THE IMPORTANCE OF KNOWLEDGE MANAGEMENT TO RAIL SAFETY

Alan Ross; MSc, BSc, CMIOSH, Grad Dip OSH
A & K Ross Associates Pty Ltd (AKRA), Australia

Conference central theme: Railway safety in times of fundamental changes.

INTRODUCTION

Wherever you go in railways you find complexity and, often, increasing complexity. Whilst computers and other technologies can help to maintain the corporate memory, the effectiveness of Knowledge Management (KM) is still heavily reliant upon human experience and memory. Every day in our industry 100s of years of valuable experience and knowledge walk out the door to be lost forever. What do we do about this?

KM emerged in the 1980s as an alternative to failed Total Quality Management (TQM) business processes and later gained significant momentum through the expansion of the Internet. KM has no universal definition but a simple attempt to define it might be: *Knowledge Management refers to a multi-disciplined approach to achieving organisational objectives by making the best use of knowledge. KM focuses on processes to acquire, create and share knowledge and the cultural and technical foundations that support them.*

The central theme of the conference is broken down further to address the economic, environmental and competition-related aspects of fundamental changes in relation to:

1. **Effects of standardised safety management systems.**
2. **Experience with risk and hazard management and interaction of all players in the railway system.**
3. **Approaches and instruments for maintaining and improving railway safety.**
4. **Methods and options for preserving railway safety knowledge in a changing environment.**

This paper will explore the options and in doing so will address the needs of all four of the Council sub-themes. Each theme can benefit significantly from improvements in KM and will be revisited in the Conclusions. Although it is from the fourth theme that the main subject is drawn, the topic is very relevant to all four themes and failure to optimise the associated KM processes will lead to many actual and potential problems that can and do impact upon safety. Examples of where this has been a direct cause of major incidents will be discussed. They include incidents that have led directly to an organisation going out of business, even ceasing to exist, incidents such as:

Piper Alpha – UK - offshore oil platform – 169 dead – (Occidental Oil went out of business)
Herald of Free Enterprise – UK -cross Channel Ferry – 193 dead – (Townsend Thoresen Ferries ceased to exist)
Hatfield – UK - derailment due to Gauge Corner Cracking – (led to the demise of Railtrack)
Potters Bar – UK - derailment due to inadequate maintenance – (Jarvis Rail share price plummeted)
Lake Megantic – Canada - 42 dead – (the operator MMA is likely to go out of business).

This is not a topic unique to one country or one region. It applies everywhere there are railways. In Hong Kong the City University has gone so far as to offer an Engineering Doctorate 'Knowledge management solutions for railway construction' (1). They observe that the lack of a systematic approach to knowledge management in railway construction can result in loss of valuable project knowledge, leading to higher risks and costs from repeated errors. All of this has safety implications, a problem equally relevant to railway operations and maintenance.

Simple processes such as Succession Planning (SP) – Pritchard, J. (2) can move things in the right direction. How many rail organisations have effective SP, or have it at all? What are the benefits of Succession Planning in relation to KM? The Paper will examine how and where KM is used effectively and what our industry should be doing to embrace the tools available. It will also provide a KM framework/guide that Council delegates can take way to use for developing a Business Case and consider for use in their own organisations.

Rail organisations are being challenged on how best to leverage their people and knowledge resources in an increasingly complex world. Examples of such challenges are:

- An established rail organisation exposed to major structural change or reform and searching for new ways to adapt operationally and innovate
- An existing rail organisation with well-networked staff but hindered by low levels of knowledge sharing
- A domestic rail organisation looking to operate internationally and faced with strong regional competition
- A new rail organisation with highly knowledgeable staff that lack trust or cohesive networks between them
- A mature rail organisation facing major demographic change and seeking to retain its corporate memory
- An existing rail organisation with a well developed culture of knowledge sharing and networking looking to raise their performance to the next level.

I am sure you have all experienced at least one of these challenges.

In the rail industry, safety performance has become increasingly important in recent years and rail safety performance is strongly linked to knowledge. Effective identification, assessment and management of rail safety risks rely upon adequate knowledge of those risks. You cannot manage a risk that you do not know about and you cannot effectively manage a risk that you do not understand.

That in order to seek truth, it is necessary once in the course of life, to doubt, as far as possible, of all things.

Descartes, Principal of Human Knowledge, Number 1

1. What is knowledge?

Knowledge – facts, information, and skills acquired through experience or education, or more likely both; the theoretical or practical understanding of a subject.

Knowledge has been defined as information that has been given meaning, and information as data that has been given structure - Glazer 1991 (3). There are as many definitions of knowledge as there are experts who talk about it. There are others who see knowledge as the start point before information can be formulated and data can be measured.

Transition into the knowledge era means knowledge has become the major asset and capability for contemporary rail organisations. These organisations face a hyper-connected, competitive and constantly shifting environment. There is growing recognition that knowledge and the ability of an organisation to learn, innovate and adapt contributes significantly towards organisational strength and survival.

I estimate that the attendees at the Council will have between them something like 4,000 – 5,000 years experience and knowledge of railways, most of it what is known as tacit knowledge.

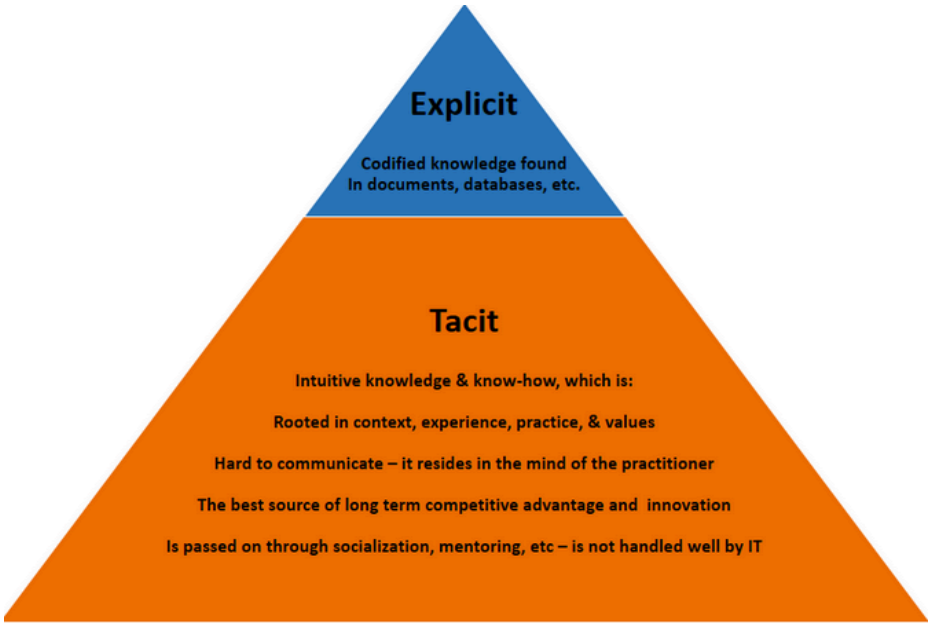
I would like to ask each of you to consider briefly everything you know about your life and your career associated with railways. Think of everything you have learned, through formal training and through your day-to-day experiences, informal learning if you like. All of that combined together represents your knowledge, some of it mundane or out of date but much of it critical and unique. Then I would ask you to consider how much of this knowledge held by you, especially critical or unique, is readily available and accessible to others in a suitably documented record.

An understanding of what constitutes 'knowledge' is central to its effective management. Knowledge is often confused with the concept of information or the gathering of data. I am certain you will all have experienced situations where you are required to submit data and rarely or never see anything coming back from it (sometimes referred to as an information 'black hole'). Information and data can only evolve into knowledge when they are interpreted and usefully applied – given meaning and given structure.

Knowledge can be thought of as either **explicit** or **tacit.** These are the terms used to describe it:

Explicit knowledge is knowledge that can be captured and codified, expressed in words, numbers or symbols and is easily articulated in processes, procedures and practices.

Tacit knowledge is more elusive as it is developed through personal skills, experience, judgment and intuition. It accumulates over time. Can be known as 'gut feeling' or even wisdom and can be hard to communicate. It is fair to say that, for most rail organisations, the majority of knowledge is tacit, some have suggested as much as 90%. This is typically the knowledge that will be lost due to an ageing workforce or during staff turnover. It is stored in people's heads.



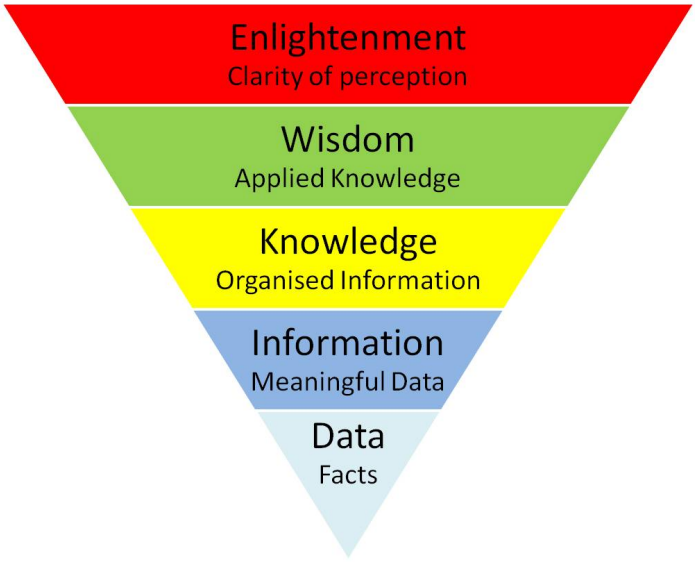
Knowledge may be a company's greatest competitive advantage. A 'learning organisation' can be described as one that is skilled at creating, acquiring and transferring knowledge and then modifying its behaviour to reflect new knowledge and insights. This all sounds fairly common sense but how to make it work? There is an old saying in safety 'that we do not have any new accidents, we just keep repeating the old ones'. This would suggest a failure in KM.

As well as 'learning organisations' there are 'knowledge creating organisations' that actively facilitate interplay of tacit and explicit knowledge. There are even 'adhocracies', organised to carry out expert work in highly dynamic settings, where teams work very closely on achieving objectives.

Given the value of knowledge as an asset, it is not surprising that greater attention is being paid to the subject of knowledge, what it is, how it differs from information and data, and how to begin to create, transfer and use it more effectively. But how do you get at it? There are approaches to this, some deemed effective. One approach that has been found, through survey, to be widely used is called *Communities of Practices* (CoP) – Carrillo 2004 (4). For this to work requires the members of the community to be happy to share knowledge and this is not always the case. Some people feel threatened by being asked to share their hard earned knowledge. In such cases it is therefore imperative to create a healthy knowledge-sharing environment.

Part of my working background is in the oil and gas industry. An example of how to tap into individual knowledge is the *BP Connect* scheme – a voluntary intranet Yellow Pages directory that makes it easier to find expert help. It contains the details of more than 12,000 employees and has a comprehensive search facility.

Among the major challenges of KM is getting buy-in from the employees. No KM system can work unless the participants fully understand the benefits of it and unless employees have formal and informal incentives to participate. Even in organisations that have a technology intensive approach to knowledge management, the extent to which the technology is put to use and depends on the accompanying culture and incentives. Of course knowledge is not the end of the story:



2. The knowledge ecosystem

From AS 5037 (5)

KM is about enabling individuals, teams and entire organisations to collectively and systematically create, share, and apply knowledge to improve the achievement of their business objectives - a kind of corporate Wikipedia.

KM can help identify and manage gaps in the ways that knowledge circulates within an organisation. It also assists in identifying future knowledge required within an organisation in changing circumstances, for example, when an employee retires.

The core of the knowledge ecosystem is the connection of desired organisational outcomes with everything else that contributes to those outcomes or aims being systematically integrated around that. The main practical purpose is to reduce the incidence of making the same old mistakes and 're-inventing the wheel' – how often do we do that? Many projects employ some kind of 'lessons learned' approach after the event, sometimes as a dynamic while the project is underway, but what happens to all of that? From a safety point of view in rail, for example with new rolling stock, a simple Hazard Log can be the way to go, or Failure Reporting, Analysis and Corrective Action System (FRACAS).

There are obviously different levels of maturity in KM and it is important to understand where your organisation stands. As you would expect there are 'tools' to assist, sometimes referred to as Knowledge Management Maturity Models (KMMM).

3. When knowledge management fails

Success has many fathers, failure is an orphan.

Anon.

Many seek credit for success, while few accept responsibility for failure. In safety and rail safety capturing lessons learned from failures can be critical to the on going health of an organisation.

KM has been around in one form or another for quite a long time, although not necessarily by that name. In order to see how it might add real value in safety, I propose to look at some well-known disasters, failures, some but not all rail. What aspects of KM, had it been in use at the time, might have prevented or mitigated the events?

Herald of Free Enterprise (cross Channel Ferry – 193 dead – Townsend Thoresen Ferries ceased to exist).

Capsized and sank 6th March 1987. As with all similar major disasters there were many factors that contributed to the ultimate consequence. The root cause of the disaster was a failure to close the bow doors prior to departure, combined with the ship being ballasted down at the bow in order to align with the dock for unloading. The risks were well known and documented (**explicit** knowledge), and following a couple of earlier near misses, the ships' Masters had lobbied for an indication of the bow door position of the bridge (the doors could not be seen from the bridge). The request was rejected – on cost grounds (estimated installation costs per ship were US$1000). So the **explicit** knowledge was there but was not acted on by senior management and the **tacit** knowledge was with the Masters and crews, but 'production' pressure meant that it was an accident waiting to happen, sooner or later.

Piper Alpha (offshore oil platform – 169 dead – Occidental Oil went out of business as a direct result).

Destroyed by explosion and fire, 6th July 1988. As with all similar major disasters there were many factors that contributed to the ultimate consequence. It was a classic 'cumulative risk' scenario. Although many things contributed to the ultimate consequence, the root cause of the disaster lay with what is known as a 'Permit-to-work' system (PTW). At that time in the oil and gas industries PTW was one of the main risk controls for maintenance activity. PTW systems were inherently fragile and relied heavily on human input and **tacit** knowledge. In 2014 many safe work plans for track maintenance in the rail industry remain equally fragile.

Hatfield (derailment due to Gauge Corner Cracking – four dead – led indirectly to the demise of Railtrack, a publicly listed company).

October 2000, derailment at high speed – the death toll could easily have been much higher. The root cause of the incident was the existence of track defects caused by Gauge Corner Cracking (GCC) that went undetected because of a poor periodic track inspection regime. However, the defect **was** known about 21 months earlier but no action was taken (**explicit** knowledge). So there was **explicit** knowledge both about the phenomenon of GCC and actual precursor rail defects that indicated possible GCC. **Tacit** knowledge among the track inspection staff was inadequate.

Potters Bar (derailment due to inadequate maintenance, seven dead – Jarvis Rail share price plummeted).

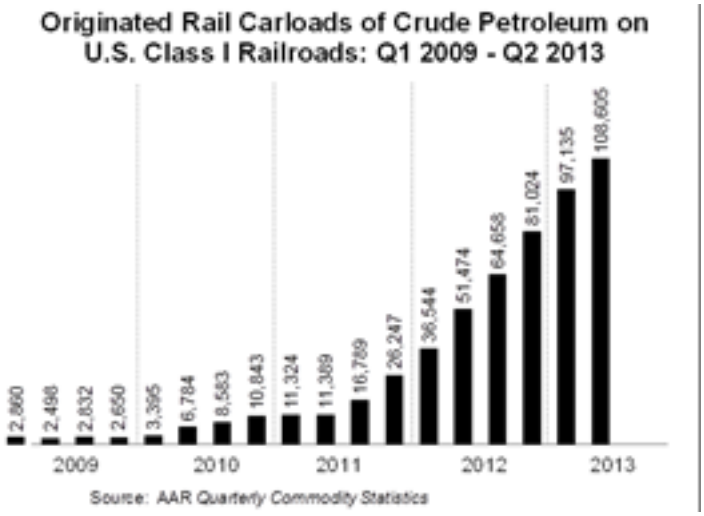
High speed derailment 10th May 2002. Again the root cause was found to be a poor inspection and maintenance regime for points. The risks associated with poor maintenance were not adequately

documented (**explicit** knowledge) and as a result of that there was inadequate systemic **tacit** knowledge – explicitly identified risks should drive training and competency management systems.

Lake Megantic (Canada) July 6th 2013 42 confirmed dead – the operator Montreal, Maine and Atlantic Railway (MMA) is likely to go out of business).

As I write, this well publicised incident is still under formal investigation so any conclusions drawn from it will be to some degree speculative, but as we know one does not wait for formal investigation reports before seeing what lessons can be learned. The tank cars used for the transport of crude oil are designated DOT-111A in the USA and CTC-111A in Canada. The Canadian Transportation Safety Board of Canada (TSB) in 2009 noted that the cars 'have a high incidence of tank failures during collisions' and 'inadequate design' (**explicit** knowledge). MMA was 'allowed' to have Single Person Train Operation and the train was left unattended with one locomotive running to provide air for the brakes, when the engineer went to a motel. The local fire service was later called out as the locomotive was reported on fire. They shut down the locomotive (lack of **explicit** knowledge), which led to the runaway. There are so many contributory factors in this disaster that would fill several conference Papers on Knowledge Management. The fact that this occurred only one year ago, unlike the other examples, highlights the lack of and need for better KM. TSB issued three recommendations in January of this year, to do with tank car design, route planning for dangerous goods and emergency response. Final report released 19th August 2014 – on TSB website – interesting reading.

The graph below reflects the enormity and challenge of managing the risks, both in US and Canada:



Hard to maintain safety levels I such a high risk activity, with such an exponential expansion of traffic

Swiss derailment – St Moritz, August 14th 2014. I would be surprised if there were not KM matters involved in this serious incident.

Of course KM does not guarantee that such things will not happen. Although this paper is advocating the use of KM in some form, there are many reasons why it can and does fail. The failure factors are divided into two broad categories: causal and resultant Frost, A. (6). **Causal factors** refer to the broad organisational and managerial issues that are required to implement KM successfully. **Resultant factors** on the other hand deal with specific problems and can be regarded more like the symptoms rather than the disease.

Causal Failure Factors:

1. Complexity and lack of performance indicators and measurable benefits
2. Inadequate management support
3. Improper planning, design, coordination, and evaluation
4. Inadequate skill of knowledge managers and workers
5. Problems with organisational culture – mistrust of the aims of knowledge sharing
6. Improper organisational structure.

Resultant Failure Factors:

1. Lack of widespread contribution, due to inadequate 'buy-in' from staff
2. Lack of relevance, quality, and usability
3. Overemphasis on formal learning, systemisation, and determinant needs
4. Improper implementation of technology
5. Improper budgeting and excessive costs
6. Lack of responsibility and ownership
7. Loss of knowledge from staff defection and retirement.

These matters are not addressed in detail in this Paper but would need to be considered. Even our Cat has knowledge:

So who does it well? **Self-Design and Self-Replication** Roberts, K. (7)

*'So you want to understand an **aircraft carrier**? Well, just imagine that it's a busy day, and you shrink San Francisco Airport to only one short runway and one ramp and gate. Make planes take off and land at the same time, at half the present time interval, rock the runway from side to side, and require that everyone who leaves in the morning returns that same day. Make sure the equipment is so close to the edge of the envelope that it's fragile. Then turn off the radar to avoid detection, impose strict controls on radios, fuel the aircraft in place with their engines running, put an enemy in the air, and scatter live bombs and rockets around. Now wet the whole thing down with salt water and oil, and man it with 20-year-olds, half of whom have never seen an airplane close-up. Oh, and by the way, try not to kill anyone.'*

I make no secret of my admiration for how these guys do what they do and their excellent safety record, considering the risks involved.

In this interesting environment there exists a rigorous program of training and retraining, so that **every** individual from the Captain down is, at the same time, training or mentoring others while being trained or mentored him/herself. This is the ultimate in Knowledge Management **and** Succession Planning, all rolled into one. It is also a way of life.

A hundred things I have no control over could go wrong and wreck my career . . . but wherever I go from here, I'll never have a better job than this . . . This is the best job in the world.

Carrier Commanding Officer

In looking at who does KM well, it is interesting to see how it features among Rail Investigators, where you might expect KM to be fundamentally essential. A sample is listed below:

ATSB (Australia) – nothing specific regarding KM

RAIB (UK) – nothing specific regarding KM

RSSB (UK) – T518 Brief + several other mentions

TSB (Canada) – Lac Megantic report 19/8/2014. KM mentioned as Item 6 of 'Comptrollership Criteria in 2003-2004 Business Plan – quite an old example.

FRA (US) – nothing specific regarding KM

Railway Safety Commission (RSC Ireland) – see below.

Mary Molloy, Deputy Commissioner of the RSC on the Malahide bridge collapse: '*The RSC welcomes the RAIU report. It is of particular concern to us the casual way in which the placement of stone, as a measure to prevent scour, was allowed to stop by Iarnrod Eireann; this matter also needs to be considered in the context of* ***Knowledge Management****, sections 30 and 31 of the RAIU report.'*

4. Succession planning and management

One of the most critical issues for building innovation capacity in rail organisations is the acquisition and maintenance of knowledge. Succession planning and management is about finding, training and **retaining** tomorrow's leaders, **today**, not waiting until staff retire or leave. Succession Planning is arguably the simplest way of capturing **tacit** knowledge. A report on the rail industry in Australia by Price Waterhouse Coopers in 2006 that tackled a range of issues stated that succession management might assist to at least begin to mitigate some of the challenges: ageing workforce, high turnover among new recruits, negative perceptions of the industry as a career option, tension between older and newer employees and the need for cultural change.

The CRC for Rail Innovation in Australia has a project that is examining the development of a national mentoring and coaching framework as they relate to succession planning (P4.119). The status of this project is not clear.

5. Knowledge Management Framework – based around AS 5037 (5)

Scientia potential est *– knowledge is power –* **this can be dangerous!**

The range of tools and modus operandi that support KM seem to be endless and any decision to adopt KM would need careful planning and assessment, as well as preparing a Business Case to justify the effort. The largest cost is likely to be people's time. A 20-minute Paper cannot hope to cover this kind of detail. Obviously the key requirement is to recognise the need for and the benefits from KM and gain initial senior management support.

5.1 Mapping

The Mapping phase focuses on charting the context for knowledge management, crucial to better understand the knowledge ecosystem and a vision for what KM means for the organisation. Scope depends on support for KM and perceived need for it. What is the gap between the existing and desired state of KM?

5.2 Existing knowledge ecosystem

An ecosystem is characterised by dynamic relationships; connected networks; internal process, content and technology. Use of the 'knowledge lens'[1] to determine:

- Who knows what
- How knowledge flows are shared
- Where knowledge is created and who creates it

[1] A term used to describe the organisation is viewed through different perspectives.

- What knowledge is being used and who is using it
- Why knowledge is valuable to the organisation.

5.3 The building phase

This involves translating the mapping into action and includes such things as pilot projects, communications, creating champions and advocates, identifying resistance to change.

5.4 Operational initiatives and capabilities

The emphasis here should be on what works, based on previous work.

5.5 Enablers

Enablers comprise tools, techniques and activities used to implement KM. A number of different enablers can be used to assist in answering questions in 5.2:

- Knowledge auditing
- Information auditing
- Knowledge mapping
- Social network analysis (this can be particularly useful to identify hidden or 'shadow' knowledge flows).

5.6 Measuring effectiveness

What will success look like? This will vary from one organisation to another.

What a Knowledge Management Framework might look like:

Success factors		Components
Leadership	→	Clear strategic focus for knowledge management and visible management commitment
Culture	→	Shared mindset → Staff capabilities → Capability for change
Infrastructure	→	Roles → Structures → Policies and processes
Technology	→	Design, functionality, integration, speed, simplicity, access
Continuous improvement	→	Metrics for contribution, usage, effectiveness

Objectives and benefits

All initiatives for knowledge management need to contribute to the organisational goals and strategic directions of the agency. **Knowledge management assists in identifying, developing and retaining those employees with critical expertise**. The benefits of knowledge management are reflected through improved relationships and strengthened networks which people use to create and build knowledge. Benefits can include:

- **increased staff retention**, created through the value placed on experience and knowledge
- **improved productivity** provided through an increasingly engaged workforce
- **enhanced innovation** by sharing ideas through communities of practice

- **addressing the issues** created by increased career autonomy, the ageing work force and skills shortages.

A more specific example of one of the benefits referred to above could be retaining an employee a little longer because they feel valued for their knowledge and experience; another example might be offsetting the negative operational impact from the turnover of mobile staff by sharing their knowledge amongst a wider group of employees.

6. Conclusions

KM has many supporters and is used to good effect in other industries. It also has its detractors but this may be because of the sheer size and complexity of the task in setting up an effective KM system. Returning to the four Conference themes and the implications for KM:

1. **Effects of standardised safety management systems.**
   In Australia, for example, the required contents of a rail safety management system are spelled out in the Regulations and supported by additional detailed guidance material. Recognising that this is the **minimum** requirement, is there anything about this approach, related to KM, that is counter productive? The main point is that, while the whole thing is somewhat prescriptive, there is no explicit mention of KM. Refer to WA PSC Guide as a good example (8).

2. **Experience with risk and hazard management and interaction of all players in the railway system.**
   In Australia such interaction could be described as superficial and ineffective, although there are moves to improve matters. National data to support KM is not readily available so that knowledge of risks, hazards and their effective management exist only in isolation. This is clearly a KM issue and a deficiency.

3. **Approaches and instruments for maintaining and improving railway safety.**
   There are many initiatives and efforts to improve railway safety but no central repository that could form the basis of KM. To be effective and successful across the sector, it should rely heavily on good KM. In Australia even the basic data to support this is fragmented and incomplete.

4. **Methods and options for preserving railway safety knowledge in a changing environment.**
   Obviously this is the heart of KM and the key words are ‘in a changing environment’, where the rate of change is arguably increasing, compared to even 10-20 years ago. With the recognized ageing workforce and resulting loss of knowledge there is an urgent need to deal with the matter.

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