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Out of sight and out of mind? Safety and procedural issues with disused and seasonal rail corridors

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ABSTRACT

Several disused and seasonal rail corridors exist in various Australasian jurisdictions that require maintenance and are accessed by road users via rail crossings. However, no research is available that examines the safety and procedural issues with these rail corridors and connected level crossings. Targeted interviews with key stakeholders (N = 15) with knowledge and experience with safety, policy, and procedures of disused lines within Australia were performed. The results suggested there was limited communication provided back to road users (e.g., via new signage) about changing rail activity; potentially increasing the risk at rail corridors. Many of the operational concerns with disused lines were framed in terms of negative financial and business-based outcomes with the local community, including resident backlash. A clear outcome was the need to pursue procedural opportunities relating to all aspects of managing a disused line. This included more specific definitions, standards, and procedures for transferring a line to a disused status, clear maintenance standards, and a well-defined process with line reopening, including communicating with local residents. Issues related to safety was a common theme throughout the interviews and it was proposed that procedural opportunities could contribute to reducing safety issues and promote consistency across the rail network.

1. Introduction

Safety on rail corridors including level crossings is a global issue, with continued concerns throughout the rail industry, respective transport authorities and wider public. According to the Australian Transport Safety Bureau, between 1st July 2002 and 30th June 2012, a total of 601 road vehicle and 92-person collisions were recorded at railway corridors, which predominately were at level crossings (Bureau, 2012). By their very design, railway crossings facilitate high points of interaction between road vehicles and rail infrastructure, creating serious potential for conflicts. Railway collisions at level crossings cause catastrophic damage to property and are the single largest cause for loss of life within the rail system (Sochon, 2008). Consequently, railway collisions impose both a substantial economic and human burden on society.

The factors which contribute to train-road vehicle collisions on rail lines are difficult to determine and generally involve several risk factors for any one incident. However, past research has commonly found road user rule violations and more often driver errors to be the most prominent contributing factor (Bureau, 2012; Laapotti, 2016; Baysari et al., 2009). Rail-based research has mainly focused on safety incidents at operational lines, however, there is a clear lack of literature examining the safety impacts around level crossings that may have an infrequent train presence. These low usage rail lines could be associated with unsafe driving behaviours. For instance, observational-based research found approximately two-thirds of drivers approaching passive level crossings on operational lines with *low train volumes* did not perform sufficient visual checks before crossing (Wigglesworth, 2001). This is quite concerning as passive level crossings only protection includes signage, either by a stop sign or give way sign (Larue and Watling, 2022; Larue and Watling, 2021). Stopping compliance is also low (Larue et al., 2018; Tey et al., 2011). Such behaviours have also been observed in driving simulations with repeated traversals of level crossings without trains (Wullems et al., 2014; Larue and Wullems, 2015). Moreover, drivers' perceptions of risk with rail crossings are lower with operational lines that have low train volumes (Davey et al., 2008). As such, rail lines that have low usage could provoke more risk taking with rail crossing

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behaviours.

Rail lines that have low train usage include lines that are either seasonal or disused. Essentially, the well documented, operational lines are considered as lines currently available for use by train operators with signage requirements as per AS1742.7 (Standards Australia, 1742). Such that, the standard AS1742.7 requires specific traffic control devices are required to be installed and used with the control of and notifying traffic at and in advance of railway crossings. Seasonal lines are regarded as lines booked out of rail traffic during non-peak rail traffic periods for cost reduction purposes by the rail infrastructure manager (e.g., grain lines) with signage requirements as per AS1742.7 (Standards Australia, 1742). Contrastingly, a disused line is regarded as a 'service suspended line' on which train operations have been suspended either permanently or for an indeterminate period (excluding seasonal lines). Commonly, these lines are not visibly differentiated from operational and kept in the same conditions with original signage. However, disused lines may also be classified as a line formally closed via governmental procedures which can revert to crown land. This means the 'railway line' and any associated railway crossings no longer legally exist. Unfortunately, there appears to be considerable variations and inconsistencies surrounding the classification of seasonal and disused lines.

Across Australasian jurisdiction, there are several disused rail corridors existing in various locations. These lines are required to be maintained due to service level agreements between Government and the rail infrastructure manager. The infrastructure along these rail corridors is maintained to differing levels of operational preparedness, depending upon future rail operations and plans. Rail corridors are predominantly located in regional areas with the crossings equipped with a passive protection system (e.g., road signage and road markings) to alert the road user of approaching trains. Compared to an active protection system that includes boom gates, flashing lights and warning bells, passive protection is associated with a higher level of risk for an incident between road user and a train [e.g., (Laapotti, 2016; Rudin-Brown et al., 2014)]. Jurisdictional differences in operational procedures could mean less optimal procedures are in effect in some regions, and in turn could lead to an amplified risk of rail crossing incidents. Moreover, the deregulation of the rail sector has substantially impeded the development of an integrated national network (Everett, 2006) and could mean vast differences in the classification, maintenance, and procedures with disused rail corridors.

Currently, the National Guidelines for Transport System Management in Australia provide frameworks, methods, processes, and tools to assist in the transport planning and decision-making across Australia (Council Australian Transport, 2006). However, there appears to be no consistent documentation or procedures in place around level crossing use for disused, seasonal, and underutilised railways. Each jurisdiction typically has a detailed guideline to appraise proposals for individual modes and road projects. Guidelines are essential in providing transport systems with a comprehensive and safe management approach for all forms of transport (Bliss and Breen, 2012). Currently, level crossings have no publicly available procedural documents in place for the closure, removal, or resumption of railway lines. Thus, substantial procedural issues across jurisdictions could exist in relation to disused rail lines. Moreover, these procedural issues could contribute to unsafe rail crossing behaviours. The current research aims to provide insight into safety risks and procedural aspects relating to disused and seasonal railway crossings.

2. Method

2.1. Participants

Several key organisations and individuals with experience with rail operations within Australia, that were related to policy, procedural and or safety of disused lines were approached about participating in the study. These individuals were asked if they knew of any other individuals with relevant knowledge or experience with disused and seasonal rail lines who could contribute to the study so they could be contacted as well. The potential participants were from organisations such as rail operations, track operations, regulators, standards, and road agencies and included occupational roles such as Project Engineers, Traffic Engineers, Safety and Policy Coordinators, and Policy Officers within their organisations. The participants represented the following *trans*-Tasman jurisdictions: New South Wales, New Zealand, Northern Territory, Queensland, South Australia, Tasmania, and Western Australia. In total, 15 participants took part in the interviews. The interviews were performed individually (n = 10) or in groups of two people (n = 4), with one participant providing emailed responses.

2.2. Materials

The format of the interviews employed a semi-structured interview design. The topics that were included in the interview were based on a literature review Larue et al. (2020), as well as considering broader issues associated with rail policy, procedures and safety. Such that, the interview probe questions were conceived to address the following aspects: i) overarching aspects of prevalence of disused or seasonal lines, ii) resumption of disused lines, iii) issues at disused / seasonal / reopening lines, including safety aspects, and iv) procedures for disused / seasonal / reopening lines with respect to road users.

2.3. Procedure

Potential participants were initially contacted via email about their interest in taking part in the study. Interested individuals were then provided a participant information sheet which outlined the purpose of the research, the procedure to ensure confidentiality and anonymity of participant responses, and their right to withdraw from the study. Specifically, participants were informed their involvement in the study would be via an interview, either a phone or video call that would take approximately one hour. The focus of the study was an investigating of policy and/or procedures associated with disused and underutilised level crossings. They were also informed they could withdraw anytime during the interview to be consistent with ethical research procedures.

Individuals who then wanted to take part in the study were interviewed over the phone or via digital platform (e.g., Zoom, MS Teams) or in the case of one participant who provided written responses to the interview probes via email. Verbal consent was obtained prior to beginning the interviews. The interviews ranged in duration from 30 to 66 min and were conducted during April and May 2020. Data from the interviews reached a point of saturation, that being no new ideas were uncovered from additional interviews. The interviews were transcribed for analysis.

2.4. Analysis

A qualitative methodology was used with the current study as qualitative methods are well suited to investigating topics that have limited understanding and or when an exploratory approach is more suited. The analytical aim was to develop an accurate representation of disused and seasonal railway crossings by systematically analysing the data while minimising research bias. The analysis was conducted at the semantic level and sought to cataloguing participants' knowledge about railway crossings rather than interrogate their views and perspectives.

Thematic analysis was used to analyse the interview data. The analysis was guided by discussions of the various approaches and methods associated with thematic analysis outlined by Braun, Clarke, and colleagues (Braun and Clarke, 2019; Braun et al., 2019). In the current study, a coding reliability approach was taken, focusing on the development of 'domain summary themes' – themes that are organised around shared topics rather than latent meaning (Braun and Clarke, 2019; Braun et al., 2019). Analysis was inductive, using open coding to

develop codes and themes directly from the data.

The Braun and Clarke (Braun and Clarke, 2006) six step approach was employed. Although Braun and Clarke have later clarified that they align themselves with an approach to thematic analysis that emphasises meaningful knowledge production and researcher subjectivity [e.g., (Braun and Clarke, 2019)], the current study used their six-step analytical approach for the purpose of systematic engagement with the data. First, familiarity with the data was achieved, followed by the generating of initial codes, searching for themes based on the initial codes, reviewing themes; defining themes; and producing the final written output. Coding and thematisation were an interactive and flexible process, whereby initial codes and provisional themes were rearranged and renamed as the analysis progressed.

Two authors who completed the interviews, completed the transcription of the interviews, and then independently analysed the codes for emergent themes to ensure analytic continuity (Fischer, 2005). Once themes were identified the entire research team reviewed the codes and themes. Any discrepancies in code and theme classification were resolved via discussion between the authors with reference to the extant literature. Throughout the analysis, the researchers sought to ensure that the extraction and interpretation of findings were based on the data rather than on their own impressions. The abstraction of the data produced nine sub-themes that were organised under three main themes: overarching aspects with disused or seasonal lines, procedural issues at disused/seasonal lines, and procedural issues at disused/seasonal lines. Specific quotations are provided as supportive evidence for interpretations.

3. Results

An overview of the outcomes from the analysis are presented in Table 1. In summary, several issues were identified from the interviews. These issues formed three main themes and within these main themes several subthemes emerged. The main and subthemes are displayed in Table 1, with a corresponding quote provided.

3.1. Overarching aspects with disused or seasonal lines

The interviewees reported numerous and differing aspects concerning the extent of disused lines. One respondent noted less than 5% of the network within their jurisdiction to be considered disused, with another respondent's jurisdiction estimating 25% as disused, as well as exceeding 50% of the network in another jurisdiction. The duration that lines had been classified as disused also varied considerably across jurisdictions; ranging from four to forty years since all rail traffic had ceased. The location of disused and seasonal lines across jurisdictions were predominantly situated in regional areas, with some respondents noting that large sections of existing rail corridors included disused lines that branched off operational lines. The issue of terminology and classification was raised during interviews, with one respondent noting that the Australian Level Crossing Assessment Model (ALCAM) database identifies hundreds of disused crossings in New South Wales, Victoria, and Western Australia that are distinguished from the hundreds of crossings in Queensland and in South Australia identified as dormant (i.e., not used for freight, but used for maintenance vehicles).

Various terminology was used by interviewees when describing disused lines, including 'standby lines', 'dormant state', 'mothballed', and 'non-operational, but not closed'. Table 2 provides a summary of the stated terms and some corresponding quotes from participants. Some of these terms differed across jurisdictions. The terms were similar in that they each describe lines as not being in active service but not officially closed either. Further points were raised by several respondents regarding the reasoning behind intermediate classification of lines (i.e., dormant state). For instance, it is preferable to keep lines in place, including keeping the rights, ownership and control of the land even if future resumption of line operations is unlikely.

Table 1
Main and subthemes obtained from the interviews and corresponding quote.

Main theme	Subtheme	Quote
Overarching aspects with disused or seasonal lines	Signage	*"When you're not going to be using a line, take measures to make sure it looks like it's not being used, so that people don't expect there to be a train" - Participant 11*
	Resumption of disused lines	*"There's always a possibility that somebody may come along, a mine might open, or some other economic reason comes up that the line needs to be reopened again" - Participant 1*
	Barriers and facilitators of reopening disused lines	*Barrier: "The first [barrier] would probably be purpose, if we don't need to [reopen] we probably wouldn't. After that hurdle, it would likely just be cost in bringing everything up to scratch" - Participant 5* *Facilitator: "It can come from the public in terms of town development groups or community groups. It can come from the railway operator itself if it believes there's a need or a want to reopen a particular piece of the corridor" - Participant 10*
Procedural issues at disused/seasonal lines	Policies/procedures and contracts	*"The short answer would be that we probably don't have an established procedure" - Participant 5*
	Complaints	*"If you haven't run a train for twenty or thirty years, there would obviously be the noise issues that you would need to deal with depending on what's happened with the adjoining lands along the rail corridor" - Participant 9*
	Incidents/non-compliance	*"The local motorists know that [these lines] have not carried a train for twenty years, so they're tending to drive through the stop signs. They're not stopping, because they know that there's no chance of getting hit by a train" - Participant 1*
	Risks with disused lines	*"Really all the inspection is, is to make sure that the infrastructure that's out there is safe in terms of underbridges and that drainage is working in accordance with how it is supposed to." - Participant 7*
Potential procedures for disused and seasonal lines	Needs and procedures	*"Seasonal corridors that might only be open for two months of the year … they become non-operational corridors with limited maintenance for ten months of the year and they normally have a big check before the first train" - Participant 10*
	Legislation guidance	*"It's very grey if there's much in there. I think there should be more guidance for people to follow. Certainly, when things are grey … it gets very hard to have something behind you to get businesses to do something" - Participant 12*

Numerous potential reasons were provided for a previously used line transitioning to a disused status. Some reasons offered by respondents were connecting mine sites that are no longer operational, a reduction in demand with the closure of farms, and less passengers on commuter lines leading to the service no longer being required. Other modes of transport are considered cheaper or faster (e.g., road trucks, bus) and

Table 2
Summary of the different terms used throughout the interviews and the corresponding quotes.

Stated term	Corresponding quote
Disused	*"Some of these lines were **disused** when they [the rail operator] took over the lease and they have never run a train on them, and they are not likely to, but they have no intention and they don't have legislative authority or power to close the lines" - Participant 7*
Suspended/ standby	*"All lines aren't officially 'closed' they could all be potentially reopened, but what is done is to **suspend** rail services and that the rail lines are more on **standby**" - Participant 13*
Dormant state	*"If you were going to bring it back into an active state, you would have to re-do an ALCAM assessment as well … because the road status may have changed during that period it's been in **dormant state** … It has to be brought into active state for the current vehicle volumes and sizes" - Participant 11*
Mothballed	*"There are mainly seasonal lines in New Zealand due to either weather or crops that I am most familiar with. Some rail corridors have been closed or '**mothballed**' but I am not familiar with these sections on this scale - Participant 2*
Non-operational	*"Seasonal corridors that might only be open for two months of the year … they become **non-operational** corridors with limited maintenance for ten months of the year and they normally have a big check before the first train" - Participant 10*

were seen as an appealing alternative form of transport. *'One reason why [lines] become disused is a reduction in requirement to run trains. The cost was cheaper to go by road than by rail' - (Participant 9)*.

Maintenance and the state of disused lines was also discussed, and similarly, these factors varied. That is, maintenance of disused lines, which included occasional crossing upkeep and foliage removal, varied from semi-regular maintenance to none at all. Irrespective of maintenance, the condition of some lines were deteriorating from the environment (i.e., vegetation, storms, landslides). 'From a railway point of view, there's no check in place because they're not running trains. From a road surface point of view, they get checked to make sure they're still safe for the road users' - (Participant 9).

3.1.1. Signage

Discussions with respondents highlighted a number of issues with the use of signage at crossings on disused lines. It was found the common practice in Australia and New Zealand was not to change any signage or modify the crossing in any way to indicate the line was not active. Seasonal lines are also subject to the same practice. This practice was largely in place to mitigate negative reactions from the general public and political entities.

Several respondents noted the role that local, state and territory-based road agencies and government personnel have in the maintenance and governance of level crossings road signage including Stop and Give way signage. '*Generally, it's the local government that will negotiate or liaise with the Main Roads regional office, and then they will go out and repair [signage]' - (Participant 5)*. Several respondents noted issues with preserving standards as well as maintenance delays of signage on private and smaller local roads. Thus, the coordination of local governments, state and territory entities, as well as owners of private roads with the relevant road agency for maintenance and governance of road signage is multifaceted and complicated.

The safety of road users at disused rail crossings in relation to signage was also discussed. The practice of not modifying or providing any official line closure signage was addressed with participants. As noted above, the general practice is to maintain, at least to some degree, the crossing (if it is to remain in service) and its signage. However, several respondents noted that road users, particularly locals who frequently traverse through a crossing on a disused line, were likely to assume no trains are active and to be less cautious with crossing behaviours. '*A lot of [disused lines] have currently got Stop signs fitted … Technically that is a regulatory sign so legally everyone has to stop, but the locals know that there are no trains, so we have some complacency issues' - (Participant 6)*. As such, the community advisement procedures outlined by the Office of the National Rail Safety Regulator (ONRSR) when a line is reopened to make them aware and provide some education about safety at crossings become an important component. *'When you're not going to be using a line, take measures to make sure it looks like it's not being used, so that people don't expect there to be a train' - (Participant 11)*.

3.1.2. Resumption of disused lines

Issues discussed in relation to the resumption of disused lines were closely related to capacity and the likelihood of the need for the line. One respondent noted there was no formal process of annual review to determine whether a line should reopen. Fundamentally, the resumption of a disused line was centred on financial and business-based factors. One participant noted, '*They look at a few things, such as whether there is economic growth in the area, the deliverability of the project, and the cost-benefit ratio [of the project]' - (Participant 15)*. Specific factors contributing to the reopening of a line include interest from developers, renewed business transaction or an increase in demand for the line. Demand aspects involved freight and passenger travel-based interest; however, passenger travel was not a large factor for reopening. Thus, the resumption of a disused line can have a number of different aspects, with funding being the main barrier to reopening a disused line. '*There's always a possibility that somebody may come along, a mine might open, or some other economic reason comes up that the line needs to be reopened again' - (Participant 1)*.

The condition of the line is also an important consideration, both financially and in terms of safety. Railway engineers would need to assess any line before reopening, to determine whether upgrades are required. Maintenance and upgrades could be limited to renewing sections or upgrading crossing infrastructure. Alternatively, in cases of substantial deterioration, maintenance could require completely replacing infrastructure – thus being an influential factor for decisions on reopening lines. Lines that have not been used for several decades would seemingly require greater upgrades and repair. As one respondent mentioned, there was no real potential for reopening some disused lines; it is likely older and severely deteriorated lines would be in this category.

In terms of safety considerations for the resumption of disused lines, maintenance at crossings on disused lines did occur to ensure the safety of road users. One respondent mentioned that semi-regular maintenance checks were performed in the interests of safety. In addition, natural weathering of railway lines (outside of the crossings) from vegetation, storm damage and washaways did hinder and create some major issues with redevelopment and resumption of a disused line. Nevertheless, there are some occasions when disused lines, or at least a section of the disused line could be reopened. If this was to occur, ONRSR outlines processes of community advisement, which needs to be carried out so the local community are aware and educated about safety at crossings of the once disused rail line.

A number of respondents highlighted the usage of ALCAM assessments when crossings are considered for reopening or to prioritise crossing upgrades and any other risk controls to mitigate safety risk at crossings. '*If you were going to bring it back into an active state, you would have to re-do an ALCAM assessment … It has to be brought into active state for the current vehicle volumes and sizes' - (Participant 12)*. Disused lines can be private or publicly owned and were known to have both active and passive crossings, with passive crossings being the most common type. For active crossings, the active controls have been powered down (or temporarily deactivated), to ensure functionality if the line is reopened. Some respondents noted that in their jurisdictions (i.e., New South Wales, Western Australia), no consolidation process was in place for the reduction of crossings at a disused line. Rather, maintenance of the crossing was only performed to ensure road and rail safety. However, other respondents noted that every crossing is re-assessed for their suitability and the need to be opened. If circumstances no longer require the crossing to be used, then it would be removed (if funding allowed).

In this situation, funding and risk were reported as the main factors to consolidating the number of level crossings in Northern Territory, Queensland, and Tasmania. Thus, procedural differences surrounding the consolidation of rail crossings associated with disused lines are apparent between jurisdictions.

The communication and engagement with the local community with resumption of a disused line is seen as a necessary and important action. The steps for conducting the engagement were determined by each rail operator, with no set guidelines to follow. Generally, this would entail the development (or modification) of a strategy to suit the purpose. Such engagement was normally targeted at increasing exposure to the changes for regional communities. Communication and engagement for the reopening of a disused line utilised local newspaper, letter box drops, radio, and advisory signs installed on road approaches to reopen a crossing. '*Fundamentally, it would be a massive [communication] campaign. There would be local articles in newspapers and flashing road signs. The drivers themselves would be warned for a week or two as they approach level crossings' - (Participant 9)*. The engagement process was usually a short-term process, to ensure the community received adequate exposure to the change with the rail line. '*The community would be involved, but to a lesser extent, because the rail line is still there and it was operating, even though it may not have operated for some years' - (Participant 1)*.

3.1.3. Barriers and facilitators of reopening disused lines

A number of barriers for reopening lines were identified in the discussions with respondents, with the biggest barrier being that of cost. For instance, the cost associated with reopening any disused line and finding the funding from parties wanting the line reopened. The importance of cost regularly appeared in the interviews with respondents and not only affected the cost of repair work on a disused line, but could also determine if crossings are maintained or even closed depending on the risk of the specific situation. '*The first [barrier] would probably be purpose, if we don't need to [reopen] we probably wouldn't. After that hurdle, it would likely just be cost in bringing everything up to scratch' - (Participant 5)*. Thus, funding and risk were the main factors with consolidating the number of level crossings. Several respondents noted that all disused lines would require a capital upgrade to meet current operational and safety standards. '*In lots of cases there are large sections of the line which are on timber underbridges … the timbers are basically rotten and would have to be replaced, escalating the cost of any line reopening significantly' - (Participant 10)*. It was encouraging that communication between rail infrastructure managers and road managers was not viewed as a barrier, just the allocation of available funding for each project.

Factors relating to safety and infrastructure were deemed another significant influence on reopening, which included assessments by engineers. These assessments would include the appraisal of sleepers, rail line, culverts, bridges and associated infrastructure such as signalling and train protection. Other considerations included in assessments were those that related to the suitability of an existing track to support the loads being placed on it. In particular, one respondent noted substantial considerations (i.e., time, finance, safety) with infrastructure that has a historical or heritage listing. As noted, many disused lines could be up to four decades old; with the general position of leaving disused lines in place, the issues around heritage management is likely to be ongoing.

While numerous barriers were presented during the interviews, facilitators were also identified with the reopening of a disused line. Community groups or development groups were identified as important facilitators that can act as an additional voice with obtaining funding. Also related to support from specific groups was the benefit of having public support working towards a common goal. '*It can come from the public in terms of town development groups or community groups. It can come from the railway operator itself if it believes there's a need or a want to reopen a particular piece of the corridor' - (Participant 10)*. Specifically, local communities could benefit from increased freight services and employment opportunities, which could motivate their involvement. Lastly, having a specific project team focused on the task of reopening a disused line while also having experienced and capable external consultants and engineers to assist with the task was seen as beneficial.

3.2. Procedural issues at disused/seasonal lines

3.2.1. Policies/procedures and contracts

The majority of rail governance and operations is determined by various established policies and procedures, with the overarching consideration focusing on safety. Thus, it was surprising to hear from several respondents that there were generally no procedures in place for transferring an active line into a disused state. For instance, '*The short answer would be that we probably don't have an established procedure' - (Participant 5)*. This was the case in most jurisdictions; however, the application of any policy would largely depend on the context and specifics of each line. While transferring any active line to a disused line was not governed by any overarching policy, a number of respondents mentioned policy in relation to line maintenance was adhered to which typically entailed lower maintenance schedules. Other related procedures were the determination of risk and level of control required at each level crossing, including signage requirements. It was noted in one jurisdiction that inflexible policies surrounding line maintenance were problematic. That is, policies covering the frequency of maintenance on disused lines are the same whether it sees heavy traffic or no traffic. '*The legislation in Western Australia is inflexible. You have a rail crossing; you need an interface agreement. It doesn't matter whether it is the busiest rail crossing … or it hasn't seen a train cross it for twenty years, they're both treated the same' - (Participant 1)*. Regarding contracts associated with disused lines (excluding interface agreements at crossing sites), it was noted that no real contractual obligations were in effect. Moreover, the only real contractual obligation was with partners using the lines, such as mining companies. Rail lines are still considered 'open' and thus, the standard processes are in line with the road agency's policy and guidelines and the road owner.

3.2.2. Complaints

Complaints with disused or seasonal lines had some common aspects with general rail operations but also some unique aspects. Common aspects concerning noise complaints related to the movements of the train (e.g., train wheels, whistles) with the reopening of lines. '*If you haven't run a train for twenty or thirty years, there would obviously be the noise issues that you would need to deal with depending on what's happened with the adjoining lands along the rail corridor' - (Participant 9)*. Other complaints were related to road users experiencing long wait times at road crossings for reopened lines, with trains involved in mining operations being approximately 2.8 km long. One respondent described how local community members submit maintenance requests and complaints to attend to the road level crossings on the disused lines. This includes complaints on overgrown vegetation growing around the track and corridor fences which should be kept neat in case of fires. '*We do get lots of complaints about vegetation in our disused lines, because we're still responsible for that and obviously it falls lower down the priority list than cutting down trees and grass in the used operational lines' - (Participant 5)*.

Complaints specific to the closing and reopening of disused lines relate to public and political sensitivities. In some cases, it was noted that there would be public and political backlash from track 'closure'. The closing of lines seemingly receives a high level of interest from local community members, such that the 'change talk' has a negative reception with locals. '*If a line is going to be closed, people don't like to hear that … It's managing the change factor and trying to understand people's perspectives of what that change actually means to them and to the community' - (Participant 10)*. However, such public and political backlash also occurred with the resumption of a disused line. As noted in section 3.1.3 Barriers and facilitators of reopening disused lines, the resumption of a disused line would be greeted by some community members as a positive (i.e., increased freight services and employment opportunities).

3.2.3. Incidents/non-compliance

Discussions with respondents relating to incidents and non-compliance provided insight into safety risks and risk mitigation strategies. Overall, incidents on disused and seasonal lines were infrequent or rare. This is believed mainly due to the lower frequency or absence of rail operations on some disused lines. Seasonal lines were suggested to have a greater potential for incidents than disused lines. For instance, seasonal rail operations with sugar cane harvesting could be associated with an increased likelihood of incidents when operations recommence.

Non-compliance at crossings of disused lines was commented on by several respondents. A common perception was that road users were generally not compliant at these crossings. Non-compliance was viewed as an artefact of low frequency rail operation (with seasonal lines) and or road users making assumptions, believing they know the timetable of the trains. '*The local motorists know that [these lines] have not carried a train for twenty years, so they're tending to drive through the stop signs. They're not stopping, because they know that there's no chance of getting hit by a train' - (Participant 1).* It was noted by Australia and New Zealand respondents that usually there was no engagement or need to involve police except when there is a recorded incident. That is, non-compliance was seen as a common occurrence with local residents and was regarded as road user behaviour issues (i.e., failure to stop at level crossings despite regulatory signage in-place). One respondent noted that there was little CCTV footage available on disused or seasonal lines, with some networks only having one or two cameras on trial, but there was no established system in place. Thus, aspects to address or even monitor compliance issues were quite limited with disused and seasonal lines.

3.2.4. Risks with disused lines

Respondents noted several risks with disused lines and the need to improve upon these aspects. Risks were identified in relation to maintenance regimes of both the disused lines and the associated crossings. *"Really all the inspection is, is to make sure that the infrastructure that's out there is safe in terms of underbridges and that drainage is working in accordance with how it is supposed to." - (Participant 7).* For instance, low maintenance regimes during lengthy non-operational periods contributed to a deterioration of rail infrastructure as well as reliability of active crossing controls when put in use. It was noted that some line inspections were limited such that they were undertaken from the roadway, and this was reported as not thorough enough. Another risk commented on by several respondents was the non-compliance issues with road users. One hypothetical situation was offered as an example – with some disused lines not having any rail operations for 40 years, some locals may never have seen a train on that line in their lifetime. The big challenge with this situation would be to change the individual's perception to anticipate an oncoming train. Thus, the need for communication and engagement with the local community is an important undertaking.

3.3. Potential procedures for disused and seasonal lines

3.3.1. Needs and procedures

The following section reviews the respondents perceived needs with policy and procedures with disused and seasonal lines. The first aspect is the need for specific signage (or even temporary signage) to be put in place when corridors are disused/seasonal or being reopened. This specific signage has the potential to act as an extra element of precaution with road users. An additional element to increase perceptions of a line being disused (with no realistic likelihood of ever reopening) would also be the removal of active level crossing systems. One example offered was with removal of warning lights at active crossings and at passive level crossings you can remove the Stop and Give way signs and replace them with a specific disused sign informing the line is non-operational. It was noted that there was a great need for more reviewing and consolidation of crossings, especially private crossings. One respondent noted that a greater and perhaps more acute need arose with notifying the public of the active use of seasonal lines. '*Seasonal corridors that might only be open for two months of the year … they become non-operational corridors with limited maintenance for ten months of the year and they normally have a big check before the first train' - (Participant 10).*

3.3.2. Legislation guidance

The creation and/or modification of existing legislation was highlighted by many respondents. For instance, more legislative guidance about seasonal level crossing signage and maintenance to disused lines was a prominent concern. Moreover, large grey areas around what is expected with the maintenance of disused and seasonal lines remain, and without the proper legislation to provide clear standards it is hard to enforce businesses to comply. It was noted by many respondents that currently, there are relatively poor standards in place. It was also noted there was no consistent methods or standards for transferring active lines to a disused status – with each line transference occurring as a one-off, even haphazard process. One respondent made it known that clear procedures would improve how the task and project progressed, which could potentially save financial resources.

A clear notion was expressed that the processes should be consolidated, as each respective network would benefit greatly from cleaning up the processes. This consolidation process would also benefit from engaging road managers in the process, given the shared involvement in rail crossings and their maintenance. '*It's very grey if there's much in there. I think there should be more guidance for people to follow. Certainly, when things are grey … it gets very hard to have something behind you to get businesses to do something' - (Participant 12).* Reopening of lines would also benefit from a consolidated process, as there are no review systems currently in place to investigate the feasibility of reopening the line. This would include a need for environmental studies to look at the feasibility of any business case. Finally, one respondent noted the need for a clear definition of what classifies a disused line.

4. Discussion

The objective of this study was to source information regarding disused and seasonal lines relevant to the Australasian context. A number of interviews were performed with individuals from organisations including rail operations, track operations, regulators, standards, and road agencies. Overall, the interviews highlighted several key findings, which can broadly be considered aspects of communication, operational concerns, and procedural opportunities. These issues will be discussed below.

4.1. Communication

The communication surrounding disused and seasonal lines was a key finding and comprises several aspects, including that of signage at disused or seasonal crossings but also with reopening a line. A common practice in Australia and New Zealand was not to change any signage or modify the crossing in any way to indicate the line was not active. Although, the utility of this common practice was raised and queried by some respondents who suggested the installation of specific disused signage would be more beneficial for safety overall. The key issue is that of creating false expectations with drivers. As noted previously, driver error remains a prominent contributing factor with train-road vehicle collisions (Bureau, 2012; Laapotti, 2016; Baysari et al., 2009). If an expectation of not seeing a train becomes a standard behaviour for drivers this could be problematic for road-rail safety at active rail lines and seasonal lines. Installation of signage can (to a point) improve road user safety behaviours such as reductions in approach speeds (Ward and Wilde, 1995; Larue et al., 2019). Yet, the common practice of not changing any signage or modify the crossing in any way did have a financial benefit (i.e., reducing costs associated with installing and maintaining new signage) as well as mitigating negative reactions from the general public (discussed below) with closing a line.

Potential drawbacks with not modifying any aspect of the crossing include the length of time the line is classified as disused and also the crossing behaviours of local residents. It was noted that some lines have been disused for decades and this length of time would mean some younger individuals might not have ever received any communication regarding the status of a disused line. Thus, any communication would need to be viable on a time scale of decades. The other potential drawback relates to the crossing behaviours of local residents. That is, locals who frequently drive through a crossing on a disused line were noted by several respondents to (correctly) assume no trains are active and to be less cautious with crossing behaviours (i.e., ignoring stop signs). Road user behaviour is the main contributing factor for train-road vehicle collisions (Wigglesworth, 2001), especially at passive crossings (Cairney et al., 2002; Pajunen, 2002). One outcome from this behaviour may be an increased likelihood of a local road user being less cautious at other nearby rail crossings that have active rail operations. Thus, measures to differentiate crossings on disused lines from a crossing with active rail operations could be a reasonable countermeasure for improving safety behaviours.

An important differentiation for crossings on disused lines versus lines with active rail operations could be the installation of specific 'disused' signage at crossings of a disused line. This signage would inform a road user the line is no longer active or 'not in use', and in effect delivers a clear message to the road user that no risk of a collision would occur on a disused line and remove the need to stop and check for trains. However, when the same road user approaches a crossing without the 'disused' signage, it should then deliver a clear message that adequate crossing behaviours (i.e., stopping at Stop signs, looking for oncoming trains) are required. Advisory signage used at passive crossings can be effective and are generally received favourably by road users (Ward and Wilde, 1995; Austin and Carson, 2002). Given the poorer safety behaviours at passive crossings [e.g., (Laapotti, 2016; Pajunen, 2002)] which were noted as the main crossing type on disused lines, it is difficult to anticipate passive crossing behaviours becoming less safe.

A potential benefit with new signage would be with informing road users of the resumption of rail operation due to seasonal activities. It was noted in the interviews that seasonal lines have the greatest potential for incidents when operations resume. Specifically, this was noted as an acute need with notifying the public of the active use of seasonal lines. Other benefits with specific 'disused' signage would be the simplifying and stripping back of only the most relevant signage at crossings on disused lines. Modifying crossings to lessen the cognitive burden on road users could have a beneficial safety effect (Bongiorno et al., 2017).

The second communication aspect related to the need of informing local residents of the resumption of rail operations on disused lines. Generally speaking, it was common for communication with the reopening of a disused line to utilise local newspapers, letter box drops, radio, and advisory signs installed on road approaches to reopen a crossing. The steps for conducting the communication strategy were determined by each rail organisation, with no set guidelines to follow. As such, the experience and skill of each organisation with community communication could be different at the state and territory-based level or even within a jurisdiction.

4.2. Operational concerns

Another of the key findings from the interviews was the many and varied concerns associated with disused or seasonal lines. The issues ranged from concerns raised by political representatives to negative exchanges at the lobby group and local public level, with reassigning a line to a disused status to issues with closing and reopening a line including finance and maintenance impacts. The issue of negative exchanges was commonly reported by respondents across different jurisdictions. Exchanges with lobby and local public groups were generally in response to limiting or reduced activity of a line and the perceived loss of transportation and the benefits it provides. The reduction of line activity can be viewed as a definitive act of rail activities never resuming. The literature review on disused lines (e.g., Larue et al., 2020) provided some examples of the social and economic effects of line closure on local community (e.g., Longworth, 2013, Taylor, 2006). In addition, the consolidation of the number of crossings on disused lines could also be interpreted in a negative manner by local residents. This reaction from local residents could likely be another factor, along with safety of road and rail operations and the issues of cost, in determining the direction of how best to govern a disused line and its infrastructure. Considered together, these negative interactions likely contribute to a practice of having unofficial disused lines, in order to mitigate the response from political and local public groups.

The issues involved with reopening a line were also a prominent discussion point. Key factors involved were the financial and business-based operational concerns, but demand aspects were also prominent. The demand aspects were likely the largest factors. The safety aspects were also discussed, which focused on aspects of line safety including infrastructure (i.e., crossings, bridges). Another safety aspect involved with resumption of a disused line was the communication of increased rail activities on a previously disused line. As noted earlier, no formal procedures are in place across the jurisdictions with how best to communicate increased rail activity to local community members.

Maintenance issues were also a key factor, with several different aspects associated with it. First and foremost was the inspection and maintenance of the disused lines. It was noted throughout many interviews that maintenance checks were performed on disused lines, which seemed to vary with the frequency of these checks. The term 'semi-regular' was offered by one respondent regarding how often these checks were performed. While the regularity of line checks were one key factor, so too was the way line checks were performed. It was mentioned that some line inspections were performed from afar, being from a roadway, which may not be adequate. Although, as some sections of disused lines were noted by several respondents as having experienced substantial weathering from storms and other environmental events, gaining safe access to disused rail lines could be a mediating factor in some locations. A related maintenance issue was the coordination and process of maintenance at crossings, especially crossings involving privately owned land. Respondents noted a number of concerns and challenges with the coordination between private owners, local and state-based authorities with timely maintenance of crossings on disused lines. Governance issues across multiple levels and partners pose unique challenges (Bache et al., 2016; Rhodes, 2000) and addressing these issues can be arduous, as each situation may require a specific resolution (Stoker, 1998). Given the multifaceted and complicated governance and related maintenance issues with disused crossings involving local governments, state and territory entities, as well as owners of private roads, the situation is particularly challenging.

4.3. Procedural opportunities

Overall, the key issue was that of a lack of procedural guidance with dealing with several aspects associated with disused lines. The lack of a framework of procedure for transferring a line from an active state to a disused state was notable. Most railway systems throughout the world base the safety of their operation on strict regulation through (standard) operating procedures (Kotsiopoulos, 1999). In fact, the absence of regulation and operating procedures has been identified as a key factor with rail incidents, including maintenance of monitoring systems (Baysari et al., 2009).

The creation of procedures and/or modification of existing legislation was a main finding as it was a prominent topic across a number of respondents. These aspects included the classification of a disused line, more specific definitions, standards, and procedures for transferring a line to a disused status, clear standards on maintenance issues, and well-defined processes for the resumption of disused lines, including communicating with local residents. It has been noted that the lack of

clear standards hinder how tasks and projects can be completed and also have a cost implication as well (Cowling, 2003; Weiss, 2000). Finally, one of the aims of the project was to pay particular attention to consistencies across jurisdictions – one clear consistency identified was actually the lack of procedure and standards with disused lines.

4.4. Limitations and future research

There are some limitations to the study that need to be considered when interpreting the study results. The total number of participants was small and thus the participants' responses might not be completely generalisable to other jurisdictions within Australia and other countries. Moreover, self-report data is susceptible to self-reporting bias and recall issues. Identifying participants who have knowledge about rail safety and procedures, especially that of disused and seasonal rail level crossings was not a straightforward undertaking with only a limited collection of individuals within Australia with specific content knowledge and experience with disused rail lines. However, the peak rail research body in Australia, being the Australasian Centre for Rail Innovation assisted the search for suitable participants. Nevertheless, it is possible that the study participants' knowledge was not unsurpassed. Future research might focus on the road users from two perspectives, being road users' behaviours at disused rail crossings and their understanding and acceptance of specific 'disused' signage that could be useful with communicating the status of the rail line to road users. Given the noted and well accepted non-compliance issues with rail crossings, particularly passive level crossings, such signage might prompt road users to be more alert and perform the necessary checking behaviours at operational lines. It is likely that interviews with road user regarding their understanding their mindset with disused and seasonal rail lines.

5. Conclusion

The aim of the current study was to further our understanding of disused and seasonal rail lines. In total, interviews with 15 individuals from key organisations related to policy, procedures and safety of disused lines such as rail operations, track operations, regulators, standards, and road agencies were performed, examining various aspects with disused and seasonal lines. The main results included aspects of communication, operational concerns, and procedural opportunities. Specifically, limited communication provided back to road users, relating to a lack of signage of the (in)active state of the rail line and this can contribute to an ambiguous understanding for road users and targeted communication efforts are likely needed to improve road users' awareness. Operational concerns from residents, lobby groups, and their elected official regarding reduced activity on a line, the placing of the line in a disused state and issues with reopening a formerly disused line were prominent issues. Many of the issues were framed in terms of negative financial and business-based concerns with the surrounding community. Other concerns included issues with maintenance that were performed infrequently, and the completeness of maintenance checks were also a problem for disused lines.

Overall, a clear outcome from the study was the need to pursue procedural opportunities relating to all aspects of managing a disused line. This included more specific definitions and terminology, standards, and procedures for transferring a line to a disused status, clear standards on maintenance issues, and well-defined processes for the resumption of disused lines, including communicating with local residents. Issues related to safety was a common theme throughout the interviews and it was proposed that procedural opportunities could contribute to reducing safety issues.

CRediT authorship contribution statement

Christopher N. Watling: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Project administration. **Grégoire Larue:** Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition. **Andrew Kidcaff:** Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization. **Claudia Luke:** Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Austin, R.D., Carson, J.L., 2002. An alternative accident prediction model for highway-rail interfaces. Accid. Anal. Prev. 34 (1), 31–42.
Bache, I., Bartle, I., Flinders, M., 2016. Multi-level governance. In: Ansell, C., Torfing, J. (Eds.), Handbook on theories of governance. Edward Elgar Publishing, Inc., Northampton, MA, pp. 486–498.
Baysari, M.T., Caponecchia, C., McIntosh, A.S., Wilson, J.R., 2009. Classification of errors contributing to rail incidents and accidents: A comparison of two human error identification techniques. Saf. Sci. 47 (7), 948–957.
Bliss, T., Breen, J., 2012. Meeting the management challenges of the Decade of Action for Road Safety. IATSS Res. 35 (2), 48–55.
Bongiorno, N., Bosurgi, G., Pellegrino, O., Sollazzo, G., 2017. How is the driver's workload influenced by the road environment? Procedia Eng. 187, 5–13.
Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101.
Braun, V., Clarke, V., Hayfield, N., Terry, G., 2019. Thematic analysis. In: Liamputtong, P. (Ed.), Handbook of Research Methods in Health Social Sciences. Springer Singapore, Singapore, pp. 843–860.
Braun, V., Clarke, V., 2019. Reflecting on reflexive thematic analysis. Qualitative Res. Sport, Exercise Health 11 (4), 589–597.
Bureau, A.T.S., 2012. Australian Rail Safety Occurrence Data: 1 July 2002 to 30 June 2012. Australian Transport Safety Bureau, Canberra.
Cairney, P., Gunatillake, T., 2022. Wigglesworth E. Reducing collisions at passive railway level crossings in Australia. (AP-R208/02).
Council Australian Transport, 2006. National Guidelines for Transport System Management in Australia. National guidelines for transport system management in Australia, Canberra, Australia.
Cowling, M., 2003. Productivity and corporate governance in smaller firms. Small Bus. Econ. 20 (4), 335–344.
Davey, J., Wallace, A., Stenson, N., Freeman, J., 2008. Young drivers at railway crossings: an exploration of risk perception and target behaviours for intervention. Int. J. Inj. Contr. Saf. Promot. 15 (2), 57–64.
Everett, S., 2006. Deregulation and reform of rail in Australia: Some emerging constraints. Transp. Policy 13 (1), 74–84.
Fischer, C.T., 2005. Qualitative Research Methods for Psychologists: Introduction Through Empirical Studies. Academic Press.
Kotsiopoulos, I.L., 1999. Railway operating procedures: regulating a safety-critical enterprise. Comput. Ind. 40 (2-3), 221–230.
Laapotti, S., 2016. Comparison of fatal motor vehicle accidents at passive and active railway level crossings in Finland. IATSS Res. 40 (1), 1–6.
Larue, G.S., Watling, C.N., Schramm, A., et al. Rail Level Crossings Along Disused/Underutilised Rail Corridors - Literature review. 2020.
Larue, G.S., Watling, C.N., 2021. Acceptance of visual and audio interventions for distracted pedestrians. Transport. Res. F: Traffic Psychol. Behav. 76, 369–383.
Larue, G.S., Watling, C.N., 2022. Prevalence and dynamics of distracted pedestrian behaviour at railway level crossings: emerging issues. Accid. Anal. Prev. 165, 106508.
Larue, G.S., Wullems, C., 2015. Driving simulator evaluation of the failure of an audio in-vehicle warning for railway level crossings. Urban Rail Transit. 1 (3), 139–148.
Larue, G.S., Wullems, C., Sheldrake, M., Rakotonirainy, A., 2018. Validation of a driving simulator study on driver behavior at passive rail level crossings. Hum. Factors 60 (6), 743–754.
Larue, G.S., Watling, C.N., Black, A.A., Wood, J.M., 2019. Getting the attention of drivers back on passive railway level crossings: evaluation of advanced flashing lights. Transport. Res. Record: J. Transport. Res. Board 2673 (2), 789–798.

Longworth, J., 2013. 'Countrymindless' Rural Railway Closure [PhD]. Charles Sturt University, New South Wales, Australia.
Pajunen, K., editor Safety at passive grade crossings in Finland. 7th International Symposium on Rail-road Highway Grade Crossing Research and Safety; 2002; Melbourne, Australia: Monash University.
Rhodes, R.A.W., 2000. Governance and public administration. Debating governance;54: 90.
Rudin-Brown, C., George, M., Stuart, J., 2014. Human factors issues of accidents at passively controlled rural level crossings. Transp. Res. Rec. 2458 (1), 96–103.
Sochon, P., 2008. editor Innovative and cooperative leadership to improve safety at Australian level crossings. World Level Crossing Symposium, 10th, 2008, Paris, France.
Standards Australia. AS 1742.7:2016 - Manual of Uniform Traffic Control Devices - Railway Level Crossings. Sydney, Asustralia Standards Australia; 2016.
Stoker, G., 1998. Governance as theory: five propositions. Int. Soc. Sci. J. 50 (155), 17–28.
Taylor, Z., 2006. Railway closures to passenger traffic in Poland and their social consequences. J. Transp. Geogr. 14 (2), 135–151.
Tey, L.-S., Ferreira, L., Wallace, A., 2011. Measuring driver responses at railway level crossings. Accid. Anal. Prev. 43 (6), 2134–2141.
Ward, N.J., Wilde, G.J.S., 1995. Field observation of advance warning/advisory signage for passive railway crossings with restricted lateral sightline visibility: An experimental investigation. Accid. Anal. Prev. 27 (2), 185–197.
Weiss, T.G.J.T.w.q., 2000. Governance, good governance and global governance: conceptual and actual challenges;21(5):795-814.
Wigglesworth, E.C., 2001. A human factors commentary on innovations at railroad–highway grade crossings in Australia. J. Saf. Res. 32 (3), 309–321.
Wullems, C., Haworth, N., Larue, G., et al., 2014. Effects of driver familiarity and prolonged or intermittent right-side failure on level crossing safety. Adv. Human Aspects Transport.: Part III. 9, 313.