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A Data-Based Evaluation of the Relationship

between Occupational Safety and Operating Performance

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A Data-Based Evaluation of the Relationship between Occupational Safety and Operating Performance

Abstract

Problem: Many occupational safety specialists and academics have argued that occupational safety is good for business; however, the rationale is based on anecdotal evidence and opinion surveys. *Methods:* Nineteen manufacturing firms collected data on quality, productivity, and economic performance. Additionally, data on safety perceptions among employees and managers were collected. *Results:* Safety was related to many of the individual indicators of internal and external performance. *Discussion:* As safety deteriorates, product quality and plant performance, based on internal and external measures, suffers. There is more scrap, more rework, and employees are less involved. Such outcomes are in line with the core concepts of total quality management which would suggest that employees who do not feel safe in their jobs are not likely to do their jobs well. *Summary:* The results support the anecdotal evidence presented previously that good safety is good business. Safety and operating performance measures should be viewed as in concert with each rather than as competing entities. *Implication for educators and students:* The results provide a solid foundation for guiding future research by safety educators to expand on the major insights from this research and to continue to make strides in an area that to date has had little work. For the classroom, the results help to arrange for lectures that guide students in understanding the relationship between occupational safety performance and a firms operating performance. For students, the results serves as an evidenced based way to help make the business case for the organizations that they will eventually serve as well as pursue research in an area that has much interest.

Keywords: Business case for safety; economics.



1. Problem

Firms that design and manufacture products and technologies typically focus on the logistics of productivity and yield quality as the primary drivers for influencing operating performance. Increasingly, these firms are centering attention on occupational safety performance and its potential for influencing operating performance (Biddle et al, 2005; Gilding et al, 2002; Linhard, 2005). Traditionally, concerns for occupational safety and operating performance have been viewed as separate lines of attack independent of and sometimes in opposition to one another. The prevailing view is that there are inherent and fixed tradeoffs when attempting to boost occupational safety performance in manufacturing environments (i.e., achieving social benefits expected from regulatory compliance versus the anticipated high costs of compliance). We hypothesize that manufacturing firms should recognize occupational safety performance as an economic opportunity, not as an annoying cost or inevitable regulatory threat. Moreover, awareness of the actual interdependence between these concerns is increasingly highlighting the need for conducting research that links occupational safety performance and operating performance (Brown, 1996; European Agency for Safety and Health at Work, 2004; Shannon et al, 2001).

Demonstrating a relationship between occupational safety performance and operating performance has always been an elusive undertaking. Epstein & Roy (2003) found that most companies do not make the strategic connection between occupational safety performance and financial performance. The question that continues to challenge manufacturing firms is “do investments in occupational safety practices contribute to operating performance”? Many occupational safety specialists and academics have answered yes (American Society of Safety Engineers, 2002; European Agency for Safety and Health at Work, 2004; Jervis & Collins, 2001; Liberty Mutual, 2001; Smallman & John, 2001); however, except for the European Agency for Safety and Health at Work’s paper, which is a compilation of case studies, the basis for the affirmative answer is largely anecdotal and/or based solely on opinion surveys. In 2005, proponents of the notion that safety is good business purchased an advertisement in a widely distributed



United States' business magazine which touted the benefits of safety to the bottom line (BusinessWeek, 2005). While it is appealing to the safety function to maintain that "safety is good business", others, from a purely economic perspective, are skeptical about how data on occupational safety performance is specifically linked to operating performance (Asche & Aven, 2004; Dorman, 2000; Shapiro, 1998). We contend that recent conventional linking of safety performance and operating performance solely by opinion-based surveys may be detrimental to the long term sustainability of occupational safety investment that goes beyond compliance. Opinions on the importance of safety to operating performance tend to shift and are prone to bias; no senior-level executive wants to publicly state negative comments about occupational safety (Smallman & John, 2001). Opinion must translate into measurable action and results.

There should be no denying that showing a relationship between occupational safety performance and operating performance has always been a complicated proposition with very real methodological issues. Even so, occupational safety specialists need to go beyond linking of occupational safety performance to regulatory compliance performance by linking safety performance to operating performance. The exclusive use of customary budget approaches (i.e., regulatory, moral), is a major factor that explains the exclusion of safety considerations during decision making in reactive organizations, during a management turnover, or during economic down-turns when internal budget requests become increasingly competitive and focus on traditionally value-added functions (Behm et al, 2004). This research was constructed to bridge that gap by examining the relationship between an occupational safety performance measure (safety perceptions) and operating performance measures (quality and productivity). The purpose of the research is to provide evidenced-based data which adds to the current body of knowledge and to provide a foundation for future research and discussion in the domain of making a business case for safety. The results should provide a solid foundation for guiding future research by safety educators to expand on the major insights from this research and to continue to make strides in an area that to



date has had little work. For the classroom, the results help to arrange for lectures that guide students in understanding the relationship between occupational safety performance and a firm's operating performance. For students, the results serve as an evidenced based way to help make the business case for the organizations that they will eventually serve as well as pursue research in an area that has much interest.

2. Theory Development

While employee perceptions are central to the measurement of safety climate (Griffin & Neal, 2000), management perceptions and actions are also key indicators of safety climate (DeJoy, 1994; Neal & Griffin, 2002). Petersen (1998) recommended that in order to understand safety climate, it is best to ask both managers and line workers about safety with a questionnaire. Flin et al (2000) determined that the prime aspect to measure in relation to an organization's safety climate is the perceptions of management attitudes and behaviors in relation to safety as well as to production, or other business operational issues.

Safety climate has been reported to have an effect on business outcomes. Krause (2000) reported that a positive change in safety spills over and affects the entire organization – from productivity and quality to morale and culture. A common element found in the case studies reviewed by The European Agency for Safety and Health at Work (2004) was that the cooperation of management and employees was a key contributing factor in improving productivity and they recommend additional research in this area.

We hypothesize that safety performance is related to a manufacturing firm's operating performance. An employee-management safety perception measure is used to test this hypothesis. The measure of safety is quantified utilizing a survey tool. However, by creating an employee-management disconnect measure, we eliminated inherent biases with using solely management surveys in the research previously



mentioned. In addition, the employee-management disconnect measured is favored over the sole use of employee perceptions in order to account for the variance that can occur between the two groups and the importance in the measure within the context of safety climate perception as described by Prussia et al (2003).

An evaluation of peer-reviewed literature on the subject of safety climate and culture shows that there are numerous scales and methods by which they have been quantified. The survey questionnaire was developed by researchers in the field of operations management, and included three questions on safety perception. We contend that because the focus of the original research was on operating performance (over 50 items) and not on safety, that this is a strength of the research methodology. By embedding safety items within a larger more focused data collection endeavor, inherent biases with answering questions about safety perception are minimized. These biases are discussed in Smallman & John (2001) and Loomes (2006). The employee-management safety disconnect measure of safety perception was constructed from three survey questions using a seven point Likert scale:

1. Worker safety suffers when workers focus on quality goals.
2. Safety is mostly given lip service around the plant.
3. Workers ignore rules and reach informal agreements to handle some situations.

We expected to find that a majority of firms would yield results that demonstrated that managers tend to report (their reality or a bias) safety more positively than employees, either because no manager wants to publicly say negative comments about safety (Smallman & John, 2001), or because line level employees truly understand the safety since they observe and live it on the production floor. This was confirmed as all managers reported higher perceptions of safety than did their employees.



We examine the theory that good safety, as measured by safety perception disconnects, is related to good operating performance. Therefore, according to our hypothesis, when safety perceptions are good and agreed upon by both employee and management, operational performance should also be good. If this relationship does exist, then the anecdotal and subjective conclusions previously stated (ASSE, 2002; Jervis & Collins, 2001; Liberty Mutual, 2001; Smallman & John, 2001) would be supported. The hypothesized relationship is shown in Figure 1.

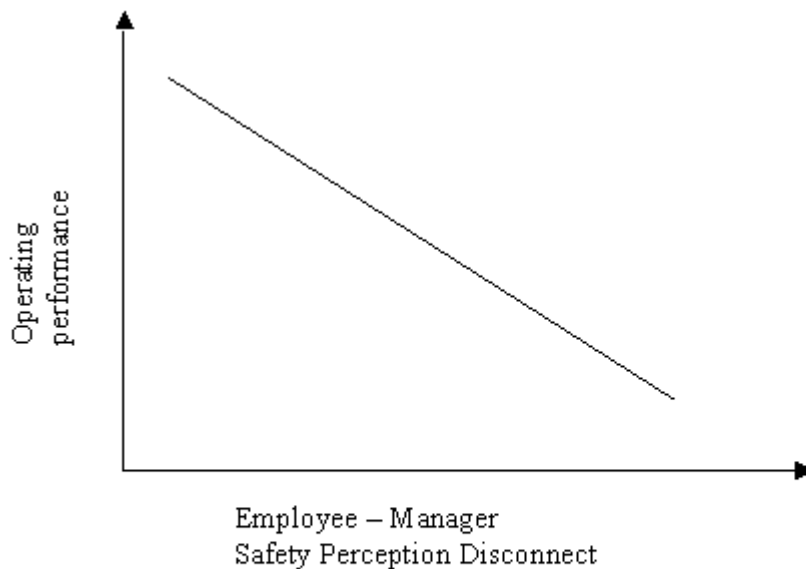


Figure 1. Hypothesized relationship between safety perception disconnect and operating performance

3. Methods

The purpose of the data utilized in this research was to examine quality, productivity, and economic performance among manufacturing firms. Our data comes from a convenience sample of 144 workers and their managers at 19 different manufacturing organizations. Three safety perception questions were embedded into both the manager and the employee questionnaire. The manufacturing firms (see Table 1)



belonged to the following standard industry classifications (SICs): SIC 34 - Fabricated Metal Products (except Machinery and Transportation Equipment); SIC 35 - Industrial and Commercial Machinery and Computing Equipment; SIC 36 - Electronic and other Electrical Equipment and Components; SIC 37 - Transportation Machinery and Items; and SIC 38 - Measuring, Analysing and Controlling Instruments, Photographic, Medical and Optical Goods. Firms in these SICs together with SIC 39 (miscellaneous manufacturing - e.g. toys, sporting goods) account for over 42% of US manufacturing sales, and engage in discrete product manufacturing where worker population, involvement and interaction can all be expected to be greater relative to continuous flow environments (U.S. Department of Commerce 1997).

Number of organizations	19
# of worker respondents	163 (144 usable)
# of manager respondents	43 (40 usable)
Manager: Worker Ratio	Maximum 8:9, Minimum 1:45

Industry Classification of respondent organizations

Fabrication	4
Equipment	3
Chemical	2
Automotive Parts	2
Electronics	2
Stamping	2
Electrical	1
Telecom	1
Forging	1
Engines	1

of production workers in plant

< 30	24%
31-100	40%
101-300	24%
301-500	5%
> 500	7%

The surveys were mailed to a single contact point (typically the VP/Director Quality) at the 19 companies with detailed instructions on survey administration. The managers were instructed to distribute the worker



version of the survey to a random sample of 10% of plant workers located at important production and quality process points at a key plant. The workers were instructed to return their responses directly to the researchers using the furnished pre-paid return envelope. The company/plant name was the only identifier in the response, with complete anonymity in all other respects. The managers were instructed to distribute their version of the survey among the production and quality managers in the plant, that were to be returned directly to the researchers with required identification information. A total of 163 worker and 43 manager responses were received from the 19 companies. Elimination of unusable responses resulted in a total of 144 worker responses and 40 manager responses.

The intended purpose of the data was not to test the model at hand. Therefore, the sample must be considered a convenience sample and this is a limitation of the research. However, we would argue this is a minor limitation given the ability of the data to empirically address a question that is in dire need of study. Still, future research should be directed at collecting data specifically to address the issue of the relationship between safety and quality, productivity and other business measures.

3.1 Measurement, Safety Perception Disconnect

Safety disconnect is the key construct in the models. We are defining disconnect as the difference in safety perceptions between managerial employees and operational employees. As this disconnect increases the overall safety worsens. We operationalized disconnect as the sum of the squared differences between managers and operational employees on the three items. We summed the scores based on the results of an exploratory factor analysis that indicated that all three items were part of the same underlying construct (Alpha = 0.5867). For the remainder of the manuscript this construct will be referred to as safety disconnect.

3.2 Measurement, Operational Performance



Researchers in the field of operations management have devoted significant effort to creating valid and reliable perceptual indicators of plant performance (Ketokivi & Schroeder, 2004). Generally these measures address either the performance of a plant as compared to major industries competitors (an external perspective) or productivity measures specific to the plant (an internal perspective). Our data included measures of both internal and external performance.

Plant performance is an element of an overall company's performance. A plant's ability to control costs, improve quality, reduce lead-times and so on influences the profitability of the overall company. Plant performance is therefore multi-dimensional. Our measures capture this multidimensionality. The external measures capture a plant's performance on quality, costs of production, innovation, delivery speed and reliability, customization and growth as compared to major industry competitors. The items used to create this construct were taken from operations management literature (Ketokivi & Schroeder, 2004) and are shown in Table 2.

Plants can also be measured on their internal performance. To address the internal performance of the plant we asked managers to rate the improvement in worker performance over the previous three years on a host of items that are generally indicators of internal plant performance. The measures captured a number of indicators including reduction in scrap rates, increases in employee involvement and so on. Factor analysis was used to create scales. Table 2 displays the items used to create this set of scales.

Table 2. Constructs for analysis

Construct	Item(s)	Notes
Safety Disconnect	Worker safety suffers when workers focus on quality goals	Factor analysis indicates that these 3 items form a single factor (0.5867)
	Safety is mostly given lip service around the plant	
	Workers ignore rules and reach informal agreements to handle some	



	situations	
Internal Performance		Changes in worker performance over the last 3 years. Magnitude of change from 100% (or more) better to 100% (or more) worse.
	Scrap and rework (ISR) – reverse coded	4 items. Alpha = .9023
	Reliability and Durability (IRD) – reverse coded	2 items. Alpha = .8346
	Employee involvement (IEI)	2 items. Alpha = .7987
	Customer satisfaction (ICS)	2 items. Alpha = .8109
	Delivery lead time (ID) – reverse coded	2 items. Alpha = .7901
	Cost (ICP) – reverse coded	Single item
External Performance (all single item measures)		Relative to major industry competitors. Rated from 1(much worse) to 7(much better)
	Extrenal Quality (EQ)	
	Cost of Production score (ECP)	
	Latest features / technological innovation (EI)	
	Delivery speed and reliability (ED)	
	Customization for individual customers (ECU)	
	Growth in market share (EG)	

4. Results

A correlation matrix was prepared and is shown is Table 3. As theory predicts, safety perception disconnect is related to many of the individual indicators of both internal and external performance.

Table 3. Correlation matrix

Safety perception disconnect	Correlation	Does the data support the hypothesis that good safety
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correlated with...	coefficient	Interpretation of the data	and good business are related?
Internal scrap and rework (reverse coded)	.322**	As disconnect decreases (positive safety), ISR decreases (performance gets better)	Yes
Internal reliability and durability (reverse coded)	.170*	As disconnect decreases (positive safety), IRD decreases (performance gets better)	Yes
Internal employee involvement	-.232**	As safety disconnect decreases (positive safety), Internal employee involvement increases (improves)	Yes
Internal customer service	.122	Safety disconnect and internal customer service are not related.	N/A
Internal delivery	.130	Safety disconnect and internal delivery are not related.	N/A
Internal costs of production (reverse coded)	-.099	Safety disconnect and internal costs of production are not related.	N/A
External quality	.187*	As safety disconnect decreases (positive safety), external quality decreases (gets worse).	No
External costs of production	-.374**	As safety disconnect decreases (positive safety), the external costs of production <u>score</u> increases (improves)	Yes
External innovation	.193*	As safety disconnect decreases (positive safety), external innovation decreases (gets worse).	No
External delivery	-.199*	As safety disconnect decreases (positive safety), External delivery increases (improves)	Yes
External customization	.049	Safety disconnect and external customization are not related.	N/A
External growth	.228**	As safety disconnect decreases (positive safety), external growth decreases (gets worse).	No

* Statistically significant at the 0.05 level

** Statistically significant at the 0.01 level

4.1 Internal measures

The hypothesis that safety is good business is supported by the data. As disconnect increases (negative safety), internal scrap and rework increases (performance gets worse). Likewise, when safety perceptions



are positive, internal scrap and rework performance improves. As disconnect increases (negative safety), performance on internal reliability and durability gets worse. Likewise, when safety perceptions are positive, internal reliability and durability performance improves. Internal reliability and durability is a measure of quality describing internal measures that will show up externally at the customer. Such outcomes are in line with the core concepts of total quality management which would suggest that employees who do not feel safe in their jobs are not likely to do their jobs well.

Employee involvement is an indicator of willingness to make process improvements and is related to safety. It is intuitive that safety and employee involvement are related since employees who are involved with operations and safety are also likely to have positive perceptions about the safety program.

Management likely facilitates employee involvement and responds to employee suggestions accordingly. Employee involvement is a key ingredient in total quality management.

4.4 External measures

The hypothesis that safety is good business is somewhat supported by the data. As safety disconnect decreases (positive safety), delivery relative to competitors improves. When safety perceptions are positive, we are faster and/or more reliable than our competitors. In addition, as safety disconnect decreases (positive safety), external costs of production improves. External costs of production are the costs of production processes relative to our competitors. A high score means that you have lower costs, so this is good (an increased score on cost of production item means that your costs are lower compared to your competitors). The data suggests that the place that top managers will notice the influence of poor safety is in their external costs compared to their competitors.

However, data from three of the external measures (external quality, innovation, and growth) does not support the hypothesis that safety is good business. External quality is a measure of how the firm's



customer views the quality of the product relative to competitors. Additionally, in firms where external innovation is increasing relative to competitors, the internal manufacturing environment is likely in constant state of flux, numerous product changes, and increased research and development. These firms may focus less on employee safety issues and/or these environments are changing so rapidly with the infusion of new innovation that safety issues are less predictable, and thus more difficult to manage compared to less innovative firms. Based on the data from our 19 companies, safety professionals who work for highly innovative firms need to ensure that safety is a core value within the design team's philosophy and that safety professionals are an integral part of new product/process development in order to counteract the changes that a high level of innovation may cause within a manufacturing environment. Lastly, firms that are growing rapidly relative to their competitors hire new employees (at all levels), expand operations, and may be investing capital heavily in production and marketing related activities rather than safety. These issues can counteract the safety effort if not managed appropriately. Safety professionals in firms who are growing rapidly need to be cognizant of the potential for safety issues to arise due to this growth. The integration of safety into operations as a core value will assist the successful management of safety as a congruent aspect of firms who are growing rapidly.

5. Discussion

Overall the analysis shows that safety perception disconnect is related to operational performance. However, safety is more of an internal measure than external and the relationship is more direct to internal measures. As disconnect increases and the safety climate deteriorates and product quality, based on internal measures, suffers. There is more scrap, more rework, and decreased reliability and durability of products. Such outcomes are in line with the core concepts of total quality management which would suggest that employees who do not feel safe in their jobs are not likely to do their jobs well.



When comparing the plant to its competitors these decreases in quality performance are manifested in increased costs in relation to major industry competitors. Managers, especially managers removed from day-to-day operations, might however miss this connection. Decision makers who do not work in the plant on a daily basis (as well as other stakeholders, such as investors) are not likely to be aware of the internal measures of performance. What is visible is a plant with costs that are higher than others in the industry. These top managers might then pursue cost reductions when what is really required is an improved safety climate. It is possible that some of the cost reduction efforts could actually harm the safety climate. For example, management could decide to run equipment longer before replacing it; this would reduce capital costs but may increase the risk of injury. Consider, also, if management instills mandatory overtime rather than hiring additional employees. Initially, employees may appreciate the extra income, but may eventually recognize that the extra hours increase fatigue and the risk of injury. Based on our analysis these cost reduction efforts would then, somewhat paradoxically, end up increasing costs.

Safety will be a challenge in organizations that are growing quickly and or innovating on a regular basis. A plethora of new hires and/or products likely indicates a great deal of change on the plant floor. In our sample the organizations that are most successful at these activities generally have higher safety disconnects. This suggests that safety in these settings will require extra work and or investments. Safety professionals need to create safety programs that can adapt as quickly as the companies in which they are implemented.

6. Impact on Industry

We have shown that performance in safety, as measured by safety perception disconnect, can have a positive influence on internal operating performance and, to a lesser extent, external operating performance. Interestingly, in terms of external growth and innovation, firms who are growing and innovating rapidly may be doing so at the risk of employee safety. Safety professionals need to



understand that when employed in these types of firms or when their existing firm is under these conditions, they need to be certain that safety is integrated into the process and the changes. Ensuring strategic ties with upper management and design and process engineers is one tactic which will help the function make safety success a reality.

The results support the anecdotal evidence presented previously that good safety is good business. Safety and operating performance measures should be viewed as in concert with each rather than as competing entities. The safety function should not be focused entirely on maintaining compliance with regulatory concerns as the main impetus for safety investment. By understanding how safety and safety performance fit strategically with their firms' operating performance, safety investment should be communicated as value-added, rather than a cost. It must be recognized that a balance in managing occupational risks and the costs of their associated counter-measures must be accepted. Some risk is inevitable and no operation is risk-free. However, understanding certain risk's impact on safety will ensure that productivity, quality, and operating performance is maintained at satisfactory levels to the organization's stakeholders.

Because of the link shown in this research, safety perception measurements, and even safety climate, may evolve into a business metric that is essential to external stakeholders. With the increase in non-financial external reporting in such documents as ESH Annual Reports, Corporate Social Responsibility reports, and the like, safety and safety climate, as well as other leading indicators of safety performance, should be included in the organization's reporting model. As with any externally reported measurement, it must be audited and verified to be valid and reliable. Socially responsible investors, as well as those investing for purely financial motives, will be interested in the firm's safety measurements. Further research on the use of safety measurements as an external reportable business measure is recommended.



Specific items that can be strategically managed to affect safety perceptions and safety climate include company strategy and policy towards safety in the areas of budget, communication, and performance evaluation (Diaz & Cabrera, 1997). Organizations must budget the safety function accordingly with stated goals and policies. The lack of an appropriate budget for safety success will be acknowledged by employees, and will be a negative consequence to the safety climate. Communication between management and employees is a key element to a positive safety climate. Management must arrange conditions for open communication and feedback to employees regarding safety policy. Including safety as a comparable component to production and quality in performance evaluations for all employees, including, and most importantly for supervisors and managers, translates into visible and meaningful actions that enhance safety climate. It is important to recognize that these precursors to safety climate are management functions that trickle down to employees and affect their perceptions.

Many constructs influence operating performance. A traditional business view of safety is one which competes or negatively influences operating performance; or at best it is simply overlooked in the strategic intent of the firm. By realizing that safety does influence internal and, to a lesser extent, external operating performance, firms may better understand their own initiatives in performance improvement and begin to include safety in strategic decision-making. Moreover, externally, safety measurements may become to be viewed as a proxy for how a plant is economically performing. Worker safety can become an order winner in labor intensive industries where other differentiators like cost and quality have become largely standardized, e.g., soccer ball manufacturing in Pakistan, carpet weaving, men's shirts and apparel etc. As firms move into sustainable business concepts and their reporting, safety must be included, not simply as a scorecard of injuries and illnesses, but rather as to how safety investments impact the economic sustainability of the firm.



We argue that the current anecdotal nature of the safety–operating performance relationship actually places occupational safety strategy and subsequent investment at a competitive disadvantage when competing internally for resources. This is true because no other function utilizes anecdotal evidence to that extent than does the safety function. This current status lends itself to the safety function taking a non-data based and thus a non-strategic view of their work and how it relates to the organization; and the organization providing lip-service as to the importance of occupational safety, while actually they take a “get by as you can” attitude and corresponding financial approach. This research evaluated a macro view of occupational safety and operating performance and developed a theory hypothesizing that safety perceptions are indeed linked to operating performance. Our hypothesis was supported by the data and the analyses. These results provide evidence to support the previous research. This research goes beyond previous research in this area by evaluating actual company data and linking it to safety performance data. We encourage additional research in this area, specifically focusing on utilizing actual company economic data to link leading indicators of safety performance measures to operating performance.



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