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ARTICLE

King of the castle: organisational influences on authority gradients between network controllers and other team members

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ABSTRACT

The rail system relies on the effective coordination of multiple disciplines and teams situated within an operational hierarchy to meet a single operational objective—the safe and timely movement of rail traffic. Power and status dispersals across these teams and the various roles within them impact interaction and communication. This study drew on the perceptions of network controllers, to identify organisational factors influencing power imbalances that generate authority gradients between network controllers and other team members. Network controllers ($N = 55$) across eight Australasian organisations engaged in interviews using the Scenario Invention Task Technique to explore perceptions of risk. Thematic analysis revealed relationships between teams were affected by: (1) the accountability mechanisms adopted by organisations; (2) the way power was vested in roles; and (3) the status attached to roles. This insight into organisational power hierarchies and the generation of authority gradients provides opportunities for understanding teamwork error.

Practitioner summary: Communication is impaired by authority gradients across teams in rail and is a contributing factor in incidents occurring on the network. This paper explores the organisational influences on power hierarchies across teams from the perspective of the network controller, pointing to an adversarial culture, resulting in tribalism impeding team interactions.

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Rail; authority gradient; power; organisational influences

1. Introduction

Rail is a highly regulated, safety-critical complex system (Read, Naweed, and Salmon 2019), where geographically dispersed teams rely on telecommunications (Roth, Naweed, and Multer 2020). As effective communication is key for safe working (Calabrese et al. 2017), focus is placed on communication rules, procedures, and protocols (Turner et al. 2017). Despite this, incidents involving communication failure persist (Andrén, Sanne, and Linell 2010; ATSB 2017; FTA 2022; RAIB 2021b).

Issues with phraseology, protocol misunderstanding, language proficiency, and transmission quality invariably impact communication, but the relationship dynamics between those exchanging information are also important (Dunbar 2015; Luva and Naweed 2022), and influence the way information is conveyed (Streeton et al. 2016). However, this area is underresearched in rail (Luva and Naweed 2022; McInerney 2005), and needs investigation to better understand the nature of miscommunication in this environment.

In aviation, Edwards (1988, as cited in Alkov et al. 1992) coined the term 'trans-cockpit authority gradient', reflecting an unequal distribution of positional power. Here, an individual is less likely to challenge the decisions of another if they perceive a power imbalance (Green et al. 2017). Thus, a co-pilot may not challenge the directives of the pilot if they perceived themselves to hold less power, even if they disagree with them. This term was later broadened to 'authority gradient' and characterised as an impediment to effective communication (Sasou and Reason 1999), and by extension, team performance. Authority gradients are linked to differences in experience and perceived value or status in roles within an organisation (Dobson, Moors, and Norris 2014). They can also occur across teams operating under hierarchical structures, such as between nurses and doctors (Appelbaum

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et al. 2016) and firefighters and emergency medical services personnel (Griffith, Roberts, and Wakeham 2015). Hierarchical structures and supervisory authority are associated with power imbalances leading to authority gradients (Cosby and Croskerry 2004) in organisations that adopt a structure where 'differently ranked job holders are assigned rank-specific duties' (Jervis 2002, 14). Employees are held accountable to those higher up, which inhibits free information exchange and creates a power imbalance. A large difference in power is characterised as a 'steep' gradient, whereas one with a small difference in power is 'shallow' (Dobson, Moors, and Norris 2014).

Network controllers and those operationalising their plans (e.g. area controllers, signallers) are typically responsible for the safe operation of rail traffic and maintenance crews.[1] (Dorrian, Baulk, and Dawson 2011). Figure 1 conceptualises the status/value and authority/power relationships between core operational teams in rail and reflects network controllers as a grouping at the apex of the hierarchy (Cheng and Tsai 2011; Luva and Naweed 2022) as both train and maintenance crews must acquire their authorisation before moving on the network. Track maintenance teams typically incorporate protection officers[2] who ensure their onsite safety by communicating with network controllers (Naweed, Young, and Aitken 2019). Aboard the train, a single driver or multi-person crew share in driving responsibilities (Naweed, Balakrishnan, and Dorrian 2018), and navigate paths set by the network controller. Adverse scenarios relating to network controller interactions with these groups include: 'SPADs', i.e. trains passing a signal at danger (ATSB 2011; RAIB 2014); errors in placement/removal of protection(s) resulting in traffic entering active worksites (ATSB 2015; TSB 2015); and workers entering active rail corridors without adequate protection (NTSB 2021; RAIB 2021a).

1.1. Towards understanding organisational influences on authority gradients in rail

Appelbaum et al. (2016, 348) state that organisations 'must take on the role of facilitating positive relationships between high and low status team members through procedures and policies that flatten hierarchy and develop leaders who exhibit inclusive behaviours'. Authority gradients within rail have been recognised at a high level (McInerney 2005), and they are known to exist between train drivers and network controllers (Dobson, Moors, and Norris 2014).

In a previous study, we identified hostile behaviour, disparaging language, punitive action, and pressure for compliance as some of the behaviours that network controllers may apply to maintain a power imbalance (Luva and Naweed 2023). This study, conducted with 55 network controllers from eight organisations across Australia and New Zealand, was a formative step into understanding the generation of authority gradients between network controllers, train crew, and track maintenance workers, and centred on understanding the individual team member's

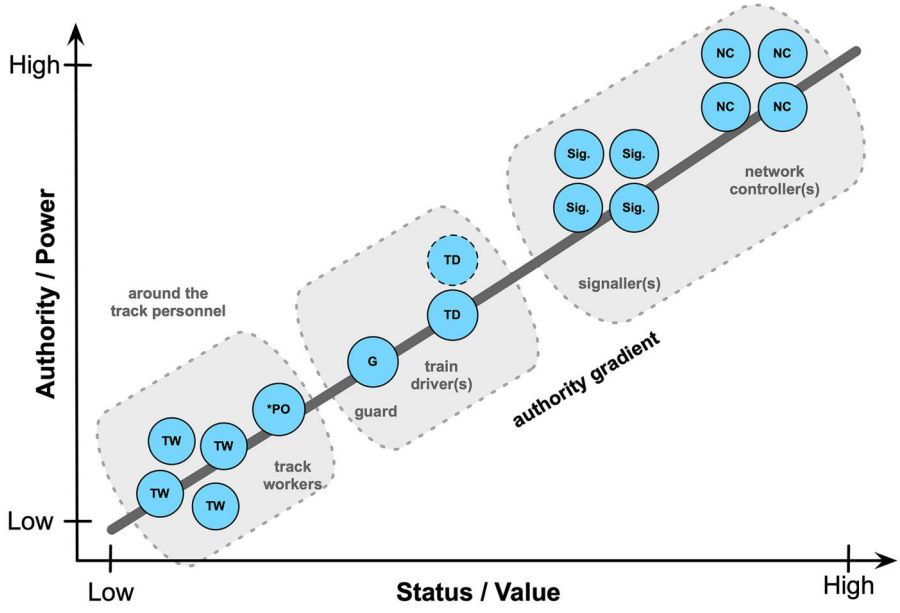

Figure 1. Authority gradients between multidisciplinary operational teams are influenced by status/value relationships with authority/power (from Luva and Naweed 2022). *Note:* Terminology is Australian domain specific, and box-shading is representative of operational teams that are co-located.

contribution to authority gradient generation across teams. In this study, the attitudes and behaviours linked with network controller perceptions of power were characterised under two themes that reflected the: (1) motivations for network controllers to maintain a power differential; and (2) behaviours network controllers used to reinforce a power differential, illustrated in Figure 2. The fear associated with the risk and consequence of error, and mistrust in the capability of other teams, effected a steepening of the authority gradient, due to the behaviours associated with efforts to mitigate risk.

Our previous study delved into how the inter-individual and between-team power hierarchies resulted in an authority gradient generation, with a focus on individual motivation and individual behaviours. However, what is currently lacking in the research space are the organisational influences; that is to say, what the organisation itself does to create an operational hierarchy where power imbalances are institutional rather than created by individual behaviours. In a sense, we have some idea of the motivations and behaviours for a network controller to effect an authority gradient, but we do not know how and to what extent the organisation drives these motivations and behaviours. In our previous study, we suggested that communications and interpersonal interactions across teams are influenced by an organisation's structure, where 'an entrenched power disparity between roles' exists (Luva and Naweed 2023, 14). Hence, in this companion paper, we seek to build on these findings by focussing on the influence of the organisation and its hierarchical structures on the generation of power imbalances. These power imbalances occur outside a direct supervisory relationship, similar to the medical context in which Oborn and Dawson (2010) found a hierarchical structure of professional groups. In this example, the contributions of some professional groups (i.e. nurses), were not valued to the same degree as others (i.e. surgeons). This

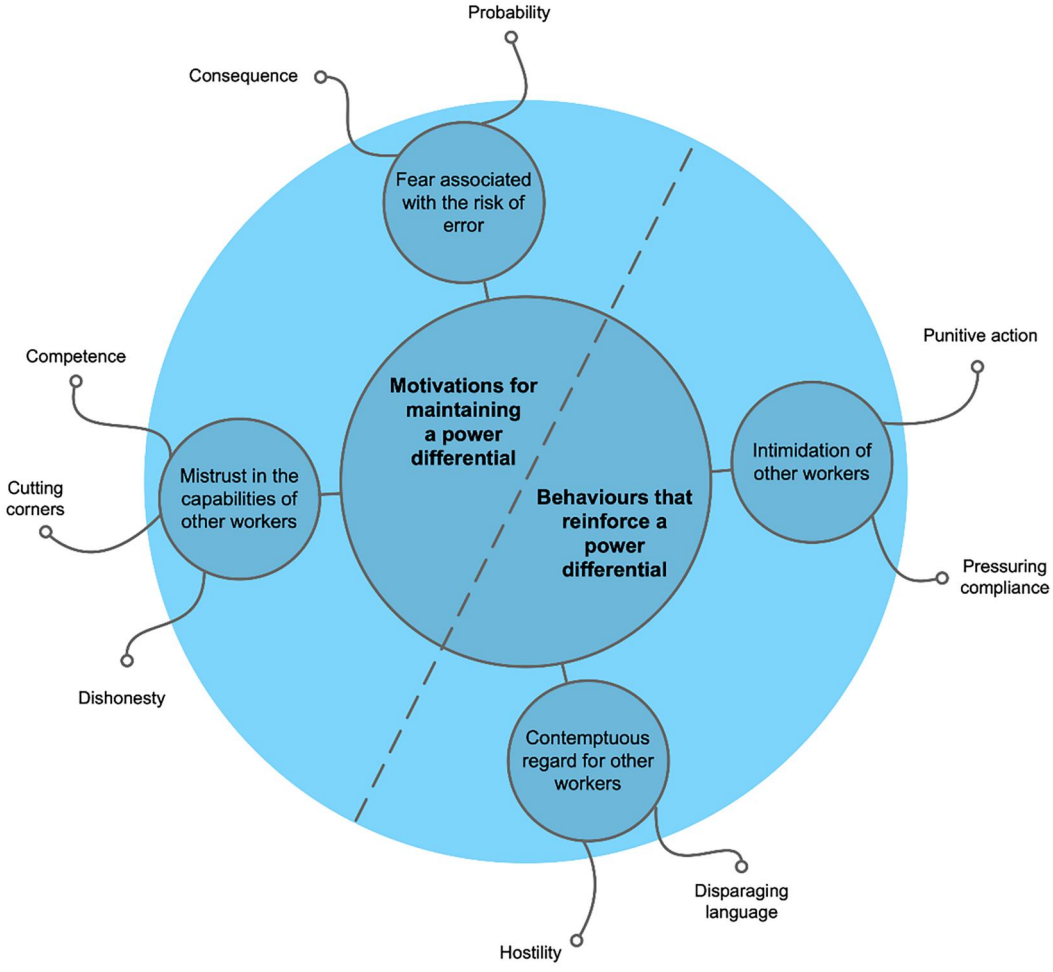

Figure 2. Themes (inner-circle) and subthemes (outer-circle) forming the basis of thematic analysis in companion paper, *Authority Gradients Between Rail Network Controllers, Train Crew & Track Workers in Australia & New Zealand—Motivations & Behaviours* (Luva and Naweed 2023).

distinction in role value within an organisational hierarchy supports the theory that authority gradient generation can be a systems problem, and organisational influences are key to exploring this systems approach.

In rail, the focus currently remains on improving communication through standardised protocols or rules and procedures (Dobson, Moors, and Norris 2014), and encouraging individual empowerment, such as non-technical skill training to increase assertiveness (Naweed and Murphy 2023; RSSB 2016). Given the implications of miscommunication in rail, and the new insights being gained in this area, mitigative approaches require a more holistic view of communication error and need to examine how power imbalances are influenced by organisational hierarchy. To this end, the focus should remain with network control, given its hierarchical positioning, safety-criticality, and extent to which interactions occur with other groups. Understanding how hierarchical power imbalances impact the way communications occur may provide a new dimension for establishing the contributing factors in rail incidents.

1.2. Aims and objectives

The network control role is responsible for the safe separation of rail traffic, protecting track maintenance teams, coordinating emergency responses to incidents and accidents, and applying safe working standards and procedures. It is thus pivotal to operational functions (Cheng and Tsai 2011). In light of the foregoing discussion, the aim of this study was to build on and extend the findings reported in Luva and Naweed (2023) and explore how authority gradients across rail operational teams are influenced by an organisational hierarchy. The objective was to undertake a new and focussed analysis of the same comprehensive dataset as the previous study, with new research questions exploring network controller perspectives on power and status, focussed on organisational influences. These were:

> RQ1. Based on perceptions of network controllers, what organisational factors influence how much power is held by different operational teams in rail?
>
> RQ2. How do network controller perceptions of power imbalances across the rail operational hierarchy influence the generation of authority gradients?

2. Methods

2.1. Study design

This study undertook a new and focussed analysis of an existing qualitative dataset. Reanalysis of qualitative data is purported to be at the core of qualitative research (Wästerfors, Åkerström, and Jacobsson 2014). It allows researchers to ask new questions, investigate different themes, and facilitates dialogue, debate, and progression in areas where it is needed. Reanalysis is also said to slow down analysis 'to a point at which new findings, theories, and methodologies can more easily crystallise' (Wästerfors, Åkerström, and Jacobsson 2014, 467). As such, the design of this study reflected the same details given in Luva and Naweed (2023). To summarise it here, a qualitative inquiry helped understand the experiences and perspectives influencing how participants (network controllers) work and interact with other teams (Curry, Nembhard, and Bradley 2009).

The dataset underlying this study was collected and established through one-to-one interviews that incorporated the Scenario Invention Task Technique (SITT) (Naweed 2015). The SITT is a tool to elicit participant knowledge and does so through the generation of hypothetical scenarios encouraging reflection and introspection (Monk and Howard 1998). Its efficacy has been verified in aged care (e.g. Naweed, Stahlut, and O'Keeffe 2021), aviation (e.g. Naweed and Kingshott 2019), maritime tourism (e.g. Pabel et al. 2022), and rail (e.g. Naweed 2013).

2.2. Participants and recruitment

The participants and recruitment sample underlying the dataset being analysed in this study followed a maximum variation sampling approach (Palinkas et al. 2015). Australia and New Zealand have a bespoke rail industry, meaning that ways of working, rail modes, and conventions differ across the industry. Participants were therefore recruited based on organisations as a unit of analysis, and sampled participation within each organisation was based on the size of their network control cohort. Data saturation during collection was monitored in terms of the scenarios and themes being conveyed in each organisation as well as the sample across organisations as a whole. A total of 55 interviews with network controllers from eight organisations across Australasia (seven Australia; one New Zealand) underpinned the dataset, with the sample including four females and 51 males, with age ranging from 22 to 67 years ($M_{age} = 45.5$; $SD = 11.1$). Most had more than 10 years of experience in their role ($M_{exp} = 15.83$, $SD = 12.18$). Organisations were recruited for their support from a national working group. Individually, participants (i.e. network controllers) were recruited

with an Information Sheet entitled *Improving Rail Safety through Teamwork: The Controller Perspective*. The study was expressed as an exploration of the controller perspective around how safety risks are perceived, managed, and mitigated, and identifying the fundamental human factors issues involved in the tasks performed by network controllers and in teamwork with other personnel.

2.3. Procedure

After participant consent was obtained, the interviews underlying the dataset occurred in two parts (see Figure 3). First, a series of (closed, cued, and open-ended) questions delved into the substance of participant roles in their organisations, operational hierarchy, and relationships with others. The second part initiated the SITT with instructions to consider a scenario where a network controller may inadvertently increase safety-risk. Scenarios were created using felt-tip pens/markers on A3 paper. Interviews were audio recorded and ranged from 90 to 120 min. Figure 4 shows a scenario illustration from the study as an exemplar of what these drawings looked like and the caption elaborates on the content. Further examples are given in Luva and Naweed (2023). The study was approved by the Human Research in Ethics Committee of CQUniversity under Approval No. 0000021909.

2.4. Data analysis

The dataset was comprised of transcriptions of voice recordings, which were supported by scenarios. Like the study in our previous paper (Luva and Naweed 2023), the research questions formulated in the current paper were used to guide a thematic analysis (Braun and Clarke 2012) concentrated at a 'latent level' (Bengtsson 2016). However, the focus here was on organisational influences on the balance of power across different operational teams. Thus, it sought to interpret and identify the underlying meaning expressed in concepts and implicit ideas, as they relate to the 'organisational climate', i.e. shared perceptions across an organisation (Wallace, Hunt, and Richards 1999), instead of individual contributions. Core themes and sub-themes emerged from connections between recurring variables (Birks and Mills 2015), in this case, attitudes pointing to values and beliefs endemic to the participating organisations. The process extracted and identified salient power/status dimensions between network controllers and other teams. Memos were created concurrently as the coding process progressed from initial coding and categorisation of data through to write-up, providing rich

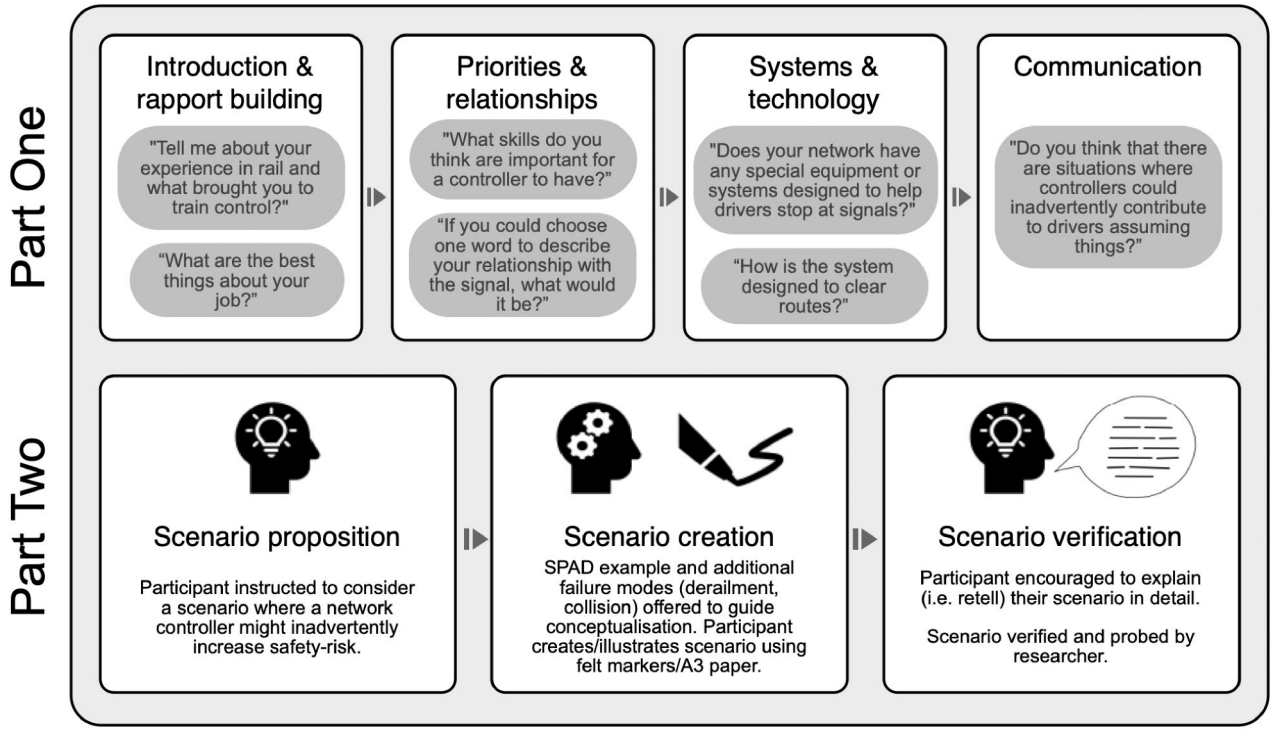

Figure 3. Overview of the interview protocol (read left to right). Example questions illustrated Part One and the key steps involved in the SITT outlined in Part Two.

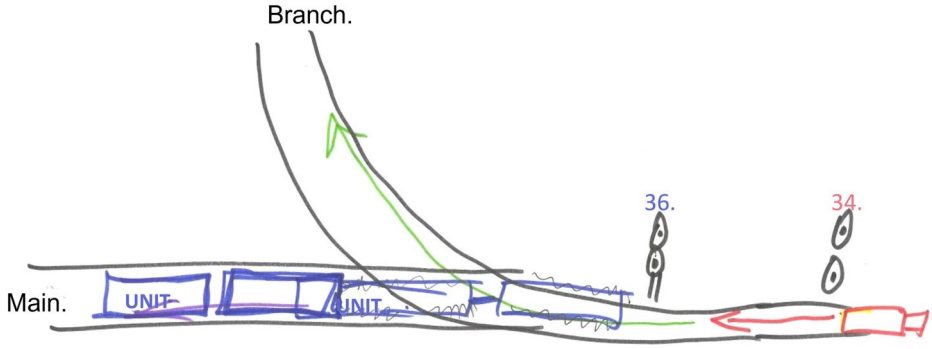

Figure 4. An example SITT scenario created by a study participant during interviews, reflecting a confluence of factors which they perceived might lead to a network controller inadvertently increasing safety risk. Handwriting has been replaced with typescript. The drawing itself displays a topographical formalism analogous with how rail and interlocking is presented to network controllers on mimic boards. The scenario itself depicts a potential for collision due to lack of clear and concise instructions from the network controller. In this scenario, the train consist (shown as blue rectangles travelling from right to left and referred to as a 'unit' by this participant) is incorrectly directed onto the main line (the principal arterial line in the system) instead of the branch line (a secondary railway line). The unit is stopped and a conversation occurs between the driver and the network controller. The driver assumes he has authority to move the train backwards, and starts moving it so that it is on the approach side of Signal 36—the signal the unit has just passed. However, the network controller has not given this authority and another train (shown as a red-coloured rectangles on the bottom-right of the picture) is already on approach to signal 36. The blue unit risks colliding with the oncoming red unit. This scenario is a platform now used to probe the relationship between driver and controller and power dynamics.

'intellectual capital' to draw from; also referred to as 'intellectual assets', this highlights the rich insights and important utility gleaned from memos for developing the comprehension of data (Birks and Mills 2015, 11). Analysis was again undertaken using NVivo (ver.12) in six steps as outlined by Braun and Clarke (2006):

1. *Understanding the data*: Interview transcripts were actively read and re-read, with patterns within responses identified and noted;
2. *Devise initial codes*: Relevant text was organised into groups that identified a feature of the data and captured patterns in the attitudes and beliefs of participants. Perceptions relating to an organisation's operation that influenced imbalances in power across teams were conceptualised into code titles;
3. *Identify themes*: Codes were grouped into overarching themes related to operational functions that illustrated the broad organisational climate of status and power;
4. *Review of coding*: Data were reviewed and codes evaluated as to their relevance with themes and subthemes;
5. *Refine themes*: Themes structured the data in a way where a narrative could be built around the 'story' it told; and
6. *Write-up*: Analysis was finalised and study findings written up.

Codes were created by defining what was seen in the data (Bryant and Charmaz 2007), in the context of the guiding research questions (i.e. codes concerned with organisational factors influencing power imbalances across teams and the rail operational hierarchy). As broad topics were identified, they were clustered into groups with unifying features and identified as themes (Braun and Clarke 2012). When linked, the themes offer a basis for understanding what aspects of an organisation's operations can influence how much power is held across the different operational teams and how perceptions of power are generated and reinforced at an organisational level across the rail industry.

2.5. Trustworthiness

The SITT involved repeated checks of understanding to ensure accurate representation of participant perspectives. The protocol was piloted with two rail organisational contacts. The research team comprised two investigators. One (the lead author) was an early career researcher with five years' prior experience as a network controller, and familiarisation with the role and workings of the rail system from an operational perspective. The second (also the second author) was a senior researcher with more than 15 years' experience in rail human factors. The second researcher designed the study and collected all the data. The first researcher analysed the data with the support of the

second at every step of the process. The team was aware of their roles as research instruments, versed in managing 'insider research' (Greene 2014, 2), and discussed their own assumptions and possible biases on the research topic at length (Creswell 2013). All quotes and excerpts reported were accompanied by ID-tags to illustrate prevalence and spread within the data.

3. Results

Three overarching themes were identified as reflecting organisational influences contributing to the generation of authority gradients. These were: (1) accountability mechanisms; the (2) power vested in roles; and the (3) status attached to roles. Figure 5 conceptualises each of the themes and their subthemes as an interlaced triquetra (or trefoil knot) to convey the close and causal interrelationships between them.

3.1. Accountability mechanisms

This theme encompassed perceptions of how an organisation investigated error and apportioned blame, which was identified as a primary driver in an adversarial mentality amongst participants. Feeling unfairly blamed for error, being fearful of consequences of error, and practical examples of corrective/disciplinary action taken by organisations were clustered within this theme.

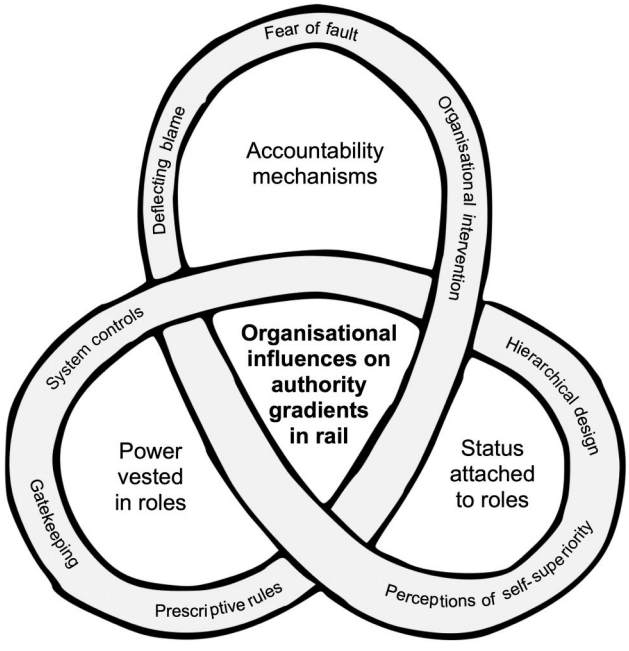

Figure 5. Identified themes conceptualised within an interlaced triquetra, with overlapping arcs illustrating the connectedness between different key themes and subthemes.

3.1.1. Fear of fault (fear/apprehension of being found to be at fault)

Participants were afraid of being at fault, *'oh shit have I done something wrong?' (Org1_Ppt3)* and tended to position themselves in opposition to other working groups in scenarios when considering their contribution to error:

> Has there been something that I could have done or is it the driver? There's really only three factors – is it infrastructure and then the other two is personal as in, driver going past or did I put a signal back that I shouldn't have? (Org1_Ppt3)

It was important for participants to know who was responsible for error, *'I like to look at the last button I touched, so okay, I wasn't the cause of it'* (Org2_Ppt10). Participants felt they needed to be prepared to justify their decisions, should an action be later called into question:

> We can make the decision what we think is correct at the time, but [managers are] going to come back and say – well, why did we do this? You knew you didn't have time. [Org4_Ppt26)

> If [the network controller] hasn't set the signal, management at times have tried to say that he's contributed to the SPAD.[3] (Org4_Ppt27)

The paperwork associated with the Train Order method of working was referred to by one organisation as *'suicide notes'*. These paper-based authorities that required an exchange of information via radio or telephone were described as *'the most likely thing to get a train controller stood down'* (Org1_Ppt5).

3.1.2. Deflecting blame (seeking to apportion blame to other team members)

Feelings of apprehension about being blamed for error, and a refusal to acknowledge contribution to error, underscored a tendency for deflecting blame. Some high-risk error scenarios (e.g. SPADs) were attributed solely to others, for example by the '*driver not paying attention, not following coloured light system*' (Org4_Ppt26), and '*if drivers drove to signals, they wouldn't have SPADs*' (Org4_Ppt25). Blame was also deflected to communications with track workers, for example, being '*preoccupied with other TOA's*[4] *on the network*' (Org4_Ppt20) was perceived to have diminished capacity to advise a traincrew of their approach to a stop signal, which then resulted in a SPAD.

An individualised view of error was common, for example, in the case of delay attribution for holding a train at a signal, '*the driver didn't challenge the signal, he didn't call me up and say "I'm sitting at the signal, what am I sitting here for?"*' (Org1_Ppt9), '*this train had*

been sitting for 15 min and hadn't called and said anything' (Org5_Ppt35), and in the case of safety incidents, '*it is the first question asked on most SPADs of the controller—"why wasn't the signal set?"*' (Org4_Ppt27). Participants perceived inequality about the extent to which controllers were held accountable in scenarios where they held no responsibility, for example, in train operation:

> One of the things that is a big bugbear of mine is when we do have a SPAD where a driver has passed the signal, where it's the driver's fault, the first thing they ask [the controller] is – why wasn't the signal at proceed? (Org2_Ppt17)

3.1.3. Organisational intervention (action taken by an organisation in the event of an incident)

Disciplinary action and staff performance management activities were both an organisational intervention providing the impetus for controllers to identify fault and attribute blame when errors occurred, '*you've got to give a "please explain" as to why you've done that*' (Org1_Ppt9). Interventions included: being '*stood down*' (Org6_Ppt45, Org7_Ppt52, Org7_Ppt51); taking a '*drug test*' (Org7_Ppt51, Org6_Ppt45); being called into a '*disciplinary meeting*' (Org6_Ppt37); and having incident details formally entered into a '*risk register*' (Org6_Ppt45). An organisational intervention was viewed as a punitive response to error, indicative of hierarchies of accountability, and gave rise to feelings of unjust treatment:

> First and foremost what we'll do is we'll take the controller out of the control room, and that's not a penalty in itself, it's just first and foremost we'll get the people out in the field and the network controller, if it's warranted, or if there is a sense that they had an involvement into the adverse outcome, all parties will be drug and alcohol tested to first determine was that a cause and a factor. (Org3_Ppt15)

Network controllers perceived that they were held accountable for errors and schedule disruptions resulting from actions by other members of the operational team:

> If one part of that team buggers up, you know, he's in trouble – well, both in trouble until they work out what happened. (Org4_Ppt20)

Being held to account for discharging an activity over which they held no responsibility created a perceived inequity, which impacted subsequent interactions and behaviours. Mitigations included a more authoritarian approach to communication to achieve compliance, i.e. '*a controller's got to take responsibility for everything he does and sometimes that means you've got to be a bit more forceful*' (Org1_Ppt4).

3.2. Power vested in roles

This theme clustered perceptions of the network controller *role* within an organisational structure possessing power through knowledge, and by holding authority over the operations of other teams based on regulatory principles and through system controls. This theme centred on how the power distribution among *roles* within the multidisciplinary team were inherently unbalanced.

3.2.1. System controls (functionality of the control interface systems)

As made evident in the scenarios, the network control role was enacted through various systems controls. The network controller controlled signalling systems, directed routes for rail traffic, and authorised safe working forms for overriding signal operation, including protection mechanisms for excluding rail traffic from maintenance sites. While this conferral of power to the network controller was a necessary tool for controlling network activities, it was also a source of conflict with others:

> I had a maintenance fitter, he's an expert as well, but he says the fitter is out in the field saying the points are locked. […] I said – 'no, I'm not issuing an order, the rules specifically state green or yellow route line to be able to authorise a driver to pass that signal at stop.' I said 'unless you ring rail safety and tell them the situation and if they say it's okay, fine, but as far as I'm concerned they're the rules.' So, yes, I've had to stand up for myself many times and say 'no, that's not what the rules say.' (Org2_Ppt19)

A 'special proceed authority' was issued to train drivers to authorise movement of rail traffic when signalling systems were not operational. Similarly, a 'track occupancy authority' or 'track warrant' was issued to track workers to grant permission to undertake maintenance work. Controlling when and how authorities were issued reinforced power imbalances. When a track worker failed to adhere to the agreed time permitted to work on track, '*I'm straight away going to reduce his time slot*' (Org4_Ppt20). System controls enabled participants to create barriers to track workers in achieving their objectives, without challenge from track workers.

Participants created scenarios where the control being exerted over signalling, e.g. '*it's my empowerment to give authority for a train to enter and run into a section of line*' (Org5_Ppt34), engendered conflicts, such as drivers becoming impatient when stopped at signals, '*I've had drivers call up and say "I'm Express, why am I getting restricted signals?"*' (Org7_Ppt51).

Train crew challenged participants on their operation of system controls, calling into question their competence:

> Yeah, it always seems to be when a driver will ring me and go 'I'm stuck at signal such and such … ' as he's ringing me I've pulled the train and he goes 'oh, that'd be right, telephone signalling.' In other words, he had to ring up to remind me to signal him. And that's not the case at all. (Org2_Ppt17)

3.2.2. Gatekeeping (controlling the flow of information)

Participants' knowledge of the operational plan for the day, or the '*bigger picture*' (Org1_Ppt6), reinforced a sense of power and control over the flow of information in ways that rendered them into gatekeeping. While an unparalleled view of the network was recognised, and '*the drivers only know what we tell them*' (Org5_Ppt35), participants were frustrated that other workers who existed *'in their little bubble'* (Org4_Ppt24) did not have such a picture of the network. This resulted in negative interactions:

> You've got to be patient, which I'm not very a lot of the time, if I'm honest, because I get cross with people because they've got no clue! And why would they? You know, they're inside a truck or a train somewhere – they don't know what's going on in train control, they're just thinking they're the only person in the world. (Org6_Ppt46)

A lack of broad operational knowledge was perceived to negatively impact other workers because *'they can't see what we can see and they get frustrated'* (Org4_Ppt24), drivers felt that they were *'being forgotten'* (Org5_Ppt36), or that information was not being shared:

> The signaller had set the signal to stop and the driver came in and went 'I almost went through that because you didn't tell me what was going on!' (Org1_Ppt5)

Giving *'too much information'* (Org1_Ppt2, Org3_Ppt14, Org3_Ppt15) to other workers was considered problematic because it could induce '*assumptions*' (Org1_Ppt9) that decreased safety. Conversely, there was support for providing *'as much information as possible so that* [train crew] *can plan ahead and they can reduce the chance of them making a mistake'* (Org4_Ppt24). Knowing how much information to share or hold back was not easy to discern, '*[controllers have] either given [other workers] too much information or not enough or not the relevant information*' (Org6_Pt42).

3.2.3. Prescriptive rules (regulations prescribing activities)

Network controllers were perceived to make decisions and issue directives based on delegated authority via prescriptive rules. This influenced the empowerment of other workers:

> [The processes to issue track authorities or train orders are] based on the original fundamentals of a train authority where the controller will dictate what he wants to occur to either the track worker or the train driver. (Org7_Ppt48)

> [Network controllers have] certain rules that we have to follow with regards to priority of services and trains. (Org4_Ppt21)

Participants pointed to service agreements and *'priority rules'* (Org6_Ppt40) as the basis for operational decisions concerning access to the network for various work groups. Prioritisation of train services over unscheduled track maintenance served to reinforce the operational hierarchy across teams: '*running trains safely is obviously a priority, then maintaining the track*' (Org6_Ppt46); *'[if] getting a gang on track is going to impact my trains running late, then I won't do it'* (Org7_Ppt50); '*if somebody comes to you wanting to do some track work, you say "well, no, I'm just about to issue a train order"*' (Org1_Ppt1).

Operational priorities were also influenced by pre-existing contracts and certain kinds of track work, *'the company has priority trains. We also have very special infrastructure personnel that can sometimes be above the priority of the train*' (Org8_Ppt53);

> If a train is early then a controller can have the discretion to holding it back until it meets its on time pathway and then to continue to promote it from there. If a train's late, then controller will do every best endeavour he can to get it back on time but consider if we have a late running train up against two on time running trains, the late running train will be held back to maintain the schedule of the two on time trains. And that's part of the train management guidelines. (Org3_Ppt15)

Adhering to rules and guidelines created friction with others workers; not being aware of the larger context meant there was little to no understanding of the priority conflicts causing delay, thus, track workers became *'irritated because they can't get their work done'* (Org6_Ppt42), and train crew became *'frustrated because […] they're tired, they've had enough and train control's put them in a loop for half an hour for NO reason they can think of'* (Org6_Ppt42).

3.3. Status attached to roles

This theme incorporated findings related to the elevated importance of some functions or roles within

organisations. This included disparities in the value of some roles as something that was inherent to railway culture and institutional power imbalances through hierarchical organisational structures tied to promotional pathways.

3.3.1. Hierarchical design (ranking of roles)

The construction of the operational hierarchy was described as a '*promotion stream*' (Org1_Ppt8) by participants across all eight organisations in the study, but best exemplified by one participant as climbing '*up the ladder*' (Org1_Ppt3) after having commenced their career at the lowest rung:

> [I started in] one of two porter positions, cleaning platforms and toilets and that sort of thing. And from there sort of progressed to a relief station master, then a station master, [...] I became a guard on the trains [...] a city train network driver and [...] in the control environment. (Org4_Ppt25)

Working '*through the ranks*' (Org1_Ppt7, Org1_Ppt1) to the network control role characterised not only the hierarchy of this career pathway but also the positioning of the network control role as one that was at its apex, '*train controllers are up [at] the top*' (Org5_Ppt31). Participants with long careers tended to characterise a controller role as a career aspiration, '*I always thought it was too far to reach for*' (Org5_Ppt34) and '*I thought it was a little out of my league*' (Org3_Ppt15). Railway career ladders are a traditional approach to career continuance, and in this case, created a legacy that influenced attitudes, '*there's a lot of old guys still in the job that pass on that superiority*' (Org6_Ppt46);

> I've got a copy, I think, of 1960-odd book of rules [sic] and when you read it there's some things that have not changed whatsoever. (Org1_Ppt5)

In some organisations, a hierarchy of power was also evident within control centre operational roles, '*the signaller is under the direction of the train controller*' (Org1_Ppt1), with implications that this created animosity, '*I would say that [Train Controllers] think they control us as much as we control the signals*' (Org5, Ppt35). In some cases, these roles were a distinct promotional pathway, '*most signallers, they may progress to the role of train controller later on*' (Org1_Ppt6). Attitudes to the status attached to these roles were also perceived to extend to workers outside the control centre. For example, when asked how drivers viewed signallers, one participant expressed '*lower down the pecking order*' (Org6_Ppt34).

3.3.2. Perceptions of self-superiority (perceptions that one has an exalted status in comparison to others)

Participants shared a broad perspective about the network controller role as '*God*' (Org1_Ppt1, Org1_Ppt4, Org5_Ppt31, Org6_Ppt41, Org6_Ppt42, Org6_Ppt43, Org7_Ppt49, Org7_Ppt50), the '*right hand of God*' (Org8_Ppt53), '*God's gift*' (Org6_Ppt44) and '*some sort of deity*' (Org4_Ppt25). These descriptions reflected perceptions of self-superiority and carried several connotations, for instance, an '*all seeing, all understanding*' (Org6_Ppt46) omnipotence about the network, and the ability to see the '*bigger picture*' (Org6_Ppt42). Network controllers perceived themselves as having an ability for '*thinking [at a] high level*' (Org5_Ppt34) and the belief that '*train controllers know everything*' (Org6_Ppt43) was projected onto other workers. Controllers perceived themselves to be a '*subject matter expert*' (Org1_Ppt1) able to '*keep trains, diggers, high rails apart with a pencil, a graph*' (Org6_Ppt37), and little else. Other metaphors used to characterise the status attached to the network controller were: '*"the hub" and everyone else as being "the wheel"*' (Org1_Ppt4), the '*"backbone" of the network*' (Org2_Ppt16), the '*king of the castle*' (Org5_Ppt33) and the '*masters of the universe*' (Org5_Ppt36).

Along with the aforementioned self-perceptions of status, participants perceived those in other operational teams to hold negative perceptions about network controllers. For example, the participants in the study (i.e. network controllers) perceived train drivers to think of network controllers as '*arrogant*' (Org7_Ppt50), '*pompous*' (Org6_Ppt46), or '*obnoxious pricks*' (Org6_Ppt47).

4. Discussion

The network controller provides a critical and central point of oversight and control of the network. Having *authority* to achieve this goal is therefore important, but an *authority gradient* hinders 'frank discussion' (Sasou and Reason 1999, 4) and effective communication. This has corresponding safety implications—the central concern driving reanalysis in this study and research questions focussing on organisational influences. While the network controller and the operational teams they engage with most (i.e. train crew, track workers) have equal value towards network operability, the results of this study lend new insights into perceptions of unequal power distribution between teams in rail.

Organisational influences that produced deferential relationships included approaches for investigating and identifying causal factors associated with error, taking a punitive approach to error, and the systems and rules governing network operations (RQ1). The rail industry functions with strong hierarchies designed to control worker performance and ensure that their objectives are met through structured reporting lines and delegations. However, this study revealed this hierarchy to be divisive; perceptions of superiority and a culture of status were attributed to those higher in the hierarchy, while teams further down were attributed with perceptions of inferiority and/or had the value of their work minimised (RQ2). Disparities existed in the perceived value of contributions between teams and influenced interpersonal interactions.

According to Dobson, Moors, and Norris (2014, 14), imbalances in power that inhibit communication can be because one person is 'frightened of the other person' or 'they are concerned that the other person will lose face if a less senior or experienced person raises an issue that they have not'. In our previous study (Luva and Naweed 2023) we identified fear associated with risk and linked it at an individual level with perceptions of the probability and consequence of error. Based on the organisational influences, we can now broaden these concepts to a fear of punitive action (i.e. being stood down or drug-tested) as an accountability mechanism employed by an organisation. The resultant anxiety and subsequent behaviours employed by network controllers in their efforts to minimise risk, included a heightened state of vigilance, rudeness in verbal exchanges, power-plays, and compliance achieved through intimidation imposed by both language and tone. These behaviours were considered to affect the 'psychological safety' of other team members in an organisational context, that is, whether team members felt safe in volunteering information or questioning a direction for fear of ridicule or of being viewed as incompetent (Edmondson 2002). In effect, frightening other team members, and thus, generating an authority gradient.

In the absence of scientific research specific to the rail context illuminating the generation and impacts of authority gradients on safety, complex safety critical systems similar to rail, such as aviation, healthcare, and nuclear power, present opportunities for translating influences on team work performance and workplace culture and design (Hignett et al. 2018; Waterson and Catchpole 2016). These are teams operating in high risk and high stress environments while performing critical operations (Morgan et al. 2006). Sekar et al. (2022) discuss authority gradients in a healthcare context, clarifying that hierarchies are not synonymous with authority gradients. While an organisational hierarchy attaches decision making with higher status or rank, authority gradients affect a perceived power imbalance, irrespective of actual positioning within the organisation hierarchy. This aligns with Dobson, Moors, and Norris (2014, 14) explanation of an authority gradient as impacting those lower down a '*perceived* organisational hierarchy'. Cognisant of a *perceived* hierarchy, this study sought to understand what contributed to the perception of the hierarchy when a formal hierarchy does not exist. There is no 'answerability' between teams, with no lines of supervision straddling the teams. Hence the significance in understand how authority gradients transpires across teams.

The findings underlying our themes of accountability mechanisms may be summarised as a conflict between network controller responsibility and accountability and is a feature of the perceived hierarchy within the operational team. Ieraci (2007, 63) asserts that responsibility is in the 'doing' and accountability the 'answerability, blame, burden and obligation'. Network controllers considered themselves to be responsible and accountable for network-wide performance. This organisational design of responsibility and accountability in operational processes (Greenwood and Miller 2010), though arguably necessary to complex hierarchical organisations (Romme 2021), is known to create 'tensions and conflicts' (Romme 2019, 7). Cornock (2011) indicates that 'to be accountable one needs to have authority over the task or role being undertaken' (Cornock 2011, 26). However, while the network control role involves authorising tasks undertaken by other teams, they do not supervise how the tasks of these other teams are planned or executed. A disconnect, therefore, exists in the discharge of responsibility and the 'answerability' (Breaux et al. 2008, 111) of network controllers in their accountability for activities that occur on the network. While a completely flattened gradient risks the removal of all accountability (Sekar et al. 2022), flattening it to any extent would involve a perception that other operational teams are accountable for discharging their responsibilities.

The network control role has the mandate and authorisation to issue directives to the rest of the operational team, and to administer 'prescriptive rules' (NRCOHSR 2004, 6). Rules creating a hierarchy of accountability reinforce perceptions of greater

importance for those higher up the hierarchy. This may, in turn, provide an organisational mechanism to blame and disempower staff, leading to authority gradient generation. The subordination of other groups also occurred through control over the flow of information, supported by the rules governing what information could or could not be shared. Protecting information is a way of maintaining 'power bases' across teams that are comprised of multiple professional groups (Carlisle, Cooper, and Watkins 2004, 549).

Dobson, Moors, and Norris (2014, 14) discuss a perception that insights and knowledge are not solicited from junior team members, who are instead viewed as 'units of labour'. This concept builds on our previous study (Luva and Naweed 2023) which explored a contemptuous attitudinal culture and demeanour of participants when interacting with other groups, especially track maintenance workers. Based on the organisational focus in the current study, 'professional guarding' was evidently found to play a role where information perceived to be inherent to a certain roles and teams is protected (Carlisle, Cooper, and Watkins 2004, 549), generating 'knowledge boundaries' (Carlile 2002, 442). Knowledge boundaries, featured in the results as 'gatekeeping', occurred when network controllers made judgements on whether the information they held was relevant to the decisions or actions of workers in other groups. An unwillingness to share information can indicate an organisational culture whereby employees with specialised knowledge become afraid of 'losing their power and importance when sharing their knowledge' (Bender and Fish 2000, 133). Knowledge is linked with power (Oborn and Dawson 2010) and is also a tool for achieving higher status (Chapais 2015) and delineating role identity across multidisciplinary teams (Carlisle, Cooper, and Watkins 2004).

Although prescriptive ruling institutes network control as authority, this does not explain the variations in perceptions of status attached to roles. The organisational hierarchy in rail operations consists of distinct teams: train drivers, network controllers/signallers, and track workers. Streeck, Seglow, and Wallace (1981) conceptualised 'elitism' among train drivers based on a hierarchy of the working class within rail. Career ladders, designed to incentivise employees to meet organisational objectives in pursuit of promotional opportunities (Magee and Galinsky 2008), generate a 'competitive component of status' (Chapais 2015, 166) focussed on outperforming colleagues and maintaining a position of status. The railway culture of rising through the ranks reinforces status as reward, impacting the perceived superior value of the network control role within the operational hierarchy.

The culture of status imbued in roles within a hierarchy extends beyond rail; in healthcare, for example, it is understood to cause team conflict (Kim et al. 2017). Entrenched hierarchies of role status in healthcare are linked to a membership in a profession (Nembhard and Edmondson 2006) with research pointing to 'tribalism' as a barrier to relationships across disciplines (Strudwick and Day 2014, 236). In an organisational context, tribalism is the formation of team subcultures or group identities in hierarchically designed organisations (Shufutinsky 2019). Just as doctors, nurses, and allied health professionals share in the singular goal of patient care, network controllers, train crew, and track maintenance workers share in their singular goal of safe and timely movement of rail traffic. Healthcare professionals experience disconnection associated with having varied educational backgrounds, training, role expectations, and physically distributed working (Braithwaite et al. 2016). This is reflected in rail, from diverse backgrounds and training experiences to the dispersed control centre, locomotive cab, and rail corridor work environments (Dorrian, Baulk, and Dawson 2011). Such disconnection leads to tribalism (Atkins 1998, 306), which impedes teamwork (Ebert et al. 2014), and is likely a mechanism underpinning organisational influence on the generation of authority gradients in this study.

Braithwaite et al. (2016) found that when collaboration was out of the usual workplace environment, the tribalism attributed to role groupings of health professionals was largely non-existent. 'Workplace socialisation, professional education, or the perpetuation of role-anchored behaviours' were the core of behaviours across operational groups that obstructed interprofessional team work (Braithwaite et al. 2016, 8). That is, organisational culture influenced stereotypes of role expectation leading to entrenched concepts of the positional power across groups in the hierarchy. These stereotypes are described by Stone-Romero, Stone, and Salas (2003, 331) as 'scripts' that are the socialised understanding (i.e. organisational culture) of prescribed behaviour in a given role, i.e. 'the way things are done around here' (Davies, Nutley, and Mannion 2000, 112). Organisations must be cognisant of the influence organisational culture has on attitudes and behaviours of staff (Johnson et al. 2016). When the culture is one of hierarchy and tribalism, efforts must be directed towards improving

interprofessional relations, if authority gradients across teams are to be addressed.

In our previous study (Luva and Naweed 2023), hostile behaviours, disparaging language, punitive action, and pressure for compliance were all behaviours that network controllers were perceived to apply to reinforce a power imbalance. The findings of the current study shed light on a much a wider context for previous research and show a range of organisational influences driving the existence of authority gradients in rail. All three of the themes in this study are embedded into the fabric of the rail system, with subthemes of hierarchical design, prescriptive ruling, system controls, and organisational intervention driving perceptions of superiority, gatekeeping, fear, and deflection of blame. Many of the broader cultural constructs (e.g. elitism, tribalism) are effectively reflections of the workplace environment.

4.1. Strengths, limitations, and future research directions

Building on previous research with a reanalysis of a large data-set, this study is the first to examine organisational influences towards authority gradients in rail. Reanalysing this dataset was a strength of this study because it derived new insights to help understand a much broader context of authority gradients, associated with the role sitting at the apex of the power hierarchy. Rather than centre on relationships or communication failures between members of the same team (e.g. pilots and co-pilots), this research centres on authority gradient generation across teams in the absence of supervisory relationships. While the focus of this study was necessarily on perspectives and experiences from one occupational grouping, it is important for future research to build on this by understanding the contributions from groups in the wider system, including train crew and track maintenance workers.

Gathering tacit knowledge from experts is challenging but pivotal for understanding the attitudinal concepts that influence authority gradient generation. Application of the SITT helped elicit attitudes in concrete scenarios; it helped participants express themselves and delved into the wider system factors influencing behaviour. The experience of one researcher as a former network controller was advantageous in that it leant contextual and technical insights. However, it also created the potential for bias. While efforts were made to manage any bias through 'bracketing' (Creswell 2013, 80), the potential for bias remains. Given the need for authority and oversight to facilitate rail network operations in most rail systems, efforts must be directed at creating environments where authority gradients can 'flatten', even as authority remains intact. As the empirical investigation of authority gradients pose a clear research gap, more work addressing organisational influences (i.e. a broader system level) is needed to understand how best to implement improvements to teamworking, collaborative communications, and leadership.

5. Conclusion

Attitudinal similarities across rail organisations suggest a culture that extends across the industry, where perceived variations in status and power exist across the network control, train crew, and track maintenance teams. These perceived imbalances in power influence how individuals within those groups interact, resulting in authority gradients that obstruct the free flow of information and negatively impact on safety. Adversarial relationships are exacerbated by an organisation's punitive approach to error and a disconnect between accountability and responsibility across teams. Role status within the rail industry has ties to legacy career ladders, designed to incentivise employees to meet organisational objectives, however, when organisations create a status hierarchy of roles or a hierarchy of levels within operational groupings, power distributions become dynamically imbalanced. This study found a number of factors within an organisation's sphere of influence that contribute to the generation of authority gradients, including approaches to discipline, the sharing of information, and support for professional respect across teams. These network controller perspectives point to an adversarial culture across teams, resulting in tribalism that further impedes team interactions.

More work is needed to understand how best to address organisation influences and implement improvements to teamworking, collaborative communications, and leadership.

Notes

1. Different terms are used in reference to the same position in different countries. For simplicity, we use Australian terms for train crew to refer to drivers or guards, network controller, signallers and area controllers, protection officer, and track maintenance worker throughout this paper. Terms used in other countries are indicated in footnotes, with further details where appropriate.

2. A protection officer (PO) is responsible for worksite safety, also known as controller of site safety (COSS) in the UK or roadway worker-in-charge (RWIC) in the US, designated to provide on-track safety for all members of the group.
3. As mentioned in the introduction, a 'SPAD' is an acronym for Signal Passed At Danger, which is an incident in which a train goes through a stop signal, or goes past its limit of authority into a section of track where it has no authority, risking collision or derailment.
4. A Track Occupancy Authority, a written or electronic/computerised authority that excludes rail traffic from a specified portion of track.

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