

### **Project Title**

Improving Safety in Transit and Freight Operations: Development of a Leadership Training Model to Improve Safety Culture

### **University**

University of Denver

### **Principal Investigators**

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### **Research Needs**

Safety culture continues to be of significant interest to transportation professionals as a key factor influencing the occupational safety health and accident and injury rates of members of their organization and the public. In 2017, the US DOT Safety Council identified safety culture as a top priority across the Department. “Safety Culture is defined as the shared values, actions, and behaviors that demonstrate a commitment to safety over competing goals and demands.”<sup>1</sup> The Transportation Research Board (2007) published a synthesis that recommended several steps an organization needs to consider when attempting to improve or establish safety culture. These were very broad non-specific steps that included assessment, identification of problem areas and implementation of a plan. However, key recommendations and practices that leaders should take were not explicitly specified.

Recent research has demonstrated an empirical link between safety culture and worker knowledge, attitudes and performance.<sup>2</sup> Results of the analyses demonstrated that safety knowledge and safety motivation were strongly related to safety performance. The contribution of a positive psychological safety climate and group safety climate were also found to have an impact on safety performance. Finally, accidents and injuries were strongly associated with group safety climate.

The NTSB cited researchers such as Petitta, Probst, Barbaranelli & Ghezzi (2017) who asserted that there is a complex relationship between organizational safety culture and safety climate, such that organizations with particular safety cultures may be more likely to develop more (or

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<sup>1</sup> FRA (2017). Safety Culture: A Significant Influence on Safety in Transportation. US DOT, DOT/FRA/OR-17/09. <http://www.fra.dot.gov/Elib/Document/17170>

<sup>2</sup> Christian, M.S., Bradley, J.C., Wallace, J.C., & Burke, M.J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology*, 94(5), 1103-1127.

less) positive safety climates. Moreover, employee safety compliance was seen as a function of supervisor safety leadership, as well as the safety climate and safety culture dimensions prevalent within the organization.<sup>3</sup>

Leadership in transportation organizations however is increasingly cited as a key factor in developing a safety culture. A recent study of the relationship between leadership style and safety management (Frazier, 2018) suggested that organizational leaders might improve safety performance by utilizing transformational leadership practices into their training programs. The study examined the role of leadership, leadership training, and leadership practices which may be related to the development of a positive safety culture.<sup>4</sup> A seminal work on the relationship between culture and organizational performance by Kotter and Heskett (1992) suggests that differences in organizational culture explains why one company success where another fails within an industry.<sup>5</sup> Additionally, one well-known business leader, Jack Welch, offered one more possibility, “If you want to change the culture of an organization change the way it develops its leaders.”<sup>6</sup>

A brief inspection of the literature reveals the importance of leadership for effective safety management. Wu (2008) suggested that safety leadership and safety climate are two important factors related to safety performance, and that safety climate mediates the relationship between leadership and safety performance.<sup>7</sup> Managers supportive of safety contribute to the overall of safety culture. A more recent study by Oah, Na, & Moon (2018) found that safety leadership and safety climate have a negative influence on cognitive and emotional risk perception. Workload, safety leadership, and the safety climate influence perceived risk more than accident experience, especially for the emotional risk perception.<sup>8</sup>

A participative leadership style was recognized as contributing to the development of safety culture and safety policy in organizations. Participative style leadership also led workers to accept responsibility and ownership for safety.<sup>9</sup> In a related study, Zohar (2002) found that managers and supervisors who are supportive of safety activities was associated with organizational culture.<sup>10</sup> Lee (2002) showed that hospital organizational culture, manager’s leadership behavior, and organization’s vision, were essential factors in organization management.<sup>11</sup> Later, Zohar (2003) showed that a leadership that encouraged workers

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<sup>3</sup> Petitta, L., Probst, T., Barbaranelli, C. & Ghezzi, V. (2017). Disentangling the roles of safety climate and safety culture: Multi-level effects on the relationship between supervisor enforcement and safety compliance. *Accident Analysis & Prevention*, 2017 Feb; 99, (Pt A):77-89.

<sup>4</sup> Frazier, L.D. (2018). A Critical Perspective of Transformational Leadership & Safety Management Practices. Dissertation, Walden University.

<sup>5</sup> Kotter, J. P., & Heskett, J. L., (1992). Corporate culture and performance. New York: Free Press.

<sup>6</sup> <https://www.forbes.com/sites/jackzenger/2017/11/25/change-your-leaders-to-change-your-culture/#3d37d71f67d5>

<sup>7</sup> Wu T.C., Chen C.H., Li C.C. (2008). “A correlation among safety leadership, safety climate and safety performance. *J Loss Prev Process Ind.* 2008;21:307–318.

<sup>8</sup> Shezeen Oah, Rudia Na, & Kwangsu Moon (2018). “The Influence of Safety Climate, Safety Leadership, Workload, and Accident Experiences on Risk Perception: A Study of Korean Manufacturing Workers.” *Safety and Health at Work*, 9, 427-433.

<sup>9</sup> A. O’Dea, & R. Flin., (2001). “Site managers and safety leadership in the offshore oil and gas industry,” *Safety Science*, 37(1), 39-57.2001

<sup>10</sup> Zohar, D. (2002). “The effects of leadership dimensions, safety climate, and assigned priorities on minor injuries in work groups,” *Journal of Organizational Behavior*, vol. 23, no. 1, pp. 75-92, 2002.

<sup>11</sup> J. S. Lee, (2002). “The relationship study of the hospital organization culture, leadership, and organizational citizenship behaviors,” M.S. Thesis, Institute of Human Resources, National Sun Yat-Sen University, 2002.

participation could increase employees' attitudes towards to improved safety climate.<sup>12</sup> Finally, Kahn 2019) showed that there was a relationship between ethical behavior, safety culture and safety performance.<sup>13</sup>

Clarke (2006) showed that leadership style had a significant impact on safety participation.<sup>14</sup> In addition, Wu's (2008) results indicated that organizational leaders would do well to develop a strategy by which they improve the safety climates within their organizations, which will then have a positive effect on safety performance.<sup>15</sup>

Yang, et al (2009) found that leadership behavior, characterized by initiating structure leadership had a greater effect on safety culture than a considerate style of leadership. The authors speculated that many high-level executives lack strategic plans and visions for initiating a safety culture. It was recommended that high level executives should not only provide initiating structure leadership should also assist employees to recognize the relationship between individual and group performance through the contingency model and safety culture.<sup>16</sup>

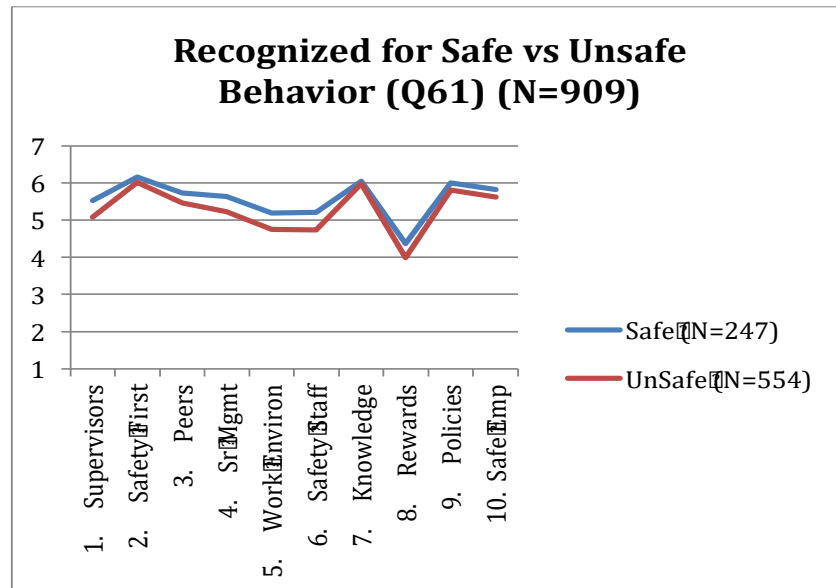


Figure 1.

As has been a theme in several studies, identifying and using a standard measure of safety culture is essential to be able to create reliable and consistent approaches to managing and

<sup>12</sup> Zohar, D. (2003). The influence of leadership and climate on occupational health and safety. In D.A. Hofmann & L.E. Tetrick (Eds.) Health and Safety in Organizations: A Multilevel Perspective, 201-232, Jossey-Bass, San Francisco.

<sup>13</sup> Nusrat Khan, Ifzal Ahmad & Muhammad Ilyas (2018) Impact of Ethical Leadership on Organizational Safety Performance: The Mediating Role of Safety Culture and Safety Consciousness, *Ethics & Behavior*, 28:8, 628-643.

<sup>14</sup> S. Clarke & K. Ward, "The Role of Leader Influence Tactics and Safety Climate in Engaging Employees' Safety Participation," *Risk Analysis*, 26(5), 1175-1185.2006.

<sup>15</sup> T.C. Wu, C.H Chen, C.C Li., (2008). "A correlation among safety leadership, safety climate and safety performance," *Journal of Loss Prevention in the Process Industries* 21 307-318.

<sup>16</sup> Cheng-Chia Yang; Yi-Shun Wang; Sue-Ting Chang; Suh-Er Guo; Mei-Fen Huang (2009). A Study on the Leadership Behavior, Safety Culture, and Safety Performance of the Healthcare Industry. *Proceedings of World Academy of Science: Engineering & Technology*; May2009, Vol. 53, p1148

developing a safety culture. Sherry & Colarossi (2016) developed a tool to measure of safety culture. The instrument was normed on a large sample of employees of a large public transportation agency (N=1909) participants were obtained. Various analyses have provided initial evidence of the validity and reliability of the Safety Culture Scale as a measure for the transportation industry in that the scale significantly differentiated ( $p < .05$ ) between persons who had been involved in accidents and safety violations thus demonstrating the relationship between safety culture and accident rates.<sup>17</sup> (See Figure 1) In addition, a follow-up study with a large regional transportation company demonstrated significant differences in safety culture and attitudes between key departments in the organization.

Measures now exist that can be used to quantify the constructs included in Figure 3. First, a Leadership Competency and style measure has been developed that can also be used to assess (Sherry & Durr, 2012).<sup>18</sup> Second, a standard metric of safety culture that enables the normative comparison of organizations to each other has now been validated (Sherry & Colarossi, 2016). This instrument will aid greatly in the identification of areas within an organization, such as departments, relationship between management and labor, training programs and other areas that are in need of improvement relative to establishing a strong safety culture. Lastly, historical records can be consulted to assess numbers of accidents, injuries, crashes and possibly near misses.

In a timely qualitative study of two large national railway systems published by the Asian Development Bank, the authors noted several areas for improvement and called for “sustained efforts from top leadership in developing a positive safety culture.”<sup>19</sup>

A quick review of the literature does not identify a readily available specific model or approaches to developing a safety culture. There are several consulting firms that offer to assist with culture change. Simplified recommendations have also been proffered by various experts. Kotter (2012) has identified an approach to organizational change in general. Kotter’s the eight-step method consists of: establishing a sense of urgency, creating a guiding coalition, developing a change vision, communicating the vision for buy-in, empowering broad-based action, generating short-term wins, never letting up, and incorporating changes into the culture.<sup>20</sup> However, this approach is not very specific nor is it tailored to either safety or transportation. Consequently, there is still seen to be a need to develop a standard model or approach to developing a safety culture within the transportation industry.

The conceptual framework linking safety culture, safety leadership and organizational outcomes is presented in Figure 3. With the utilization of standardized measures of Safety Culture (Sherry & Colarossi, 2016) and Leadership Behaviors (Durr & Sherry, 2009) (see Figure 3):

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<sup>17</sup> Sherry, P. & Colarossi, D. (2016). Development and validation of a measure of transportation safety culture. National Center for Intermodal Transportation, Research Report, January 2016.

<sup>18</sup> Sherry, P. & Durr, R. (2009). Identification of a Leadership Competency Model for Use in the Selection, Development and Retention of Intermodal Transportation Workers. NCIT Final Report.

<sup>19</sup> Bugalia, N., Y. Maemura, & K. Ozawa. (May, 2019). Safety Culture in High-Speed Railways and the Importance of Top Management Decisions. ADBI Working Paper 955. Tokyo: Asian Development Bank Institute. <https://www.adb.org/publications/safety-culture-high-speed-railways-importance-top-management-decisions>

<sup>20</sup> Kotter, J. (2012). Accelerate. Harvard Business Review, November.



Figure 2. Safety Leadership, Culture and Accidents process model.

The proposed project will build on previous research to develop a training model that will aid leaders in demonstrating the behaviors and best practices that will lead to the development of an effective safety culture characterized by reduced numbers of accidents and injuries.

### Research Objectives

The objectives of this project are as follows

1. Review current literature on safety culture and leadership
2. Identify key leadership behaviors related to effective safety culture
3. Identify key factors related to safety culture
4. Identify a model of safety culture development
5. Gather stakeholders to review and discuss model components
6. Conduct pilot demonstration of implementation
7. Gather evaluative data to assess impact of training model
8. Write report and develop recommendations
9. Conduct workshop to facilitate technology transfer regarding what has been learned
10. Present at key conferences
11. Post final report on web site

### Research Methods

The project will primarily utilize survey and interview methodologies to gather data which will be analyzed using statistical techniques to review and evaluate the conceptual model.

#### *Measures & Data Collection*

**Safety Culture Survey.** The data on safety culture will be obtained through the administration of Safety Culture Scale (SCS) (Sherry & Colarossi, 2016). The SCS was developed using a large sample of employees from a large public transportation agency (N=1909). Confirmatory factor analysis (CFA) compared the fit of likely models. One-way between groups analysis of variance, and post hoc tests provided initial evidence of the validity and reliability of the SCS as a measure for the transportation industry in that the scale significantly differentiated ( $p < .05$ ) between persons who had been involved in more accidents and safety violations thus demonstrating the relationship between safety culture and accident rates. Implications of these findings are that the safety culture survey could be

used to assess safety awareness and safety culture of trucking or transport companies, small communities, and other organizations involved in transport. By carefully monitoring scores on the SCS efforts could be made in various communities and organizations to improve attitudes towards safety and ultimately to reduce accidents and improve road safety.

**Observational Data.** A team of investigators will conduct onsite inspections and observations of work behavior and conditions of the sample railroad during a one week period of observation. The inspectors will be looking for examples of safe and unsafe worker behavior. A checklist of typical railroad work behaviors will be prepared prior to the onsite visit.

**Leadership Style & Competency.** Leadership style & competency will be measured using a version of the leadership competency assessment instrument developed by Sherry& Durr, (2009).<sup>21</sup> This instrument consists of 100 items and other questions designed to collect demographic and other identifying information collectors. The instrument is useful in determining what types of activities and emphases are supported y by the leader. This instrument can be administered on line and is computer scored. Factor analytic studies support the underlying scale structure.

**Historical Data.** Reports on the accident incident rate of the study organization will be examined. Data will be gathered and compared to scores obtained on the survey instrument (SCS). Both analysis of variance and regression analysis will be used to obtain estimates of the relationship between and the impact of safety culture variables on the occurrence of accidents and incidents. Since this is a correlational field study only associational relationships will be possible to determine.

## **Expected Outcomes**

The research will identify a standardized model for the training of leaders intending to implement and develop a safety culture in a transportation organizing. This will serve as an important document and training tool that will significantly enhance the safety practices throughout the transportation industry. Hopefully, it will be adopted by APTA, AAR and ASLRRRA as a standard of excellence throughout the industry.

## **Relevance to Strategic Goals**

This project will contribute to the two of the USDOT Strategic Goals, namely safety and economic competitiveness. The safety of the employees and the public is maintained by an organizational culture and policies practices and procedures which ensure the safety of the employees working in the transportation systems while also directly maintaining the safety and security of the public at large. In addition, the economic competitiveness of the transportation system is also influenced by the maintenance of safe work practices and safety culture in that safety is directly tied to the bottom line of a transportation organization. Decreasing accident injuries and fatalities ensures the safe, ethical operation and economically competitive nature of the system. One need only look at lapses in safety culture that have had catastrophic effects on the economy and the environment such as the Exxon Valdez accident and the Deepwater

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<sup>21</sup> Sherry, P. & Durr, R. (2009). Identification of a Leadership Competency Model for Use in the Selection, Development and Retention of Intermodal Transportation Workers. NCIT Final Report.

Horizon oil spill which cost Anadarko over \$4 billion in fines and damages not to mention the immeasurable harm to the environment. In the rail industry, recent NTSB investigations of collisions in Cayce, South Carolina, involving Amtrak and CSX, as well as in the UPRR Granger collision, reported that, “the evidence indicates that human decision making, and actions likely played key roles in the accident scenarios. In both accidents, safe movement of the trains through the signal suspension depended on proper switch alignment, which, in turn, relied on error-free manual work. The risk of error in the manual work was not safeguarded, either by technology or supervision. Thus, the reliance on error-free human performance for safe train movement created a single point-of-failure in the operating practices currently used and in compliance with extant regulations.”<sup>22</sup>

The proposed study will contribute to the transportation industry by providing a viable practical training model for managers and leaders of transportation organizations that shows how to create and maintain a safe and efficient operation. In addition, it will enhance and contribute to the safety of the transportation industry and the public at large. Thus, the project will enhance the existing federal effort by **contributing to safety, economic competitiveness and efficiency and developing the work force** in the transportation system in the US.

### **Educational Benefits**

Several graduate students will assist with the project thereby contributing to the development and education of graduate students who will later be employed in the industry. These students will gain experience in the data collection techniques commonly used in the rail industry. In addition, they will gain an understanding of the theory and best practices associated with safety and safety culture.

### **Technology Transfer**

In order to facilitate the technology transfer obtained in the present investigation three separate events will be undertaken.

1. Educational briefing for stakeholders in the immediate project held on the site or the premises of the research sites.
2. A workshop on the DU Campus with invitees from local DOT and other community agencies to review and discuss key findings.
3. The development of a video and webinar on the findings to be posted on NCIT web page.

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<sup>22</sup> NTSB (2018). Safety Recommendation Report: Train Operation During Signal Suspension. Safety Recommendation Report, RRD18MR003, R-18-005. February 13, 2018.

## Work Plan

Achieving the overarching goal of this project requires the completion of several different tasks. Since the project will be built upon the previous work and studies we anticipate that the results will be a significant contribution to the existing literature. Permission from participating organizations will be needed to gather data from participants.

### Task 1 - Literature review

Various sources will be consulted to identify relevant psychological, operational, and experimental studies and papers. These papers will be reviewed for their identification of relevant work practices relevant to the measurement of safety culture, leadership competencies and the associated risk of accident of injury.

### Task 2 – Data collection

Data collection in the various methods and techniques outlined above (survey, observation, and historical). Meeting with key stakeholders will be held to obtain information on best practices and current efforts of leaders to implement and develop safety culture.

### Task 3 – Data analysis

Data will be analyzed to assess the relationship between the various measures, observed work practices and the accidents and injuries associated with indicators of safety culture.

### Task 4 - Report writing

A draft report will be produced describing the results of the research and identification of hypothesized linkages. These results will first be discussed with stakeholders and then disseminated at regional and national meetings where members attend and posted on relevant web sites. The results will also be presented at national conferences and disseminated in the form of scholarly papers which will be published in reputable journals.

### Task 5 – Tech transfer meetings with stakeholders

A series of meeting with stakeholders and interests parties will be held following the completion of the draft report. The draft report will be shared with stakeholders and relevant feedback will be obtained and integrated into the report.

	Months						
Task	1 – 3		4 – 6		7 - 9		10 – 12
1	■	■					
2		■	■				
3				■	■	■	
4					■	■	■
5							■



## Project Cost

Total Project Costs:	\$250,000
MPC Funds Requested:	\$125,000
Matching Funds:	\$125,000
Source of Matching Funds:	Massachusetts Bay Area Transit Keolis Commuter Services

## References

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