# Invisible Hands: Status, Credibility, and the Systematic Invisibility of Technical Labour in Engineering Commissioning

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## ABSTRACT

Status processes shape authority and recognition in professional workplaces, yet how gendered credibility dynamics operate in high-stakes, time-compressed technical environments remains incompletely theorised. This paper examines commissioning engineering as a critical case: a project phase whose defining conditions—technical uncertainty, compressed decision windows, and ambiguous authority—intensify precisely the processes through which epistemic injustice operates.

The paper introduces the Invisible Hands Phenomenon: a status-theoretic construct describing the systematic organisational invisibility of preventative, anticipatory, and integrative technical labour, produced through credibility deflation, visibility asymmetry, and attribution gaps. Drawing on both status characteristics theory and epistemic injustice theory, it argues that commissioning environments are epistemically vulnerable, and that status-based credibility assessments shape which technical judgements are trusted, whose safety concerns are heard, and which contributions are remembered and rewarded.

Empirical grounding is provided by a global survey of engineering professionals (N=335, 22 countries across six continents; commissioning subsample, n=81; 24% of the full sample) and by a systematic qualitative analysis of practitioner open-text responses. Commissioning engineers described professional invisibility at nearly thirteen times the rate of other roles (10.4% vs 0.8%, Fisher's exact, $p = .005$)—the starkest role-based visibility gap in the entire qualitative dataset. Across the full sample, 80.9% report peer pressure causing rework and errors, with commissioning engineers significantly more affected than all other roles. Practitioner accounts directly describe the attribution gaps, safety voice suppression, and blame absorption that the theoretical framework predicts. The paper identifies three commissioning-specific mechanisms—credibility circuits, strategic invisibility in safety voice, and credibility deficit cascades—through which gendered credibility dynamics shape technical authority and career trajectories and proposes targeted interventions to disrupt these inequalities.

## Keywords

Status characteristics; gender and status; epistemic injustice; credibility and authority; technical workplaces; task allocation; safety voice; status interventions; STEM workplace inequality

## 1. INTRODUCTION

Status characteristics theory holds that diffuse status characteristics—socially salient categories such as gender, race, and age—shape expectation states and credibility assessments in task-focused groups, even when those characteristics are formally irrelevant to performance (Ridgeway 2001). These dynamics are predicted to intensify under conditions of uncertainty, time pressure, and ambiguous authority, precisely because the absence of clear performance information increases reliance on social status cues. Yet the mechanisms through which status processes operate in professional workplaces, and how they accumulate into durable career disadvantage, remain incompletely theorised. This paper examines commissioning engineering as a theoretically critical case. Commissioning—the verification, integration, and performance validation of complex systems before operational handover—is characterised by high technical uncertainty, time-compressed problem-solving, and elevated safety risk (Whyte et al. 2016; Singh and Anumba 2024). It involves irregular rosters, live troubleshooting, and cross-disciplinary coordination—conditions under which team dynamics, authority, and perceptions of competence become acutely visible (Locatelli et al. 2014; Singh and Anumba 2024), and under which status-based credibility assessments carry disproportionate weight.

The empirical scale of commissioning's organisational marginalisation is now documented. A global survey of engineering professionals (Ayres et al. 2026a), found that 80.9% (N=335, 22 countries across six continents)of engineers across all roles report that peer pressure has caused rework, errors, or delays—suggesting that social authority, not technical merit alone, shapes professional decision-making in engineering. Commissioning engineers report significantly higher rates of process skipping, workarounds, and out-of-sequence work than all other roles (Ayres et al. 2026a). Qualitative analysis of open-text responses from the same survey (Ayres et al. 2026b)found that commissioning engineers described professional invisibility at nearly thirteen times the rate of other roles (10.4% vs 0.8%, Fisher's exact, $p = .005$)—the largest proportional visibility gap of any code in the entire qualitative dataset. These figures are consistent with theorised patterns of gendered credibility disadvantage and provide structural grounding for the mechanisms proposed in this paper.

This paper asks: How do status processes shape credibility, authority, and recognition during the commissioning phase of engineering projects, and how can integrating status characteristics theory and epistemic injustice theory illuminate the mechanisms by which status-based disadvantage is produced and sustained?

## 2. THEORETICAL BACKGROUND

This section maps the theoretical landscape across four bodies of literature: status characteristics theory and expectation states research; gender in engineering workplace scholarship; commissioning as an organisational and technical context; and epistemic injustice theory as an interpretive framework for status processes in professional settings. Because this study develops a conceptual framework grounded in a global survey of engineering professionals, the scope is appropriately limited to synthesising insights across adjacent domains rather than exhaustively cataloguing technical commissioning literature.

### 2.1 Literature Search Strategy

Targeted database searches in Scopus were conducted to confirm the absence of scholarship at the commissioning–gender intersection, rather than to produce a systematic review.

Searches combining commissioning activities, engineering contexts, and gender or equity dimensions returned no results when all three domains were combined, confirming that commissioning is an empirically neglected site within engineering gender scholarship.

As a conceptual analysis, the aim is theoretical clarification rather than empirical generalisation.

### 2.2 Literature Review Approach

Given the absence of research on the commissioning–gender intersection, the literature review synthesises insights from three bodies of scholarship: gender in engineering workplace research, commissioning technical literature, and related organisational phenomena, including safety voice, gendered task allocation, and field-based work dynamics. Sources were identified through targeted searches, citation chaining from recent reviews, and examination of key journals in each domain, including Engineering Studies, Gender, Work & Organisation, Safety Science, and Construction Management and Economics.

### 2.3 Theoretical Development Approach

This paper develops a conceptual framework grounded in two forms of empirical evidence: quantitative survey data from a global cross-sectional study(Ayres et al. 2026a), which establishes the structural conditions within which the theorised mechanisms operate, and systematic qualitative analysis of open-text responses from the same survey (Ayres et al. 2026b), which provides practitioner-language evidence for the mechanisms themselves. The commissioning subsample (n=81, 24% of the full sample) provides the primary empirical grounding for the mechanisms theorised in this paper. The causal pathways require direct validation using observational and longitudinal methods.

## 3. CONCEPTUAL FOUNDATIONS AND GAP MAPPING

### 3.1 An Unexplored Intersection

Targeted searching identified no peer-reviewed studies examining gender within commissioning engineering contexts. This finding held across multiple search strategies and demonstrated that commissioning is an empirically neglected phase within engineering gender scholarship.

This constitutes a significant empirical gap. Commissioning's documented characteristics—technical uncertainty, time pressure, high operational visibility, cross-functional coordination, and safety criticality—align closely with conditions under which gender scholarship predicts differential experiences. Yet these dynamics remain unexamined.

### 3.2 Conceptual Foundations from Adjacent Literatures

#### *3.2.1 Women in engineering: persistent inequalities*

Research consistently demonstrates that women remain under-represented and unevenly distributed across engineering disciplines, career stages, and organisational hierarchies (Powell et al. 2009). Inequality is reproduced through everyday organisational processes rather than individual deficits, underscoring the structural nature of gendered disadvantage(Faulkner 2009).

Contemporary scholarship extends beyond numerical representation to examine belonging, occupational identity, and perceived fit. Studies show that women engineers navigate

gendered organisational norms that shape legitimacy, identity, and access to technical authority (Cech 2013; Powell et al. 2009). Senior women often face cumulative barriers, including marginalisation from influential networks and constrained access to high-value technical work (J. Williams et al. 2014; Powell et al. 2009; Britton 2000).

Despite the breadth of research, the existing literature treats engineering work as homogeneous. It seldom disaggregates women's experiences by project phase—such as design, construction, commissioning, or operations. As a result, little is known about how specific engineering contexts shape gendered experiences.

### *3.2.2 Commissioning in engineering projects*

Commissioning is widely recognised as a critical phase in which engineered systems are verified, integrated, and prepared for operation (Singh and Anumba 2024). Research in construction and project management characterises commissioning as a structured process linking installation, functional testing, and performance validation (Bosch-Rekveldt et al. 2011). Commissioning has been shown to influence overall project quality, system performance, and operational readiness, yet recent reviews emphasise a lack of consistent documentation practices and methodological standardisation (Singh and Anumba 2024).

### *3.2.3 Gendered organisations and role congruity*

Theories of gendered organisations and role congruity provide strong conceptual foundations for anticipating gendered patterns in commissioning environments. Acker's theory of gendered organisations argues that organisational processes, structures, and interactions are implicitly gendered, disadvantaging women through seemingly neutral practices such as evaluation, task allocation, and expectations of availability (Acker 1990). Subsequent work extends this perspective, demonstrating how organisational cultures and logics reproduce gendered patterns of recognition, authority, and legitimacy (Britton 2000; C. L. Williams 2013).

Within engineering, women often experience organisational cultures that position them as exceptions, shaping role expectations and access to high-value technical work (Cech 2013; J. Williams et al. 2014). Role congruity theory holds that prejudice arises when a mismatch is perceived between gender stereotypes and role demands, leading to stricter competence evaluations for women in technical roles (Heilman 2012).

### *3.2.4 Safety, risk, and voice in high-risk work*

Research from high-risk fields shows that gender is relevant to safety voice intention, hazard perception, and authority in high-risk technical settings (Detert and Burris 2007). Given commissioning's time pressure, interdisciplinary coordination, and ambiguous authority lines, similar dynamics are predictable, yet the commissioning literature has not investigated safety or risk through a gendered lens.

### *3.2.5 Work–life relations, mobility, and commissioning-type roles*

Commissioning roles are typically characterised by extended or irregular shifts, on-site presence, travel to remote locations, and periods of concentrated workload around start-up milestones. Although project management research acknowledges these features, evidence is limited on how women experience them and on how commissioning-specific working conditions influence career decisions. Taken together, these literatures suggest that commissioning is a theoretically rich but empirically unexamined site for understanding gendered dynamics in engineering practice.

### *3.2.6 Status characteristics theory and expectation states*

Status characteristics theory (SCT) provides the primary theoretical foundation for this paper's analysis of credibility dynamics in commissioning. SCT holds that in task-focused groups, both specific status characteristics (task-relevant abilities and credentials) and diffuse status characteristics (socially generalised categories such as gender, race, and age) shape performance expectations, influence task allocation, and determine whose contributions are credited (Ridgeway 2001). Crucially, diffuse characteristics exert influence even when they are nominally irrelevant to the task at hand: they operate through expectation states—implicit assessments of likely performance—that shape interactional behaviour before any actual performance occurs.

Three predictions from SCT are particularly relevant to commissioning contexts. First, in the absence of clear performance information, diffuse status cues carry greater weight—a condition that maps directly onto commissioning's characteristic uncertainty and time pressure. Second, status disadvantage compounds: engineers whose contributions are systematically discounted accumulate lower expectation states, which, in turn, constrain future task allocation and recognition, creating a self-reinforcing inequality (Ridgeway 2001). Third, these dynamics are most consequential at career entry and during high-visibility project phases, when expectation states are being established. Commissioning is precisely such a phase.

SCT also provides a basis for theorising interventions. Experimental research in the expectation states tradition has demonstrated that explicitly equalising status information—through competence assignments, public recognition of contributions, and accountability structures—can disrupt status-based interactional inequalities (Berger 1977). This paper develops commissioning-specific analogues of these interventions in Section 6. The integration of SCT with epistemic injustice theory (Fricker 2007) is theoretically productive because epistemic injustice specifies the mechanisms through which status processes operate at the level of knowledge claims: credibility deflation (testimonial injustice) and interpretive erasure (hermeneutical injustice) constitute the epistemic face of SCT's expectation-state dynamics.

## 3.3 Research Gap and Study Objectives

Three key insights emerge. First, gender inequalities in engineering are well documented, yet the literature treats engineering practice as homogeneous, neglecting phase-specific dynamics. Second, commissioning remains predominantly unexamined within the workforce context, despite its established role as a gateway to senior technical positions (Singh and Anumba 2024). Third, SCT, gendered organisational theory, role congruity, and safety voice research converge to predict that gender—as a diffuse status characteristic—will shape credibility, task allocation, and authority in commissioning environments, with career-multiplying effects.

Despite this, empirical studies examining gender, diversity, or equity within commissioning engineering roles are virtually absent, and current evidence indicates that research does not consider how women experience commissioning work, including task allocation, technical authority, and career progression. This omission defines a clear and significant gap in the literature that the present study addresses.

## 3.4 Why Gender Matters Specifically in Commissioning Contexts

While credibility dynamics intersect with seniority and organisational tenure, gender remains a structurally salient axis through which epistemic disadvantage is produced. Commissioning intensifies reliance on traits culturally coded as masculine—decisiveness under uncertainty, visible technical confidence, and tolerance for risk exposure. When technical authority is evaluated under ambiguity and time pressure, women are more likely to experience credibility deflation and constrained access to high-visibility tasks, even when formal qualifications are equivalent (Ridgeway 2001). In commissioning, where authority is negotiated in real time, these assessments are particularly consequential, making gender constitutive of how epistemic injustice manifests.

## 4. THEORETICAL FRAMEWORK: STATUS PROCESSES AND EPISTEMIC INJUSTICE IN COMMISSIONING

### 4.1 Status Processes and Epistemic Injustice in Technical Work

Status characteristics theory holds that diffuse status characteristics shape expectation states and, through them, task allocation and credibility assessments in task-focused groups (Ridgeway 2001). Epistemic injustice theory specifies the mechanisms through which these status processes operate at the level of knowledge claims: in commissioning environments, status dynamics shape which technical judgements are trusted, whose interpretations are acted upon, and which contributions become visible within organisational narratives (Fricker 2007). The two frameworks are theoretically complementary—SCT explains the social structural conditions that generate inequality; epistemic injustice theory explains the interactional and cognitive mechanisms through which it is enacted.

Two forms of epistemic injustice are particularly salient for understanding commissioning dynamics: testimonial injustice and hermeneutical injustice. Testimonial injustice occurs when a speaker's credibility is systematically deflated due to identity-linked assumptions rather than the substance of their contribution (Fricker 2007). In commissioning contexts, this manifests when technical warnings, interpretations, or recommendations are questioned, minimised, or overridden based on who delivers them, even when comparable contributions from others are readily accepted. These credibility assessments are rarely explicitly framed as bias; instead, they emerge from routine interactions shaped by familiarity, perceived authority, and time pressure.

Hermeneutical injustice arises when there is a lack of shared interpretive resources to make sense of specific experiences (Fricker 2007). In commissioning work, this becomes evident in the difficulty of articulating forms of technical judgement that involve anticipation, unease, or preventative intervention. When organisational language privileges visible failures, formal test outcomes, or decisive interventions, quieter forms of sensemaking and risk avoidance may lack recognised status. As a result, some technical contributions become difficult to name, document, or defend retrospectively.

These forms of epistemic injustice are likely to be amplified in commissioning environments. Commissioning decisions are made when systems are incomplete, behaviours are unstable, and formal documentation often lags real-time conditions (Singh and Anumba 2024). Under such circumstances, technical judgement and experiential knowledge carry heightened importance. At the same time, commissioning is highly visible: delays are costly, failures are public, and accountability is often assigned after the fact (Whyte et al. 2016). In this context,

credibility functions as a key organising mechanism, shaping who is trusted, whose judgements are acted upon, and whose contributions are remembered.

### 4.2 Commissioning as a Status-Amplifying Environment

Commissioning exhibits a structural constellation that simultaneously amplifies the conditions under which SCT predicts status effects will be strongest, making it a site of intensified status dynamics rather than incidentally gendered organisational processes.

First, commissioning is characterised by high technical uncertainty. Systems are newly integrated, operating parameters are still being established, and unexpected interactions may occur daily. Decisions must often be made with incomplete information, requiring engineers to rely on judgement rather than procedural certainty.

Second, commissioning unfolds under acute time pressure. Start-up schedules, contractual milestones, and operational constraints compress decision windows and limit opportunities for extended deliberation. Under these conditions, rapid consensus is often prioritised, and dissenting or cautious interpretations may be reframed as obstructive or commercially naïve.

Third, commissioning work exhibits pronounced visibility asymmetries. Certain activities—such as leading live tests, making decisions in control rooms, or interfacing with senior stakeholders—are obvious and readily attributed to individuals. Other forms of work, including preparatory checks, incremental adjustments, and preventative interventions, remain largely unseen. Survey data from a global sample of commissioning engineers (n=81) document these asymmetries empirically: 93.8% report proceeding with incomplete documentation often or very often, 85.2% report working extra hours to stabilise premature commissioning, and only 18.5% report receiving formal recognition for their work often or very often (Ayres et al. 2026a). These figures suggest that invisible labour may be structural rather than incidental.

Survey data document the consequences of this constellation: 74.1% of commissioning engineers report pressure to accept equipment in an as-is condition for handover often or very often, and 72.8% report concerns about their team's competence to execute commissioning safely (Ayres et al. 2026a). This vulnerability is particularly consequential for engineers whose authority is already socially contested due to gender, race, age, or outsider status (Bosch-Rekveldt et al. 2011; Whyte et al. 2016).

### 4.3 The Invisible Hands Phenomenon: A Status-Theoretic Construct

The Invisible Hands Phenomenon theorises a pattern in which preventative, anticipatory, or integrative technical work becomes organisationally invisible due to credibility dynamics, attribution gaps, and the absence of recognised interpretive resources. It predicts that essential commissioning contributions—particularly those that avert failures or stabilise systems—will be systematically under-recognised, weakly attributed, or retrospectively erased.

Three mechanisms are theorised to underpin the Invisible Hands Phenomenon: credibility deflation, in which preventive judgements are discounted or questioned; visibility asymmetry, in which high-value anticipatory work leaves no observable trace; and attribution gaps, in which successful outcomes are decoupled from the individuals whose interventions enabled them. Together, these mechanisms are predicted to produce cumulative credibility deficits that shape authority, safety voice, and career progression.

Practitioner accounts from a global engineering survey (Ayres et al. 2026b) are consistent with these mechanisms. On attribution gaps and the invisibility of preventative work: “Commissioning is never thanked for what we do, just blamed for delays as we are visible at the end” (Woman, 25–34, Commissioning, Water); “No one sees the extra work we do to get the project handed over” (Woman, 18–24, Commissioning, Water); “Commissioning tends to be invisible to everyone in the organisation unless it goes wrong or causes delays” (Man, 25–34, Commissioning, Mining). On credibility deflation: “I feel management above commissioning management have no idea what we do, no respect for us and the issues we face” (Man, 35–44, Commissioning, Water); “Commissioning is not recognised so safety does not align with us” (Man, 25–34, Commissioning, Mining). These accounts are not exceptional; the qualitative analysis found that commissioning engineers described professional invisibility at 10.4% versus 0.8% for all other roles (Fisher’s exact, $p = .005$), with blame absorption and unrecorded hours also significantly elevated in the commissioning group (Ayres et al., 2026b).

In commissioning contexts, certain forms of technical work involve anticipation, coordination, and preventative judgement. These include identifying subtle inconsistencies before they escalate, adjusting parameters to avert failures, coordinating across disciplines to prevent conflicts, and maintaining safety margins under uncertain conditions. Although such actions materially shape commissioning outcomes, they are likely to leave no visible trace. When success is defined as the absence of failure, it becomes structurally difficult to attribute positive outcomes to specific acts of judgement or intervention.

The Invisible Hands Phenomenon is closely linked to testimonial injustice. When technical contributions occur outside visible decision-making arenas—in preparatory checks, incremental adjustments, or quiet problem prevention—the engineers responsible may not be recognised as authoritative, even when their work proves consequential. Over time, this is theorised to produce credibility gaps in which specific individuals are repeatedly absent from organisational narratives of technical success.

The phenomenon also reflects hermeneutical injustice. Organisational accounts of commissioning typically privilege dramatic breakdowns, decisive interventions, or formally documented achievements (Singh and Anumba 2024). There is often no shared language for recognising avoided risks, stabilised systems, or incremental improvements achieved through anticipatory work. As a result, engineers engaged in such work face systematic difficulty articulating their contributions in ways that align with prevailing evaluative frameworks.

Crucially, theory predicts that invisibility is not evenly distributed. Engineers already positioned at the margins of credibility hierarchies—whether due to gender, seniority, disciplinary background, or organisational outsider status—are predicted to be more vulnerable to having their work rendered invisible. Conversely, those with established authority benefit from retrospective attribution even when their direct involvement was limited. The Invisible Hands Phenomenon thus operates as a mechanism through which epistemic injustice becomes embedded in everyday commissioning practice, systematically disadvantaging those whose credibility is already contested.

Figure 1 presents a conceptual model of the epistemic ecology of commissioning. It illustrates how structural conditions create epistemic vulnerabilities that enable the Invisible Hands Phenomenon, and how these dynamics produce organisational consequences related to authority, safety voice, and career progression. The model synthesises the mechanisms identified in this section and provides a framework for future empirical investigation.

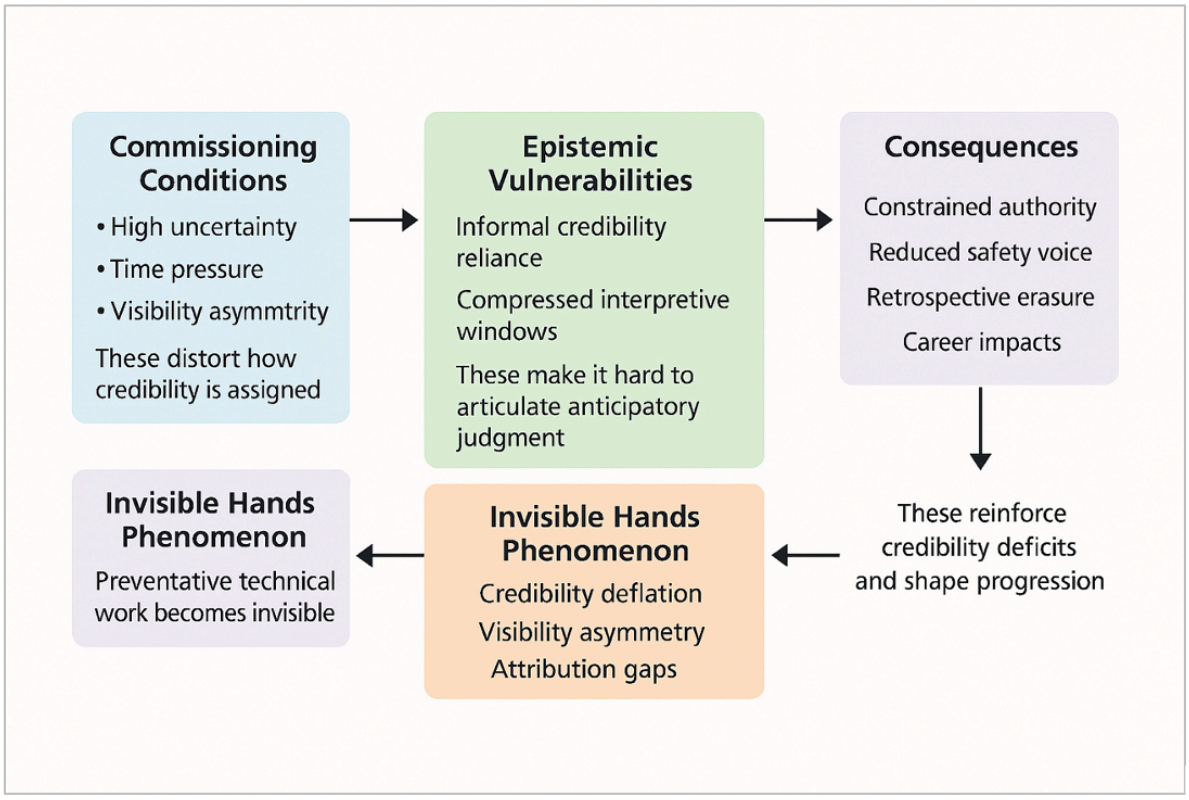


***Figure 1. Epistemic ecology of commissioning work.***

This conceptual model illustrates how commissioning conditions—high uncertainty, time pressure, distributed authority, and visibility asymmetries—generate epistemic vulnerabilities that enable the Invisible Hands Phenomenon. The phenomenon is driven by credibility deflation, visibility asymmetry, and attribution gaps, resulting in constrained authority, reduced safety voice, retrospective erasure, and career impacts.

## 5. STATUS PROCESSES IN COMMISSIONING PRACTICE: THREE MECHANISMS

The mechanisms described in this section are theoretically derived and warrant empirical investigation rather than being claimed to be descriptive in all respects. This section examines three manifestations: task allocation through credibility circuits, safety voice and strategic invisibility, and cumulative credibility deficits over time.

### 5.1 Task Allocation, Status, and Credibility Circuits

Status characteristics theory predicts that in task-focused groups, expectation states derived from diffuse status characteristics shape who is assigned high-visibility, consequential work (Ridgeway 2001). Task allocation during commissioning is shaped not only by formal role definitions but by informal assessments of credibility and trust that reflect these status-based expectations. In commissioning, task allocation operates simultaneously at three levels—formal (role descriptions), informal (credibility-driven delegation), and emergent (crisis-driven redistribution under time pressure). As a result, high-visibility, system-critical tasks often fall to a subset of engineers, while others are assigned preparatory, coordinating, or support-oriented work. These patterns are rarely framed as status-based or hierarchical,

yet they produce systematically uneven access to commissioning experience and recognition (Cech 2013; Williams et al. 2014; Britton 2000).

Over time, these dynamics are theorised to form credibility circuits: feedback loops in which prior visibility influences future task allocation. Engineers perceived as credible are more likely to be entrusted with complex or risky work, further reinforcing their authority. Conversely, engineers whose contributions remain less visible encounter systematic constraints on future opportunities, even when their technical competence is comparable. Commissioning's compressed decision windows accelerate the formation of these circuits, because rapid task allocation under uncertainty magnifies reliance on diffuse status cues.

Epistemic injustice is predicted to operate within these circuits through two mechanisms. Testimonial injustice arises when engineers' knowledge claims or expressions of capability are discounted in task-allocation decisions (Fricker 2007). Hermeneutical injustice compounds this effect by obscuring the technical significance of less visible contributions—preparatory work, risk mitigation, system stabilisation—making them difficult to name or defend as evidence of expertise. Together, these dynamics are theorised to shape the uneven accumulation of commissioning knowledge and authority.

Crucially, successful commissioning outcomes tend to be retrospectively attributed to visible interventions, while preparatory or preventative work fades from organisational memory. Such attribution patterns reinforce existing credibility hierarchies and influence subsequent role assignments across future commissioning cycles.

### 5.2 Safety Voice, Status, and Strategic Invisibility

Theory predicts that safety voice during commissioning is shaped by credibility dynamics that determine whose concerns are heard and acted upon. Safety-related input may be reinterpreted through dispositional lenses rather than engaged with substantively, altering the calculus of speaking up (Edmondson 1999). Expressions of caution or anticipatory concern risk being dismissed as excessive risk aversion—a dynamic that theory predicts will be more pronounced for engineers whose diffuse status characteristics generate lower performance expectations (Ridgeway 2001), shaping whose safety knowledge enters collective decision-making.

Under time pressure, expressions of caution risk being reframed as risk aversion or lack of confidence, shifting attention from the technical substance of a concern to perceived characteristics of the speaker. For engineers whose credibility is already contested, this creates a disincentive to raise safety issues (Detert and Burris 2007), a dynamic consistent with broader findings that risk communication is shaped as much by social credibility as by technical content (Eagly and Karau 2002).

This dynamic is theorised to create a double bind. Speaking up carries the risk of dismissal or reputational marginalisation, while remaining silent increases the likelihood that technical judgement will remain invisible and unrecognised. Either choice involves epistemic cost. The decision to limit visible safety interventions, therefore, reflects strategic adaptation to credibility constraints rather than technical disengagement or lack of safety commitment. This strategic invisibility is also a form of hermeneutical injustice: engineers lack recognised organisational language for anticipatory unease, pre-failure signals, or preventative judgement, making certain forms of safety knowledge difficult to articulate or legitimise.

Practitioner accounts provide direct evidence of this dynamic. A woman commissioning engineer in oil and gas described: “Often shouted at in meeting rooms—it makes me scared making a mistake at site” (Woman, 35–44, Commissioning, Oil and Gas). Another described the consequence of refusing to compromise: “I often get pushback as I say no to turning things in too early and it adds to extra stress” (Man, 25–34, Commissioning, Construction). A third described a direct instruction to bypass a client requirement: “Project Engineer asked me to ignore a client’s requirement on a remote site to get work signed off” (Woman, 65–74, Commissioning, Water). These accounts, drawn from engineers across multiple countries and sectors, describe the double bind theorised above: speaking up incurs cost, remaining silent renders technical judgement invisible (Ayres et al. 2026b).

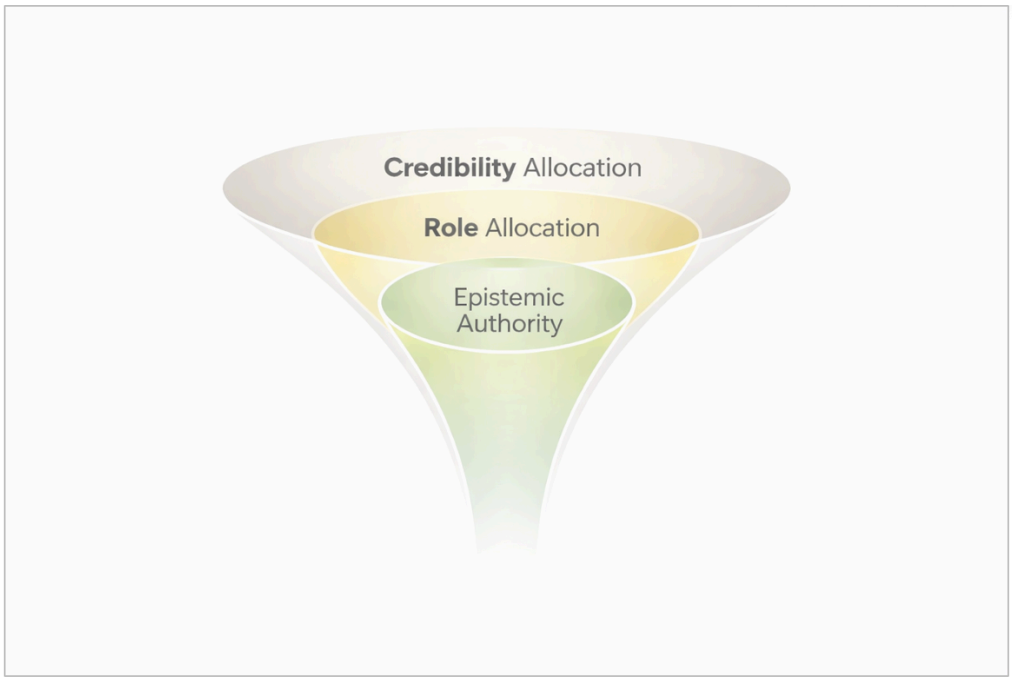


***Figure 2. Epistemic Compression in Engineering Commissioning***

This conceptual illustration shows how credibility, role allocation, and epistemic authority are filtered through informal, differential, and concentrated mechanisms during the commissioning phase.

The theorised practice of strategic invisibility in safety voice is predicted to have collective consequences for commissioning teams. When credibility constraints systematically mute certain forms of technical judgement, the team’s epistemic capacity is reduced. Hazards may be identified later than optimally, learning opportunities may be missed, and responsibility for safety outcomes may become unevenly distributed across team members.

### 5.3 The Credibility Deficit Cascade: How Status Disadvantage Compounds

Status characteristics theory predicts that status-based inequality compounds: lower expectation states constrain task allocation, which limits performance opportunities, which in turn reinforces initial status assessments (Ridgeway, 2001). The status dynamics identified in task allocation and safety voice therefore have cumulative implications that extend beyond individual commissioning episodes. This section introduces the credibility deficit cascade: the mechanism through which early experiences of status disadvantage during commissioning compound over time, reshaping access to learning, authority, and

career progression in ways that convert temporary interactional inequality into durable structural disadvantage.

The cascade is theorised to operate through sequential reinforcement of credibility gaps. When epistemic injustice reduces the visibility of certain engineers' contributions during commissioning, theory predicts that those individuals become less likely to be associated with successful outcomes in organisational memory. Importantly, the credibility deficit cascade is a structural accumulation mechanism rather than a psychological process: it operates through patterned task allocation, recognition practices, and organisational memory, not individual dispositions. This invisibility constrains access to informal recognition and mentorship—forms of validation that are central to developing commissioning expertise and technical authority. The qualitative data provide structural evidence consistent with this cascade: commissioning engineers reported the lowest rate of positive and protective workplace experiences of any role group (6.2% vs 21.9% for all other roles, p=.015), and the highest rates of blame absorption and unrecorded hours, suggesting a working environment in which contributions accumulate without recognition while accountability flows consistently downward (Ayres et al. 2026a)

Reduced visibility then constrains knowledge transfer opportunities. Engineers who are systematically excluded from high-visibility troubleshooting, system-level decision-making, or critical incident response accumulate less complex commissioning experience. Over time, this limited exposure may be retrospectively interpreted as a sign of limited capability, reinforcing initial credibility deficits rather than being recognised as due to unequal task allocation.

As the cascade progresses, engineers facing persistent credibility gaps are excluded from high-trust assignments that serve as gateways to career advancement in commissioning-intensive roles. These exclusions narrow viable career pathways and may influence decisions about continued participation in commissioning work altogether. The credibility deficit cascade, therefore, illustrates how testimonial and hermeneutical injustices interact over time, transforming momentary credibility losses into durable structural inequalities.

Presence politics are predicted to intensify these dynamics. Commissioning cultures that valorise constant availability and sustained physical presence create additional credibility barriers, particularly when on-site visibility becomes equated with technical commitment. Survey data confirm this is not merely theoretical: 86.4% of commissioning engineers report pressure to work beyond contracted hours, and 81.5% report working beyond their formal role boundaries (Ayres et al. 2026a). For engineers already experiencing epistemic disadvantage, these expectations compound existing credibility gaps, as their absence—whether due to work–life constraints, safety concerns, or strategic withdrawal—may be interpreted as a lack of dedication rather than as a structural constraint.

The gendered dimension of this cascade warrants particular attention. While credibility dynamics intersect with seniority and role tenure, theory predicts that gendered patterns of epistemic injustice may prove more persistent and less reversible across career stages. Gender shapes not only initial exposure to credibility deficits during commissioning but also the cumulative durability of those deficits over time. Early commissioning experiences may have disproportionate long-term effects on women's career trajectories in technical leadership.

# 6. DISCUSSION

## 6.1 Contributions

This study makes three primary contributions to the social psychology of status and to scholarship on gender, engineering work, and project-based technical practice.

### *6.1.1 Integrating Status Theory and Epistemic Injustice*

This analysis extends epistemic injustice theory into time-pressured, high-stakes project phases—a context to which Fricker's (2007) framework appears not to have been previously applied. Drawing also on status characteristics theory (Ridgeway 2001), it demonstrates how structural conditions in commissioning amplify status-based credibility dynamics. The Invisible Hands Phenomenon theorises how hermeneutical injustice compounds testimonial injustice when interpretive resources themselves are contested: engineers engaged in anticipatory work lack established frameworks for articulating the value of their contributions, thereby intensifying the credibility challenges they face.

### *6.1.2 Commissioning as a Critical Case*

This study positions commissioning as a critical case for understanding gendered dynamics in technical work (Flyvbjerg 2006). Commissioning meets Flyvbjerg's criteria for a critical case because it is both extreme in its epistemic conditions and theoretically illuminating: if status-based credibility dynamics operate anywhere, they will operate here. Commissioning's role as a gateway to senior technical positions means that epistemic injustices concentrated in this phase have multiplicative career effects, converting interactional disadvantage into structural inequality (Singh and Anumba 2024). Studying project phases discretely reveals how inequalities are actively constructed through the temporal organisation of work itself.

### *6.1.3 Methodological Contribution*

Methodologically, this study demonstrates the value of conceptual analysis for empirically neglected intersections. When prior empirical evidence is absent, theoretical frameworks are needed to explain why the gap matters and what dynamics may be operating. The synthesis of status characteristics theory, commissioning literature, gender in engineering scholarship, and epistemic injustice theory creates an interpretive architecture that subsequent empirical work can test, refine, or challenge. The cross-national survey data (Ayres et al. 2026a) provide structural grounding and practitioner validation while stopping short of causal claims; the conceptual framework specifies what observational and longitudinal research should look for.

## 6.2 Implications

### *6.2.1 Implications for Practice*

This paper suggests three practical implications. First, visibility systems should explicitly document preventive and anticipatory contributions. Anticipatory work—identifying risks before they materialise, integrating systems before conflicts emerge—is technically demanding yet organisationally undervalued. Structured documentation protocols should record risks prevented and coordination work that enabled smooth handovers, creating an evidence base for contributions that currently remain invisible. Second, task allocation monitoring can reveal whether credibility patterns rather than capability drive assignment decisions. Where high-visibility troubleshooting is consistently allocated to some engineers while preventative tasks go to others, managers should examine whether these patterns

correlate with demographic characteristics. Third, safety voice governance must account for the dynamics of credibility. Anonymous reporting systems, structured safety debriefs, and explicit protocols for responding to concerns can reduce the role of interpersonal credibility in determining whose voice matters. Tracking not only what concerns were raised but also who raised them and what follow-up occurred can surface patterns in which certain engineers' concerns are consistently deprioritised.

#### *6.2.2 Implications for Research*

For researchers, this study underscores the value of phase-specific analysis in engineering work. Treating engineering practice as a uniform context obscures how different project phases shape gendered authority, recognition, and career progression. Commissioning's structural conditions—uncertainty, time pressure, distributed authority—make it a theoretically rich site for examining when and why epistemic injustice intensifies. Future research should examine task allocation, credibility dynamics, and safety voice across distinct project phases—design, construction, commissioning, operations—to determine whether the patterns identified here are commissioning-specific or represent broader phenomena that intensify during high-pressure transitions.

Empirical research is needed to test these dynamics. Observational studies of commissioning teams could examine real-time task allocation and which technical judgements are accepted. Longitudinal tracking of careers before, during, and after commissioning assignments would reveal whether experience translates into advancement differently for women and men. Survey research could quantify the prevalence of strategic invisibility and credibility-driven decision-making in safety voice.

Two commissioning-specific constructs warrant dedicated investigation. The Commissioning Visibility Deficit (CVD) operates at the institutional level—commissioning's absence from professional standards and curricula (Ayres et al. 2026a)—and at the project level, where anticipatory work is organisationally undervalued. Commissioning Risk Drift (CRD)—the process by which credibility-driven task allocation shifts risk exposure and responsibility attribution—requires empirical examination through longitudinal tracking of task allocation patterns, responsibility accumulation, and attribution in incident investigations.

Finally, intervention research is necessary. If credibility audits, visibility protocols, and safety voice accountability systems are implemented, experimental or quasi-experimental designs could assess their effectiveness in disrupting gendered patterns of task allocation and recognition. Action research approaches could work with commissioning organisations to co-design and test interventions, documenting what works, what fails, and under what conditions change is possible. Such research would move beyond documenting inequalities to building evidence for transforming commissioning practice.

### 6.3 Limitations

This study develops a conceptual framework grounded in survey data and practitioner accounts but without direct observational testing of the theorised mechanisms. The study relies on self-reported survey data rather than direct observation of commissioning practice, and findings reflect patterns within this dataset rather than verified causal pathways. Future research should examine these dynamics through observation of commissioning teams, analysis of task allocation patterns, and longitudinal studies of career trajectories. Empirical validation across different commissioning contexts would strengthen the framework's applicability.

## 7. CONCLUSION

This study establishes commissioning engineering as an empirically neglected yet theoretically significant site for understanding how gendered credibility dynamics operate in professional technical work. Targeted literature searching identified no peer-reviewed studies examining gender within commissioning contexts, despite commissioning's documented role as a gateway to senior technical positions and its concentration of conditions (Singh and Anumba 2024)—high uncertainty, acute time pressure, distributed authority, and safety-criticality—under which gendered inequalities are known to intensify. This omission represents a significant gap in gender and work scholarship, which has largely treated engineering practice as uniform rather than attending to how specific project phases concentrate epistemic disadvantage.

The Invisible Hands Phenomenon, credibility circuits, and credibility deficit cascade provide new theoretical constructs for the status literature: they specify how status processes generate organisational invisibility, accumulate across career stages, and convert interactional inequality into structural disadvantage. The framework also provides a foundation for intervention research (Berger 1977)—the expectation states tradition has demonstrated that status effects are disrupted by explicit equalisation mechanisms, and the commissioning context suggests practical candidates: credibility audits, visibility protocols, and safety voice accountability systems. More broadly, this study shows that phase-specific inquiry reveals how inequalities are reproduced through the temporal organisation of work itself. When status-based credibility serves as a gatekeeper to technical authority, organisations lose the benefit of diverse technical judgement precisely when uncertainty and complexity make it most valuable. Commissioning is therefore not exceptional but revealing: its extreme conditions make visible the status processes that operate more subtly across other phases of engineering work.

### Author Positionality

As an engineer with more than twenty-five years of experience in socio-technical safety, commissioning, and organisational systems work, my perspective is shaped primarily by long-term engagement with complex technical environments and the practical realities of engineering judgement. This professional background informs how I understand credibility, integration, and the undervaluation of preventative and anticipatory labour. My approach to this conceptual analysis is grounded in practice-based knowledge and a commitment to improving the organisational conditions under which engineers exercise expertise, rather than in personal narrative.

### Protection of Vulnerable Populations

This manuscript draws on anonymised survey data reported in full in Ayres et al. (2026a, 2026b). No primary data collection was conducted for this paper. Participant data were collected in accordance with the informed consent procedures described in those manuscripts. Care was taken to avoid deficit framings and to represent gendered organisational dynamics responsibly, particularly when discussing credibility, marginalisation, and inequity in engineering practice.

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**Conflict of Interest Statement**

The author declares no conflicts of interest.

**Use of AI statement.**

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**References**

Acker, Joan. 1990. "HIERARCHIES, JOBS, BODIES: A Theory of Gendered Organizations." *Gender & Society* 4 (2): 139–58. https://doi.org/10.1177/089124390004002002.

Ayres, J. R., I. May, R. Bustami, J. H. Adam, and SHPW Gamage. 2026a. "Pre-Print - Global Workplace Pressures in Engineering: A Cross-Sectional Survey of Role-Based Pressures, Peer Influence, and Psychological Outcomes." Preprint. https://doi.org/10.31224/6598.

Ayres, J. R., Ian May, Rosmina Bustami, Jethro Adam, and Sithara Gamage. 2026b. *Pre-Print. What Engineers Actually Say: A Qualitative Analysis of Workplace Pressure in a Global Engineering Survey*. March 10. https://doi.org/10.31224/6614.

Berger, Joseph, ed. 1977. *Status Characteristics and Social Interaction: An Expectation-States Approach*. Elsevier Scientific Pub. Co.

Bosch-Rekveldt, Marian, Yuri Jongkind, Herman Mooi, Hans Bakker, and Alexander Verbraeck. 2011. "Grasping Project Complexity in Large Engineering Projects: The TOE (Technical, Organizational and Environmental) Framework." *International Journal of Project Management* 29 (6): 728–39. https://doi.org/10.1016/j.ijproman.2010.07.008.

Britton, Dana M. 2000. "The Epistemology of the Gendered Organization." *Gender & Society* 14 (3): 418–34. https://doi.org/10.1177/089124300014003004.

Cech, Erin A. 2013. "The (Mis)Framing of Social Justice: Why Ideologies of Depoliticization and Meritocracy Hinder Engineers' Ability to Think About Social Injustices." In *Engineering Education for Social Justice*, edited by Juan Lucena, vol. 10. Philosophy of Engineering and Technology. Springer Netherlands. https://doi.org/10.1007/978-94-007-6350-0_4.

Detert, James R., and Ethan R. Burris. 2007. "Leadership Behavior and Employee Voice: Is the Door Really Open?" *Academy of Management Journal* 50 (4): 869–84. https://doi.org/10.5465/amj.2007.26279183.

Eagly, Alice H., and Steven J. Karau. 2002. "Role Congruity Theory of Prejudice toward Female Leaders." *Psychological Review* 109 (3): 573–98. https://doi.org/10.1037/0033-295X.109.3.573.

Edmondson, Amy. 1999. “Psychological Safety and Learning Behavior in Work Teams.” *Administrative Science Quarterly* 44 (2): 350–83. https://doi.org/10.2307/2666999.

Faulkner, Wendy. 2009. “Doing Gender in Engineering Workplace Cultures. I. Observations from the Field.” *Engineering Studies* 1 (1): 3–18. https://doi.org/10.1080/19378620902721322.

Flyvbjerg, Bent. 2006. “Five Misunderstandings About Case-Study Research.” *Qualitative Inquiry* 12 (2): 219–45. https://doi.org/10.1177/1077800405284363.

Fricker, Miranda. 2007. *Epistemic Injustice: Power and the Ethics of Knowing*. Oxford university press.

Heilman, Madeline E. 2012. “Gender Stereotypes and Workplace Bias.” *Research in Organizational Behavior* 32 (January): 113–35. https://doi.org/10.1016/j.riob.2012.11.003.

Locatelli, Giorgio, Mauro Mancini, and Erika Romano. 2014. “Systems Engineering to Improve the Governance in Complex Project Environments.” *International Journal of Project Management* 32 (8): 1395–410. https://doi.org/10.1016/j.ijproman.2013.10.007.

Powell, Abigail, Barbara Bagilhole, and Andrew Dainty. 2009. “How Women Engineers Do and Undo Gender: Consequences for Gender Equality.” *Gender, Work & Organization* 16 (4): 411–28. https://doi.org/10.1111/j.1468-0432.2008.00406.x.

Ridgeway, Cecilia L. 2001. “Gender, Status, and Leadership.” *Journal of Social Issues* 57 (4): 637–55. https://doi.org/10.1111/0022-4537.00233.

Singh, Jyoti, and Chimay J. Anumba. 2024. “Building Commissioning Process and Documentation: A Literature Review and Directions for Future Research.” *International Journal of Construction Management* 24 (1): 75–85. https://doi.org/10.1080/15623599.2023.2211409.

Whyte, Jennifer, Angelos Stasis, and Carmel Lindkvist. 2016. “Managing Change in the Delivery of Complex Projects: Configuration Management, Asset Information and ‘Big Data.’” *International Journal of Project Management* 34 (2): 339–51. https://doi.org/10.1016/j.ijproman.2015.02.006.

Williams, Christine L. 2013. “The Glass Escalator, Revisited: Gender Inequality in Neoliberal Times, SWS Feminist Lecturer.” *Gender & Society* 27 (5): 609–29. https://doi.org/10.1177/0891243213490232.

Williams, J., Katherine W. Phillips, and Erika V. Hall. 2014. “Double Jeopardy? Gender Bias Against Women of Color in Science.” Preprint, Unpublished. https://doi.org/10.13140/2.1.1763.8723.