = 2).

Technical validation confirmed correct routing functionality. All respondents completed universal modules as designed, and role-specific modules were delivered only to respondents who self-identified with the corresponding role category. No technical errors or routing failures were identified during the pilot deployment period.
Response quality indicators supported instrument viability. Completion patterns indicated engagement with both universal and role-specific content, and respondents provided substantive answers to open-ended items. Qualitative responses (n = 23 substantive comments from 52 respondents) demonstrated thematic diversity aligned with the instrument's conceptual framework, including themes related to timeline pressure, management disconnect, documentation quality, client pressure, workload, safety risk, micromanagement, and resource constraints.

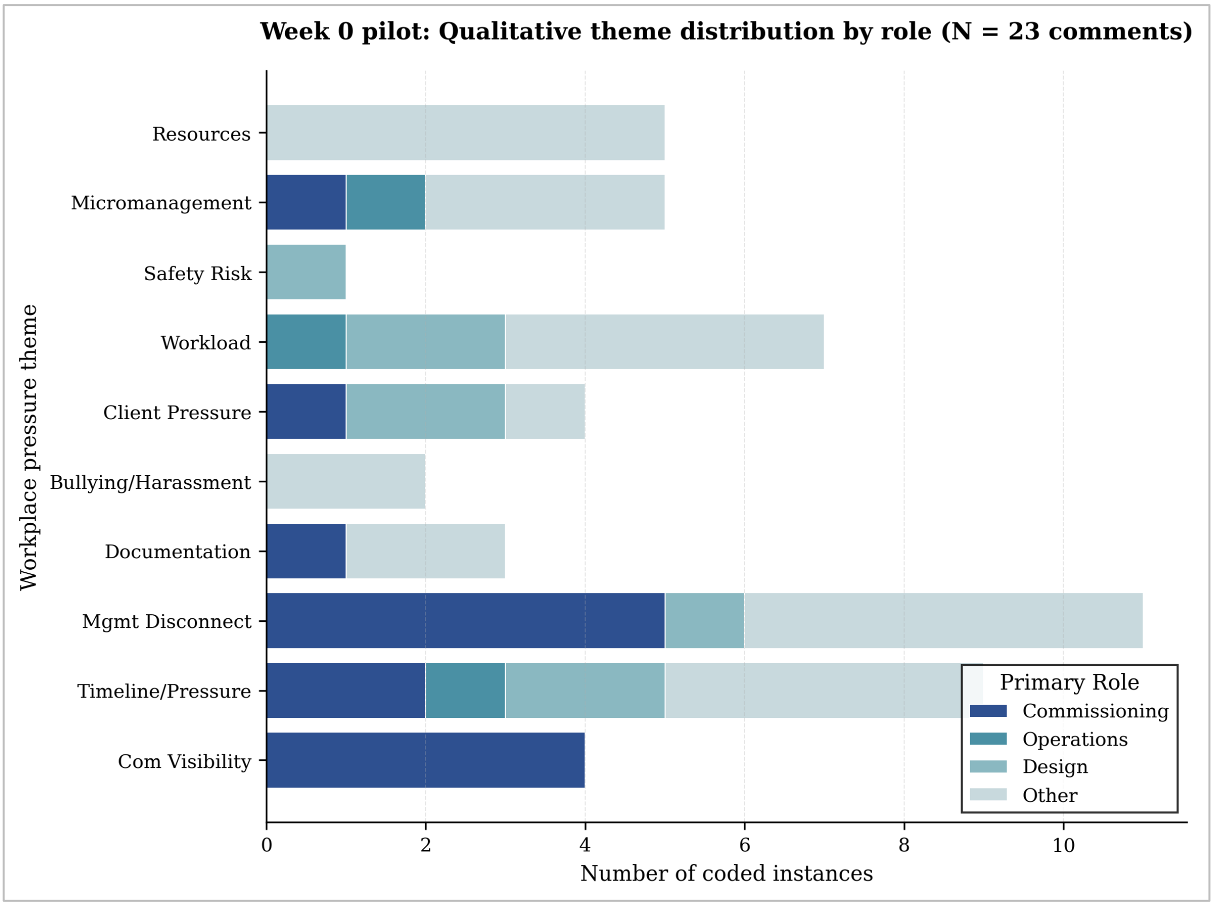
Preliminary thematic analysis of open-ended responses revealed role-specific manifestations of workplace pressure consistent with the instrument's design logic. For example, commissioning respondents cited visibility deficits and management disconnects in commissioning work, while design engineering respondents emphasised timeline pressure and client-driven demands. This initial thematic differentiation supports the rationale for role-specific measurement while confirming that universal pressure constructs resonate across roles.

The Week 0 pilot served its intended purpose as a technical validation exercise, confirming instrument functionality, routing integrity, and response quality before full-scale deployment. No modifications to the instrument structure or branching logic were required following pilot analysis.

Table 4. Week 0 pilot sample characteristics (N = 52)

Primary Role	Total Number	Percentage
Commissioning / Start-up	4	7.7
Operations / Maintenance	2	3.8
Design Engineering	7	13.5
Planning / Project Controls	1	1.9
Leadership / Management	2	3.8
Other roles*	36	69.2
Geographic Region		
Australia	44	84.6
Other (Malaysia, Philippines, UK, USA)	8	15.4

*Notes: * Other roles include project management, construction, trades/technicians, commercial, HSE/WHS, and technical specialists.*



Notes: Themes were coded from open-ended responses. Role-specific patterns emerged consistent with instrument design logic, with commissioning respondents reporting visibility and recognition issues while design engineers emphasised timeline and client-driven pressure.

Figure 2 Preliminary thematic analysis of Week 0 pilot qualitative responses by primary role (N = 23 substantive comments from 52 respondents).

4.2 Construct validity considerations

The instrument was designed around theoretically coherent constructs intended to capture workplace pressure, peer influence, organisational context, and their perceived impacts on quality, delivery, and wellbeing. Universal constructs were operationalised using multi-item scales, while role-specific modules targeted concrete practices and decision contexts rather than latent psychological traits.

Formal assessment of construct validity, including exploratory and confirmatory factor analyses, is planned after data collection is complete. Convergent validity will be assessed by examining correlations between theoretically related constructs (e.g., workplace pressure and peer influence), while discriminant validity will be evaluated through expected differentiation between conceptually distinct measures (Campbell and Fiske, 1959; Hair, 2010).

Given the intentional separation of instrument design from empirical analysis, this paper reports the planned construct validation approach rather than presenting preliminary factor structures.

4.3 Reliability assessment

Reliability assessment will be conducted using internal consistency measures, including Cronbach's alpha, for multi-item scales within the universal modules (Cronbach, 1951). Reliability thresholds will be evaluated in line with established conventions for organisational and workplace research.

Test–retest reliability was not pursued because the survey was fully anonymous and did not include respondent identifiers. This limitation is acknowledged as a trade-off associated with prioritising participant anonymity in a global workplace study.

4.4 Response quality and fatigue management

Several design features were incorporated to support response quality and mitigate respondent fatigue. Branching logic ensured that respondents were presented only with role-specific questions relevant to their primary role, preventing exposure to irrelevant content and substantially reducing completion burden compared with flat survey designs (Dillman et al., 2014).

In addition, all universal constructs required for cross-role comparisons were placed at the beginning of the instrument. This sequencing was an explicit design decision intended to preserve comparative analytical integrity in the event of partial completion or disengagement during later sections.

Response quality will be assessed by examining completion rates by role, response time patterns, distributions of missing data, and the detection of straight-lining or invariant responding within Likert-scale items.

4.5 Sampling and generalisability

The target population comprises individuals aged 18 or older who are currently working or have worked in the past five years in engineering or closely related technical roles. The survey is distributed globally through professional networks, online platforms, and industry contacts, enabling participation across sectors including utilities, water, construction, infrastructure, energy, mining, manufacturing, and engineering research.

While the global scope supports broad applicability, using an English-language instrument may limit participation in some regions. This is acknowledged as a constraint on generalisability and may be addressed in future adaptations of the instrument.

4.6 Limitations

Several limitations are inherent to the study design. As with all self-report instruments, responses may be influenced by recall bias or subjective interpretation. The voluntary nature of participation may introduce self-selection bias, with individuals experiencing higher levels of workplace pressure potentially more likely to respond.

The absence of longitudinal tracking limits the ability to assess the temporal stability of responses. However, this limitation reflects a deliberate prioritisation of participants' anonymity and ethical protection.

5. Discussion

5.1 Methodological contribution

The primary contribution of this paper is to articulate a transparent and replicable framework for designing integrated multi-role survey instruments in engineering contexts. Rather than treating role diversity as a sampling complication, the framework positions role as a central design consideration, enabling both cross-role comparison and role-specific depth within a single instrument.

By combining universal core modules with targeted role-specific branches, the design avoids the traditional trade-off between breadth and specificity that characterises many workplace surveys. The explicit sequencing of universal measures before branching ensures that systemic organisational phenomena can be examined across roles. At the same time, role-specific modules allow investigation of how those phenomena manifest in practice.

Importantly, this work's contribution is architectural rather than construct-based. The novelty lies not in individual survey items but in the way established constructs are integrated, sequenced, and operationalised across multiple roles without fragmenting the dataset.

While branching logic itself is not novel, this work's contribution lies in the explicit architectural integration of universal and role-specific measurements within a converge–diverge–reconverge framework. Existing applications of adaptive surveys in engineering workplace research rarely document sequencing, routing, and reconvergence decisions at a level that supports reuse or replication.

5.2 Managing respondent burden without sacrificing analytical integrity

Respondent burden and fatigue represent persistent challenges in workplace survey research, particularly in complex professional environments such as engineering. The branching architecture presented in this paper demonstrates how depth can be achieved without exposing respondents to irrelevant content or excessive survey length.

Branching logic was used deliberately to control respondent burden, while completion-time parity across roles was treated as a design constraint rather than an incidental outcome. At the same time, front-loading universal modules ensured that core comparative data were captured for all respondents, preserving analytical integrity even when partial completion occurred.

This approach contrasts with flat, role-agnostic instruments that either overburden respondents or sacrifice role-specific insight. The framework illustrates how survey architecture itself can be used as a methodological tool to manage fatigue while maintaining data quality.

5.3 Implications for engineering workplace research

The framework presented here responds directly to the need for methods capable of capturing systemic workplace phenomena in engineering organisations. Many organisational outcomes of interest—such as safety performance, delivery reliability, quality degradation, and workforce attrition—emerge from interactions across roles rather than from isolated functions.

By enabling simultaneous examination of shared organisational conditions and role-specific practices, integrated multi-role instruments support more nuanced diagnosis of workplace dynamics. This has implications not only for academic research, but also for organisational self-assessment, benchmarking, and intervention design.

While demonstrated in the context of engineering workplace pressure, the framework is transferable to other domains characterised by role diversity and interdependence, including healthcare, manufacturing, information technology, and other safety-critical industries.

5.4 Design trade-offs and limitations

As with any survey-based methodology, the framework involves explicit trade-offs. Prioritising anonymity precludes longitudinal tracking and test–retest reliability assessment, while relying on self-report introduces potential recall and perception biases. These limitations are not unique to the present instrument and reflect deliberate design choices aligned with ethical and practical constraints.

The use of role self-identification as a routing mechanism may introduce some misclassification; however, this affects the depth of role-specific data rather than the integrity of universal measures. By treating role as a pragmatic routing variable rather than a latent construct, the design maintains robustness in cross-role analyses.

5.5 Future research directions

Separating instrument design from empirical analysis provides a clear foundation for subsequent research phases. Following data collection, the instrument will support construct validation, reliability assessment, and cross-role comparative analysis without requiring post hoc modifications to the survey architecture.

Beyond this specific study, the framework offers a template for future multi-role workplace research. Researchers may adapt the branching architecture to different organisational contexts, refine role-specific modules, or integrate longitudinal deployment where anonymity constraints permit.

More broadly, the approach highlights the value of treating survey architecture as an explicit methodological contribution, rather than as a neutral technical implementation.

6. Conclusion

This paper presented a structured methodological framework for designing integrated multi-role survey instruments in engineering contexts. By explicitly addressing the challenge of capturing systemic workplace phenomena across diverse roles, the framework demonstrates how survey architecture can preserve cross-role comparability while enabling role-specific depth.

The instrument design combined universal core modules with targeted role-specific branches, supported by deliberate sequencing and branching logic. Front-loading universal measures ensured that essential comparative data were captured for all respondents, while role-specific modules allowed detailed examination of localised pressures and practices without increasing respondent burden. These design decisions were intentional and grounded in both methodological considerations and practical constraints of engineering workplaces.

The contribution of this paper lies in its focus on instrument architecture rather than empirical findings. By separating design from validation and analysis, the framework promotes transparency and reduces the risk of post hoc modification of measurement tools. This approach supports replicability and provides a clear foundation for subsequent empirical research.

While demonstrated through a global engineering workplace pressure survey, the framework is transferable to other complex, multi-role organisational settings. Researchers and practitioners seeking to understand how systemic pressures propagate across roles may adapt the approach to suit different industries, organisational structures, and research objectives.

Advancing workplace research in engineering requires methods that reflect how work is distributed, pressured, and negotiated across roles. The framework presented here offers a practical and defensible pathway for designing instruments that can capture that complexity.

To support replication and adaptation of this framework, comprehensive documentation is provided in the appendices and supplementary materials. Appendix A presents the complete survey instrument structure including a selection of representative items from all modules, while Appendix B provides a visual representation of the branching logic. Supplementary Material 1 documents the informed consent process with implementation details, and Supplementary Material 2 offers practical guidance for researchers seeking to implement converge-diverge-reconverge survey designs in other organisational contexts. These resources are designed to enable direct replication, adaptation, or extension of this approach by other researchers studying multi-role organisational phenomena.

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