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## Safety culture in High-Speed Railways and Importance of top-management decisions

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### Abstract

Safety is a central issue that challenges decision-makers during the planning and implementation of High-Speed Railways (HSR), and appropriate systems should be in place to ensure safe performance during operations. To contribute towards the capacity-building efforts in countries importing HSR technology, the present study aims to highlight the importance of a rather rarely discussed but inarguably essential factor, i.e., the role of top-management in improving the safety culture of organizations. The present study adopts a multi-dimensional dynamic framework to assess the present state of safety-cultures at two railway companies – Indian Railways (IR) East Japan Railway Company. Interviews with senior officials from the two organizations were conducted to assess the current state of safety cultures using the adopted framework consisting of 11 tangible and 7 intangible aspects of safety culture categorized into five levels. The aim is to develop temporal profiles of safety cultures for each organization and to reveal the underlying dynamics and associated challenges in changing safety culture. However, preliminary results highlighting the current state of safety culture for the two organizations, when juxtaposed, reveals opportunities for improvement for IR. Detailed discussions using examples obtained from the interviews are then used to illustrate the importance of sustained efforts from top-leadership in developing a positive safety culture. The paper concludes that dynamics related to safety culture is also affected by the other components of the system such as organizational structure, training system etc. Hence, an integrated approach considering the dynamic interactions between technology, human resources, management, and safety culture is deemed necessary to both analyze the current safety performance and design new management policies

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## 1. Introduction

Evans (2013) argues that because of strong institutional, legal and political pressure, a number of railway safety measures are adopted despite low benefit-cost ratios. Indeed, for users and operators, safety is considered the fundamental value of a railway, in particular for High-Speed Railways (HSR), where it is expected that if railways are perceived as a safety threat to neighbors, the environment, customers, or staff, society will choose not to use them (International Union of Railways, 2018). Safety performance can thus have a dramatic impact on the quality of such cost-intensive investments such as HSR.

From the perspective of a railway organization, acknowledging the importance of safety implies that an *integrated safety approach* may be necessary to gain trust from the public and the government (Hale, 2000). In such an integrated approach, the basic design of a technology should aim to simultaneously minimize the consumption of material, energy, and land; environmental pollution; as well as external and occupational safety and health risks. In addition, Hale (2000) describes the need for the railway industry to have a *dynamism of safety culture* to cope with ever-changing safety issues that emerge from a changing socio-economic environment. Multiple scholars (Hale and Borys, 2013a, 2013b; Hale, 2000; Parker et al., 2006; Westrum, 1996) have argued for the need to shift safety cultures from being calculative or reactive towards becoming pro-active or generative (these terms will be defined and discussed later on in the paper).

Despite the adequate attention given to safety in academic literature and by industry leaders, railways across the world continue to face various challenges related to safety culture.

In Japan, even after the early recognition of the importance of human-factors towards safety management (Saito, 2002), discussions on safety culture in the context of railways have been rather limited (Itoh et al., 2004). In Japan, the development of superior technology to eliminate hazards (even those posed by human errors) and efforts to maintain the asset quality have been central to safety management (Arai, 2003; Saito, 2002). The zero-fatality record of the Japanese HSR in 50 years of its operation is often touted as a testimony for the success of their safety management system (Saito, 2002). However, a serious accident in 2005 in western Japan highlighted the problems with a prevailing punitive safety culture in some of the Japanese railway organizations (Atsuji, 2016; Chikudate, 2009; Okamoto, 2016). The accident prompted an initiative by the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) in 2006 (Okamoto, 2016), in which top management was pressured to become more involved with respect to developing a positive safety culture. India, a country that plans to import Japanese railway technology, has also seen the safety performance of Indian Railways (IR) has improved dramatically over the last few decades (see Figure 3), but high-level reports identify a number of pressing issues related to safety culture in the organization (Kakodkar, 2012).

Safety culture issues observed both in Japan (and India must be considered carefully for the upcoming Mumbai-Ahmedabad HSR (MAHSR) project planned in India. The MAHSR system will be based on the current system utilized by JR East's HSR operators while being implemented by an Indian entity, a majority of whose management staff are likely to be from IR. Many unanswered questions remain such as how to evaluate the characteristics of the safety culture at MAHSR, how to affect, change, or develop this culture, and the role of top-management in doing so. A thorough understanding of these aspects will help the design and implementation of new mechanisms for improving safety culture for the MAHSR.

In this context, the objective of the present study is to assess the current safety culture in Japan and India through case studies of JR East and at IR and to illustrate the role of top-management in improving the state of organizational safety culture. The study is also aimed at identifying the challenges in improving safety culture. An understanding of the safety culture and challenges should generate important lessons for both Japan in sustaining their exemplary safety records, as well as for partner countries like India, which plan to implement new HSR projects.

The remainder of the paper is organized as follows: Section 2 discusses the evolution of safety concepts in the context of railways and highlights the need for a continuous shift in safety management. The relationship between safety culture and safety is explored in detail, and a framework suitable to assess the current state and dynamics of safety culture within HSR operators is identified in this section. Section 3 provides an overview of safety performance at IR and JR East. Section 4 provides details on the methodology adopted to apply the selected framework in the current study. For this study, authors conducted interviews with railway officials and combined these insights with secondary sources. Section 5 summarizes the results obtained from the application of the framework for IR and JR

East respectively, providing detailed information on the current state of safety culture in both organizations. In section 6.1, the authors discuss the necessity of a multi-pronged approach by top-management in improving the state of safety culture within the organization through an in-depth review of examples obtained in interviews. Section 6.2 then discusses the challenges associated with improving the safety culture of organizations and proposes a novel approach to assess these challenges and find solutions. Finally, limitations of the study are summarized before conclusions are presented.

## 2. Literature Review

### 2.1. Paradigm shifts in railway safety management

Based on the analysis of the European railway industry, Hale (2000) describes paradigms of safety thinking in railways (Figure 1). The early (first age of) safety inspectors were engineers that sought for answers to technical failures and their technical fixes. Technology improvements continue to be an important factor in railway safety management especially as a means to eliminate hazards. In that, the use of technology as a means to manage safety has become proactive in nature (reporting and monitoring), as opposed to reactive (corrective actions), (Saito, 2002) and is gradually becoming predictive (safety modeling). For example, Arai (2003) describes how railway companies in Japan have developed technologies that can predict potential hazards associated with natural disasters and suggest appropriate countermeasures that not only improve safety performance but also improve other parameters of service quality such as punctuality.

While there is no denying the importance of technical enhancements as a means of eliminating hazards for safety management, nearly two-centuries worth of experience in the railway industry suggests that such systems tend to be complex and unpredictable under emergencies (Rasmussen and Duncan, 1987). As the industry increasingly began to acknowledge the importance of human-technology interfaces or the ergonomics of safety management, human-factors became a central element of safety management, bringing about the second age of safety (Bainbridge, 1983; Hale, 2000; UGAJIN, 1999).

A detailed review of ergonomic studies in railways is beyond the scope of this paper but readers can find comprehensive discussions in Wilson et al., 2007, Wilson and Norris, 2006, and 2005. Ergonomic studies have had a significant impact on improving railway safety, through design improvements to procedural components such as cabin monitors and signal visibility.

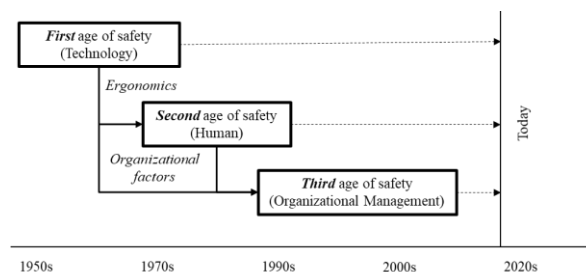


Figure 1 Evolution of safety thinking (Hale, 2000; Schubert et al., 2010; Stolzer et al., 2008)

Despite the combined emphasis of technology and human factors, technical failures and human errors are still the leading cause of safety-related incidents (Baysari et al., 2008). Kyriakidis et al. (2018) make a similar observation based on European and American experiences. Recent studies have focused on identifying the underlying causes of failures and thus has highlighted the need for yet another paradigm in safety thinking, towards the organizational management of safety.

For example, Baysari et al. (2008) found that there was at least one organizational factor behind the technical and human failures and errors for the Australian railway industry, such as the lack of maintenance. Research that further investigated human errors (Reason, 1997, 1990) suggest that accidents were a result of errors caused not only by front-line operators but also by errors of designers, managers, supervisors, and maintenance staff. In recognizing the need

for addressing *organizational factors for safety management*, Hale (2000) highlights the need for *integrated planning* and an organization-wide perspective on safety management, while describing how railway employees tend to manage all of the risks for their domain without due consideration to the cost or redistribution of the resources to other priority areas. Hale (2000) thus calls for the adoption of an organization-wide perspective on safety management. Hale (2000) and other researchers (Wilson and Norris, 2006) examine the use of safety rulebooks as a means of managing human errors and updating organizational rules, identifying a problem in which the creation of new rules after every accident would lead to the formation ever-increasing rulebooks. Hale (2000) sees such an arrangement as a one-off, top-down, reactive approach where top-management does not invest any more consideration in proactive planning. Atsuji (2016), Chikudate (2009), and Hale (2000) regard the workforce’s attitude towards these rules as rather worrying, and studies have identified problems such as employees reporting that there are too many rules that often conflict and hinder other operational tasks, and are perceived as a tool for pinning blame rather than promoting understanding ((Hale and Borys, 2013a). Punitive rules can also lead to a situation where the staff becomes habitual and professional violators of rules (Atsuji, 2016; Reason, 1997, 1990). Under this context, the need for a system is stressed where employees can self-regulate and continuously improve a safety management system in lieu of the ever-changing safety requirements for railways.

Considering the challenges posed by the first two ages of safety (as highlighted above), studies increasingly target the need to bring systems thinking to railway safety management (the third age of safety). This approach focuses on the *integration* across components (technical, human, managerial) and management levels, and the *dynamism* to cope with changing demands put on railways (Doi, 2016; Kawakami, 2014; Rajabalinejad and Dongen, 2018; Santos-Reyes and Beard\*, 2003; Sussman et al., 2007; Wang et al., 2017). Performance state of safety or punctuality are seen as emerging properties of the systemic interaction of its components, and an explicit focus on system thinking is evident through its adoption by many high-level railway bodies across the world (IHRA, 2016; UIC, 2018).

2.2. *The concept of Safety Culture*

Safety management systems (SMS) refer to an approach that is designed to manage safety elements in the workplace. Figure 2 describes the key components of an SMS as per Schubert et al. (2010). The concept of SMS in Figure 2 has been described for the airline industry but is considered generic, and are relevant to the railway industry (Kawakami, 2014). An important pillar of the SMS is safety risk management. This includes elements such as hazard identification, risk analysis, risk assessment, and risk control/mitigation. Considering the third-age of safety, a number of recent studies have taken a systems thinking approach (dynamic interaction of technology, human resources, and management) to identify hazards/risks at various levels (Kawakami, 2014; Salmon et al., 2018). On the other hand, safety culture as a pillar for SMS has gained attention partly because of the attribution of a number of railway accidents to negative safety culture within the organizations (Atsuji, 2016; Chikudate, 2009; Okamoto, 2016). However, Reiman

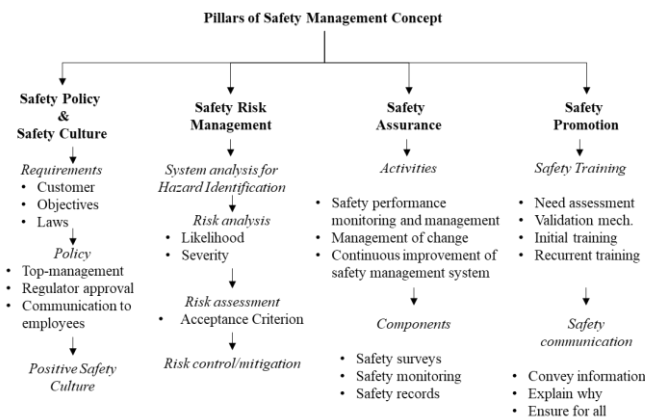


Figure 2 Pillars of the Safety Management Concept, adapted from (Schubert et al., 2010)

and Rollenhagen (2014) have highlighted that in practice, safety culture is seldom truly integrated with systems thinking.

The literature provides various concepts that can act as tools for assessing the dynamism of safety culture in the context of railways. Clarke (1998) describes the key elements of a safety culture, as comprised of beliefs and attitudes that are shared among employees and are expressed in the day-to-day behavior of the staff. Clarke (1999) goes on to suggest that improvements in safety culture can be more effective than rigorous supervision. The necessity for a safety culture to continuously identify hazards has been shown in (Reason, 1997), where effective safety cultures are shown to incorporate safety information systems that collect, analyze, and disseminate safety data, and encourage employees to report their mistakes for learning purposes.

A few studies have identified challenges in assessing safety culture (Parker et al., 2006). As safety culture is likely to change within a single organization (Parker et al., 2006; Zohar, 2000; Itoh et al., 2004), it is necessary to use a dynamic framework that can integrate formal safety systems with that of the safety-related behavior of all employees of the organization. Furthermore, Safety culture is a multi-dimensional concept that includes individual factors such as the perception of senior management's attitude with respect to safety (Clarke, 1999), communication skill, and hazard reporting ((Zohar, 1980) on railways), as well as organizational factors such as auditing and company policies (Parker et al., 2006). Considering the different levels of sophistication in safety culture (Westrum, 1996), this study adopts the (Parker et al., 2006) framework.

The framework is suitable for being applied to the railway industry for various reasons. First, the framework is suitable in demonstrating how an organization could shift towards an advanced and mature safety culture, whereas the need to continuously improve railway safety management has been well established (Hale, 2000). The framework can be applied at different employee levels, and can then be used to identify positive and negative elements within the organization, an issue that railway organizations often face (Itoh et al., 2004). Furthermore, the framework is suitable for identifying the intangible and abstract aspects of safety culture that can be combined with tangible safety assessments to provide a comprehensive assessment (as necessitated by the systems thinking approach for railways (Reiman and Rollenhagen, 2014)).

### 3. Overview of safety state for Indian Railway (IR) and JR East

#### 3.1. Overview of safety at IR

Despite the significant improvements seen in safety over the past 5 decades, IR is still facing a number of issues. The casualties per million passengers have increased despite the decrease in the number of accidents (Figure 3) suggesting the need for increased safety measures in lieu of increased passenger volume and human interaction at IR. It is important to note that there is still no reliable data for injuries or fatalities of people trespassing the railway tracks (Kakodkar, 2012). Moreover, the proportion of accidents attributed to errors of railway staff has been well above 70% since 1965 (Indian Railways, 2013). Consequently, IR has expressed an explicit focus on improving safety culture in its corporate safety plans from 2003-13, recognizing its importance in achieving higher safety levels (Ministry of Railways India, 2003).

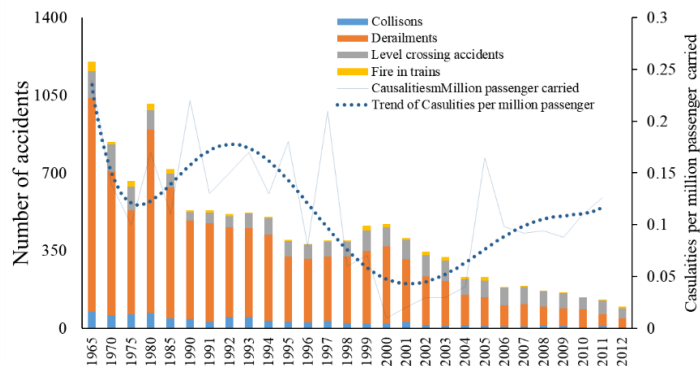


Figure 3 Long-term safety trends for Indian Railway (Indian Railways, 2013)

In terms of organizational structure, the Ministry of Railways is the apex body providing policy guidelines and budget approvals. The Railway Board is the main body to lead control, planning, and monitoring actions to the entire IR, and it is at this level that the Chairman of the Board is placed in charge of safety (as head of the safety-directorate). However, there is no explicit representation of the safety organization at this level. IR is instead categorized into 17 zones which are further divided into multiple divisions headed by a Divisional Railway Manager (DRM). Safety Organizations (SO) are present at all of these divisions and zones. With assistance from members of each department (such as mechanical, electrical, civil etc.) the SO is led by dedicated safety officers, who report directly to the corresponding DRM or GM. This highlights the importance of SOs in the organization and its equivalence to other departments. The main function of the SO is to audit, overlook emergency responses, conduct safety seminars, educate staff, and conduct accident analysis.

3.2. Overview of Safety at JR East

At present, JR East operates approximately 7,500 km of urban-rails and regional trains including approximately 1200 km of HSR lines. The total number of safety-related cases have been reduced to about half since 1988 (Figure 4). Most of this reduction has been achieved by efforts in reducing accidents at railway crossings. The number of “Train accidents”, which includes occasions of fire, derailments, or collision, have historically been low but have continued to decrease gradually. On the other hand, fatalities or injuries including customers on platforms or trespassers on tracks encountering trains, and customers falling onto the tracks from platforms have grown as a proportion of total accidents as well as in absolute terms. Safety has been a priority of top-management since the inception of the company (JR East, 2017). In pursuit of zero accidents involving passenger injuries or fatalities, and zero accidents involving employee fatalities (including Group and Partner Companies), JR East has emphasized learning from past-accidents and employs the continuous development of tangible and intangible safety aspects through coordination and team-work. Beginning in 1988, JR East has adopted 5-year group safety plans to prioritize safety-related efforts. Recent safety plans (5<sup>th</sup> (2009-13) and 6<sup>th</sup> (2014-18)) have explicitly mentioned a need to focus on improving the safety culture within the organization.

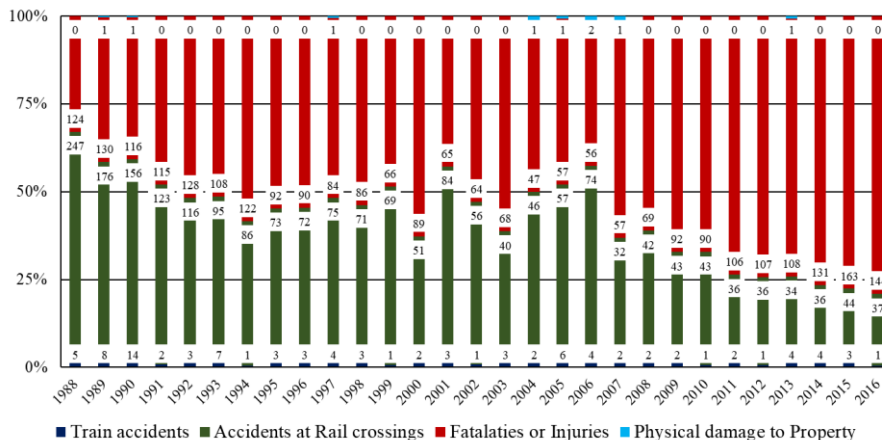


Figure 4 Safety trends for JR East (JR East, 2017)

The safety organization at JR East is as follows. Led by its president, JR East is divided into the Headquarter (HQ), branch office, and field office levels. Field offices include stations, rolling stock depots, drivers, and conductors depots. Safety responsibilities are distributed throughout the organization but each person involved in safety works closely with the top-management for various safety activities. At HQ, the Transport safety department (SD) reports to the President through the Director General of railway operations. Similar duties are performed by transport safety sections at each branch office, which is presided by the GM. The Transport SD has a strong presence with equal status

among other departments. SD undertakes activities including investment planning, accident analysis, countermeasure design, safety system development, designing safety standards & procedures, disaster training and inspecting vocational attitude for the drivers. In addition, safety strategy team within SD undertakes measures for improving safety culture as well as measures on developing safety in-charge personnel.

A quick comparison of the safety organization at IR and JR East easily reveals that safety department at JR East undertakes comprehensive responsibilities in close coordination with its top-management when compared with IR. Additionally, there is an explicit focus on improving safety culture in the responsibilities of safety departments. In the next section, we will focus on evaluating the safety culture at both of the organizations. We will revisit the discussion on safety organization and its relationship with the safety culture in later sections.

#### 4. Methodology

Westrum (1996) suggested that one way to distinguish between organizational cultures was to observe how organizations internally handled safety-related information. Consequently, he had proposed three levels of safety culture – Pathological, Bureaucratic, and Generative. Considering suggestions by (Reason, 1997), Parker et al. (2006) have improved this three-level system to a 5 level safety classification as shown in Table 1. Two additional levels, namely Reactive and Proactive, allow for more subtle classifications. In addition to the levels, the framework proposed by Parker et al. (2006) investigated 11 tangible and 7 intangible aspects (prepared for multinational oil companies) of safety cultures (Table 2). A full description of the proposed framework is not presented here and can be found in Parker et al. (2006). The framework thus proposed is generic and was adopted in the current study with an assumption that the description of each aspect-safety-level is also relevant for railways, and has been validated through the application of the framework.

To apply the framework, authors conducted interviews with management official at IR and JR East. The management officials being interviewed had more than 10 years of work experience in various departments of the organizations. Each interview lasted approximately 2 hours and officials were asked to comment on current practices related to various tangible and intangible safety aspects at their respective organization. The questions were framed as “what-type” and “how-type” questions, so as to identify the current state of the system rather than discussing the challenges in achieving the current state of the system. In addition, the relevance of these aspects to the railway industry was also confirmed. The interviews were unstructured and aspects were not discussed in a sequential manner. To avoid biases, the interviewee was not informed about safety level classifications beforehand. Interviews with Japanese operators were conducted in Japanese with simultaneous interpretation in English. Interviews with Indian officials were conducted in Hindi through telephone, with a native Hindi speaker. In the case of Japan, additional information on safety management was also assessed from the safety reports of the company (JR East, 2017).

Table 1: Level of safety classification as per framework by (Parker et al., 2006)

Safety level	Description
<b>Pathological</b>	Who cares about safety as long as we are not caught?
<b>Reactive</b>	Safety is important; we do a lot every time we have an accident
<b>Calculative</b>	We have systems in place to manage all hazards
<b>Proactive</b>	We try to anticipate safety problems before they arise
<b>Generative</b>	Safety is how we do business here

Table 2 Organizational aspects of safety-culture as per framework by (Parker et al., 2006)

Tangible Aspects	Intangible Aspects
Trend analysis; Audits and review; Incident/accident reporting, investigation, and analysis; Hazard and unsafe act reports; Work planning; Contractor management; Workers interest in competency training; Work-site Job safety; Daily safety responsibility; Size of the safety department; Rewards for good safety performance	Who causes the accident in the eyes of the management; What happens after an accident?; How do safety meeting feel; Balance between safety and Profitability; Is management interested in communicating safety issues with the workforce?; Commitment level of workforce and level of care for a colleague; What is the purpose of procedure;

The answers received from the interview were then summarized in 2-3 sentences for each aspect. The categorization for each aspect into the level of safety was done by the authors referring to detailed definitions provided in (Parker et al., 2006). The classification and the summarized sentences were then sent to the officials for their confirmation. Short descriptions were modified to reflect feedback, and the final description is shown in Figure 5 -7. The next section presents a few examples of the classification process, where results from the interviews are summarized. Naturally, one interview cannot suffice to account for variations in safety culture across management levels and railway organizations. However, interviews were helpful in identifying and comparing general aspects of safety cultures within actual organizations.

Aspect	Indian Railway	JR East
Tangible aspects		
Benchmarking, Trends and Statistics	Trends are identified, understood and their solution are found at all levels of management. Absolute safety may not be practical hence zero-tolerance to risks ( <i>Proactive</i> )	Trends are analyzed and utilized at all levels of management combined with “soft” lessons from previous accidents. Management is seeking zero accidents ( <i>Generative</i> )
Safety Audits	Extensive cross-auditing. Audits are seen as learning opportunity. Audits focus on system level ( <i>Proactive</i> )	--
In(ac)cident reporting, investigation	Detailed procedures for reporting accidents and incidents. Trends are systematically analyzed and lessons learned are shared across organization ( <i>Proactive</i> )	Analysis driven by deep understanding of accident causation (4M, Man, Machine, Media, Management). Follow up is systematic. ( <i>Generative</i> )
Hazard and unsafe act Reports	All encouraged to report near-misses/hazards. Reports also focus on identifying the possible improvements. Follow-up is done but not by all employees. ( <i>Calculative</i> )	--
Work planning	Hazard analysis is included in work plan but only for Track related work. A standardized process is followed with occasional feedback( <i>Calculative</i> )	Safety is integral aspect of the planning where employees continuously think, anticipate and review the work plans thus prepared. ( <i>Generative</i> )
Contractor Management	Safety track record is not mandatory but, IR keeps internal record of safety performance and banning of business is practiced for contractors with negative records. IR assigns safety staff to contractor for ensuring safety. ( <i>Calculative</i> )	--
Workers interest in competency training	Training is done to maintain the safety attitude. Competency matrices are still under-development. There is some On-the job training ( <i>Calculative</i> )	Leadership realizes the importance of continuous improvement in “on-the job training”. Safety leaders working closely with employees identify the training requirements ( <i>Generative</i> )
Work-Site job safety	Experienced supervisors are staffed at work-site. Plans are also discussed with contractors. Workforce awareness of safety is a challenge ( <i>Calculative</i> )	--
Daily safety responsibility	Site activities are regularly checked as per the written procedures. Everyone is encouraged to check safety. Internal cross-audits at all management levels. However, a few opportunities to improve are missed ( <i>Calculative</i> )	Everyone checks for hazards, for themselves and for others. Management promotes “Stop trains” policy whenever there is a doubt on safety ( <i>Generative</i> )
Size of the safety department	SD has equal status than other departments. People with experience in train operation receive priority to work in SD. Experience at SD is highly valued ( <i>Proactive</i> )	Safety is distributed through out the company. The department is powerful and considered as an important job. SD reports to top-management ( <i>Proactive</i> )
Rewards for safety performance	Good safety performance is considered in appraisals. Evaluation is on safety process followed. Good performance is recognized across IR. ( <i>Proactive</i> )	Individual safety behavior is recognized by the top-management. Recognition is seen as high-value. ( <i>Generative</i> )
(--) Conclusive information could not be obtained at the current stage of interviews		

Figure 5 Descriptions of current state of tangible safety aspects



## 5. Measurement of Safety Culture at IR and JR East

### 5.1. Safety Culture at IR

Identifying trends for safety-related issues is one of the key responsibilities of the safety organizations at IR. The interviewee stated that “At IR, we believe that accidents do not occur because of a one-time event but the underlying causes accumulate over the time”. This response captures the underlying philosophy behind the trend analysis as a proactive means to search for risks. The purpose of trend analysis is to recognize patterns, identify their solutions, and provide suggestions for effective countermeasures and not to benchmark year-on-year performance of employees or management. The system of trend analysis appears to be aimed at anticipating the safety problems before they arise and hence is categorized as being proactive. On the other hand, a calculative organization would have focused exclusively on summarizing the incident data, whereas a generative organization would have combined the knowledge obtained from other resources to look for solutions involving all levels of management.

In addition, SO also performs frequent regular safety audits and surprise mock-drills to further assess safety responses. Although independent safety audits are reserved only for major accidents, inter-divisional and inter-zonal cross audits are conducted regularly. Management sees safety audits as genuine learning opportunities for procedural lapses as well as technical and managerial challenges in their respective departments. A positive attitude towards being audited itself can be seen as management’s understanding of their own biases and proactively accept help to reduce risks. An organization with generative safety culture in this aspect could be expected to have a system to audit for behavioral aspects.

SO organizes safety seminars where good safety behavior by employees is rewarded with some prize money and division or zone-wide appreciation (appreciation is considered more valuable than the prize money). Employees are also appraised for their safety consciousness. In addition, regular safety training for employees is deemed essential for business operations at IR. Although safety training is an important means to introduce new rules, remind employees of existing safety rules, and introduce best practices, the training are often designed in a top-down manner with mono-directional communication (trainers to the employee). The quality of trainers is often an issue and prospects of on-the-job training are limited. Such a system could be categorized as being calculative and is in the scope for improvement for IR. A more detailed description of the current state of culture related aspects can be seen in Figures 5-7. There are positive examples where safety culture at IR has reached higher safety levels, e.g., the purpose of procedural lapse is not to blame the violators but to identify the reasons why the rule could not be followed. In addition, to improve the compliance to rules, IR issues local safety circulars, which are suitable for local needs and incorporate existing tacit knowledge. However, considerable scope for improvement exists for a few intangible aspects such as in establishing a balance between conflicting demands, i.e., safety, punctuality, and profitability, or in cooperation with the community to improve safety performance.

### 5.2. Safety Culture at JR East

The strength of JR East’s safety culture lies in its comprehensive on-the-job and off-the-job training systems. JR East has taken a bottom-up approach in its safety training management. Under such a system, people who have demonstrated excellent safety acumen in their own work, as well as retirees who have extensive safety experience, are in the frontlines engaging in continuous improvement in safety training. Furthermore, a system of close mentoring during training has enabled JR East to disseminate its safety lessons and tacit knowledge as well as transfer the principles and philosophy behind safety rules to a young recruit. In addition, the interactive presentation of training materials and mutual communication between staff and trainers during on-the-job training enables training needs to be identified based on the requirements of the staff. Such a system that enables active participation for all employees is categorized as being generative.

Additional descriptions of the various aspects of safety culture are given in Figures 5-7. The visible commitment of its top-management to ingrain five practices (prompt and proper reporting; hazard recognition and sharing; honest and open discussion for accident investigation; continuous learning and awareness; and to think and take safety actions) is also among the strengths of the safety culture at JR East. JR East’s involvement of top-management includes regular visits by the President with employees to hold discussions about elements of safety culture, making a majority

of the safety culture dimensions generative. In addition, the safety challenge campaign encourages employees to take active roles in improving safety, and winners are acknowledged and awarded by their department as well as by the President. Such a system, which has shifted from “punish to correct” to “praise to encourage” is employed to give employees a feeling of accomplishment and encourage the further actions to support a generative safety culture, i.e., to be an organization that places its highest priority to safety.

Aspect	Indian Railway	JR East
Intangible aspects		
Who causes the accident ?	Failure in processes, procedures are looked upon in addition to technical and human failure. Management identifies the need for self-improvement ( <i>Calculative</i> )	Management accepts take responsibility of the accident and strive to remove the root-cause. Accident causation follows 4M principle ( <i>Generative</i> )
What happens after accident?	Independent investigations focus on underlying causes and reported to supervisors. Management asks about the well-being of those involved. Follow up is top-down and systematic. Not Participative. ( <i>Calculative</i> )	Investigations focus on underlying causes and reported to supervisors. Management is seen as taking a leadership role in response. Follow up is bottom-up with direct coordination with top-management ( <i>Generative</i> )
How do safety meetings feel	At higher level, meetings are regular and interactive. At lower level meetings are rather one-way ( <i>Calculative</i> )	--
Safety and Profitability	Preventive maintenance is priority but absolute safety is thought as costly. Some cost escalations are accepted to achieve safety standards ( <i>Calculative</i> )	Safety and profitability are seen in total balance as safety is seen as making money. The company minimizes delays while ensuring full safety ( <i>Generative</i> )
Safety and Punctuality	Safety is prioritized over punctuality but situation where there is a need to balance the two arise often. Some delays are accepted to achieve safety ( <i>Calculative</i> )	Safety is top priority. Effective measures are taken to improve punctuality while striving for zero-accident. ( <i>Generative</i> )
Safety communication	Management shares a lot of safety information with workers but the process is rather one-way. ( <i>Calculative</i> )	Management shares a lot of safety information with workers and a two-way process is in place. Staff is invited at Head office to speak about safety ( <i>Proactive</i> )
Commitment level for workforce	There is an increasing safety awareness due to efforts by top-management. Safety issues are seen as something to avoid. Pride is beginning to develop ( <i>Proactive</i> )	Levels of employee commitment are very high and employees demonstrate passion to live up to the aspirations. ( <i>Generative</i> )
Cooperation with community	Community awareness steps are undertaken to stop accidents at the crossings. Community representatives are sometime consulted ( <i>Calculative</i> )	Community is considered a key stakeholder in safety designing and managing safety solutions ( <i>Generative</i> )
Purpose of procedures	Procedures spread best practices. But non compliance of rules is investigated properly. Local adaptation of procedures is implemented ( <i>Generative</i> )	--
(--) Conclusive information could not be obtained at the current stage of interviews		

Figure 6 Descriptions of current state of in-tangible safety aspects

## 6. Discussions

Based on the interviews, additional tangible and intangible aspects were identified not contained within the adapted framework from Westrum (1996) and Parker et al. (2006). These aspects are the balance between safety and punctuality (intangible), and safety measures in cooperation with the community (intangible). Figure 7 presents the classification of different aspects into safety levels introduced in Section 4, in line with examples from interview testimony (as explained by the example in Section 5). The purpose of this exercise is not to provide a one-on-one comparison of the two systems, but to highlight a useful contrast in the current state of safety cultures across the two organizations, and to highlight the scope of improvement for IR. The next section will focus on highlighting the role of top-management in improving the safety culture.

### 6.1. Role of Top-Management in improving the Safety culture

We hypothesize that top-management must adopt a multi-pronged approach to improve the safety culture of an organization. There is no one-dimensional management strategy that is sufficient for improving the level of an

Aspects	Calculative	Proactive	Generative
Purpose of procedures			Red, Green
Size of the safety department		Red, Green	
Benchmarking, Trends and Statistics			Green
Safety Audits			Green
In(ac)cident reporting, investigation			Green
Hazard and unsafe acts reports			Green
Rewards for safety performance			Green
Commitment level for workforce			Green
Cooperation with community			Green
What happens after accident?	Red		Green
Daily safety responsibility	Red		Green
Work planning	Red		Green
Contractor Management	Red		Green
Workers interest in competency training	Red		Green
Work-Site job safety	Red		Green
Who causes the accident ?	Red		Green
How do safety meetings feel	Red		Green
Safety and Profitability	Red		Green
Safety and Punctuality	Red		Green
Safety communication	Red		Green
Indian Railway		JR East	

Figure 7 Scope of safety culture improvement at IR

organization’s safety culture. For example, the overt involvement of top-management can have a significant impact in improving the safety level from being *Proactive* to *Generative* for both tangible and intangible aspects. On the other hand, a number of organizational/structural changes along with sustained leadership efforts are necessary to improve the safety levels from *Calculative* to *Proactive* and even *Generative*.

In the context of integration of the railway and the community that it operates in, an examination of key stakeholders for each of the railway organizations will clarify the role of the top-management in improving safety culture. For JR East, the top-management have acknowledged the regions or communities surrounding JR East infrastructure as its key stakeholders (JR East, 2017). The inclusion of this group as a stakeholder improves public accountability of the organization and puts additional demand on the safety performance of the organization. Such increased demand in the level of safety requirements then manifests in on-ground implementation of increased safety measures and puts pressure on the safety culture. For example, JR East actively monitors the deaths and injuries for trespassers or passengers at the station, leading to increasing awareness among employees about such issues as well as measures such as installing barriers at the station. In addition, JR East engages the local communities and residents nearby crossings to co-design solutions. Such solutions are also proven to be effective in the long-term due to enhanced community ownership. On the other hand, at present, such a practice does not exist within IR (Kakodkar, 2012). Hence, a number of initiatives adopted by IR are not based on community participation and may have limited effects. For example, IR uses street-plays to raise public awareness, but the effect is arguably short-term. Explicit acknowledgment of the communities in the stakeholder groups will also provide opportunities to mainstream some safety practices in a coordinated manner. For example, a collection of information on injuries and causalities of trespassers could be mainstreamed through initiatives of the top management, which will then require an increasing focus on safety by the employees.

A similar discussion in the context of the effectiveness of safety departments reveals the necessity of sustained efforts by the top-management in addition to slight changes required in organizational structure. The president of JR East is directly involved in various railway safety promotion committees (both at HQ and at branch offices). These committees engage in trend analysis. Members of each department are integral in these safety committees. Such an

arrangement thus ensures effective coordination and integrated decision making across departments and increases the accountability of each department towards safety. On the other hand, IR safety committees only report to immediate supervisors, and top management is not directly involved. In addition, SD must coordinate with each department as these are not directly represented within SD. Authors consider that IR could also benefit from such a system of integrated decision-making practice where only active efforts from top-management along with slight organizational restructuring could improve the efficacy of investigation and workings of the safety department. Such a recommendation was also made by the high-level safety review committee for IR (Kakodkar, 2012).

On the other hand, a shift in safety culture through strengthening training systems will require organizational reforms along with sustained efforts from top-management. One of the JR East's strength lies in its comprehensive training system. As highlighted in Figure 8, the safety strategy team at HQ oversees the development of persons in charge of safety (PICS). There are two types of PICS in JR East, namely Safety Professionals (SP) and Key Persons for Safety Guidance (KPFSG). SP is a person who understands the mechanisms of safety in the organization, is recommended by the branch office, and is certified by the HQ. SPs are responsible for handing down safety expertise to branch offices. SPs along with PICS are responsible for developing off-the-job training programs at various training centers. PICS are located at any of the field offices (e.g. Stationmaster in case of a Station) and possess familiarity with weak points, safety rules, and past accidents of the field office. The prime responsibility of the PICS includes providing On-the-job training in which focuses not on the “know-how” but on the “know-why” and “show-how”.

There are certain characteristic features of this training system. First, the SPs are people with exemplary safety experience. Their extensive experience is something that makes them suitable to closely analyze the difference between rules and real practice, and to formalize tacit knowledge. Through their close interactions with employees, they are expected to have familiarity with the training needs of the employees. In addition, the quality of trainers is assured through certification and recommendations of various intermediate management levels.

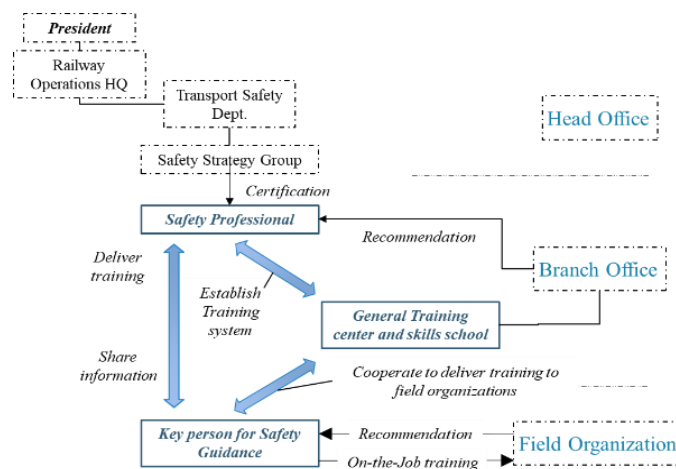


Figure 8 Safety training system at JR East

On the other hand, there are some fundamental differences in the training system at IR. Rules related to the selection of trainers are not enforced by management themselves, and the training abilities of trainers themselves have been questioned (Kakodkar, 2012). This highlights the need for sustained efforts from the leadership in ensuring the quality of training systems. In addition, the role of SD in designing the training is limited to circulating information on rules. Whereas informal on-the-job trainers are not formally recognized in SD. Thus the full potential of the experienced staff is not realized in imparting adequately designed training materials and methods. Such an issue can only be solved by the involvement of top-management in redefining the roles and responsibilities of employees within the organization.

From the discussions presented in this section, the role of top-management in improving the safety culture at an organization is highlighted. The actions by top-management become even more prominent when shifting from a proactive safety culture to a generative culture. The sustained efforts from leadership are necessary to set incremental

targets, take an active involvement in enforcing safety practices, increasing coordination within the organization, and developing a positive safety culture. In addition, top-management has the ability to create the necessary organizational/structural reforms to steer safety culture the organization. Our discussion suggests that a variety of strategies need to be utilized to manage improvements in safety culture and there is no “one size fits all” solution.

## 6.2. Challenges in improving safety culture and the need for an integrated dynamic framework

An examination of safety training systems also reveals an important lesson about railway operators overall – that is, safety-cultures and their dynamics cannot be considered in isolation but must be integrated with other elements of the safety system. In other words, cultural aspects must be studied in tandem with technology, human and management aspects. This integrated nature of safety culture then poses challenges for top-management as there are many indirect factors that affect safety culture and performance. A number of such examples that were obtained through our interviews and secondary sources are discussed here.

The high-level report on safety at IR highlights (Kakodkar, 2012) the “top-heavy” situation at IR. Such a state in the organization is reached when there are far fewer numbers of employees at a working level than at the manager level, and when executive powers are too centralized at the manager level. Such “top-heavy” organizations coupled with lack of feedback from the executive staff can lead to excessive pressure on executive staff and could negatively affect the safety attitude of the employees, gradually weaken the safety culture of the organization. A complex interconnected system produces situations in which impacts are only observed after a time lag. Considering the examples discussed here the authors would like to emphasize the need for an integrated framework that could capture the dynamic interactions between technology, human resources, management, and culture. Such a framework, when converted to a quantitative or non-linear system dynamic model could well serve as a policy or performance analysis tool for the top-management of railway organizations, providing them with an opportunity to analyze long-term implications of management decisions.

## 7. Limitations of the study and future strategy

In previous sections, authors have demonstrated a number of advantages of the methodology adopted in this study. The juxtaposed state of the safety cultures for the two organization could highlight contrasts between the two and was effective in highlighting the role of top-management in improving the safety culture for a number of tangible and intangible aspects. However, there are a number of suggested improvements in the methodology.

First, in the present study, the applicability of the original framework presented by (Parker et al., 2006) was assumed to be true for the case of railways, however, a number of new aspects emerged through the interviews (highlighted in bold in Table 1). Hence there is a need to conduct the exercise similar to that of (Parker et al., 2006) and extend the survey to more executives to refine the framework.

Second, the framework utilized here is qualitative in nature that tends to capture the mere existence of the some of the systems and does not delve into details of the efficiency of these systems, which can only be assessed through more detailed and quantitative assessments. For example, for the case of IR, cross-auditing within the organization is perceived as a positive norm which should be categorized as proactive as per (Parker et al., 2006). However, these audits were found to be too frequent, with a time-gap between audits that was, in fact, shorter than the time required to implement recommendations from previous audits (Kakodkar, 2012). Under such conditions, the number of recommendations will continue to increase without any implementation, leading to a situation where despite the presence of a proactive safety culture, improvements in the level of safety are throttled. Authors would continue to explore this aspect of including the quantitative aspects of the methodology.

Finally, in the present study, an attempt to derive lessons from one organization to another is made. However, authors believe that it will be meaningful to apply the methodology to different points of time for the same organization, i.e., to create a temporal profile of safety culture within the same organization. A temporal profile thus created can divulge important underlying dynamics related to various aspects of the safety culture and more importantly, highlight the challenges faced by the organizations in improving safety cultures. Future work should focus on generating such findings that can be contextualized in the socio-economic environment to reveal generalizable and transferable lessons.

## 8. Conclusion

This paper has examined the current state of safety cultures at a Japanese HSR operator as well as at Indian Railways, to highlight the role of top-management in improving the safety culture, a significant issue, and challenge for managers involved in the development of HSR projects in developing countries.

In this paper, a multi-dimensional framework suitable to highlight the dynamics of the safety-culture was adopted and modified for application to the railway industry. At this stage, the framework was developed and refined through interviews with two senior officials – one from Japan and India. To improve the robustness of the framework, more interviews at multiple organizations should be conducted.

Authors found the present methodology suitable for developing and comparing temporal profiles of safety culture within organizations. When the descriptions for the current level of safety for different organizations is juxtaposed, a contrast is clearly visible. Detailed discussions were made to illustrate the importance of sustained efforts from leadership in taking an active involvement in safety aspects, increasing the coordination within the organization, and developing a positive safety culture. In addition, it was illustrated that a multi-pronged approach is necessary for the top-management to steer safety cultures across multiple dimensions. However, authors have also highlighted a need to carry out more interviews as well as conduct a quantitative assessment to improve the present methodology.

Finally, the paper argues that safety-culture and its dynamics cannot be considered in isolation but must be integrated with the system-thinking framework, i.e., the dynamic relations between Technology, Human Resources, Management, and Culture must be considered simultaneously to develop an understanding of the temporal profile of safety performance and to develop analytical tools for evaluating management-policy.

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