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Is Safe Production an Oxymoron?

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This research examines how organizations simultaneously manage their operations and occupational health and safety. Although both safety and operations scholars conduct research in the same operational settings, they have reached different, yet untested, conclusions about the relationship between creating a safe workplace and creating a productive workplace. The results from a series of 10 case studies show that it is *possible* to create safe and productive workplaces, but that many facilities fail at this task because of problems associated with the culture management creates and the practices management adopts.

Key words: operational safety; human resources; practices; qualitative research
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1. Introduction

Worker safety is a persistent social issue that has been virtually ignored in the operations literature (e.g., Brown 1996, Das et al. 2008). Although both the numbers and rates of workers who suffer occupational illness and injury have generally been declining in North America for most of a decade (Bureau of Labor Statistics (BLS) 2012, WSIB 2012a,b), the reality is that worker safety could still be much better. The overall declines cannot hide that in the United States in 2010, the most recent year for which data are available, approximately 3.1 million people suffered workplace-related injuries and illnesses and 4547 fatal accidents occurred (BLS 2012). And in manufacturing, accident rates actually increased in 2010. The Occupational Safety and Health Administration (2013) estimates the costs of these occupational injuries and illnesses at $170 billion annually. Accidents rates are similar in other developed countries and much higher in the developing world (e.g., Hämäläinen et al. 2006).

One would expect that an issue of this magnitude would attract significant attention from operations management researchers. Yet, nearly 20 years after Brown's (1996) seminal call; operations management research that considers safety remains very sparse (for notable exceptions, see Das et al. 2008, Pagell and Gobeli 2009). Beyond the obvious impacts on workers, this oversight has other critical consequences, especially when it comes to regulation.

Operations management scholars are not the only researchers who focus on the measurement, monitoring, and controlling of operational systems. Researchers in fields such as occupational health and safety (OHS) and social psychology also focus on the impact of operational systems and practices on workers. Much of this research concludes that the practices operational managers engage in to improve operational performance put workers at increased risk (e.g.,

Brenner et al. 2004, Ford and Tetrick 2008, Landsbergis et al. 1999, Lewchuck et al. 2001, Parker 2003, Pate-Cornell and Murphy 1996, Zohar 2002, Zohar and Luria 2005).

This conclusion is not just of academic concern. These researchers are often funded by health and safety regulators (e.g., WSIB 2012b), fostering a relationship where their conclusions drive regulation. Furthermore, because this research generally overlooks operational outcomes, safety regulation is being created based on research conducted in operational settings that ignores operational outcomes. Safety regulators have recognized this shortcoming. There have been numerous calls in the safety community to address the safety and business impacts of operational practices simultaneously (American Society of Safety Engineers 2002, European Agency for Safety and Health at Work 2010, National Institute for Occupational Safety and Health [NIOSH] 2009). However, today safety regulators are still making decisions based on research conducted in operational settings that treats safety as somehow separate from other operational outcomes.

This research provides an initial empirical exploration of the business case for safety with the objective of exploring key relationships between safety practices and outcomes and other organizational practices and outcomes. The results show that organizations can manage a facility to be simultaneously safe and productive. However, this outcome is based on having specific elements in place, including the development of a supportive culture and a joint management system. These elements were missing in the majority of the studied facilities that were neither safe nor productive.

2. Literature Review and Research Questions

The literature review is organized around three central themes. (i) Can production systems be managed to be safe and productive? (ii) Can safety and operational practices be integrated or joined? (iii) What is the role of culture in determining if a production system is safe and productive? The five main constructs of interest are operations practices, safety practices, operational outcomes, safety outcomes, and the organization's culture.

2.1. Can Production Systems Be Managed to Be Safe and Productive?

The literature provides limited insight into the relationships between safety practices and outcomes and operational practices and outcomes. Safety outcomes are the number of injuries and illnesses that occur in the plant as well as the costs and lost time associated with these incidents. Operational outcomes are the plant's performance on metrics such as cost of production, quality, flexibility and delivery, not company financial metrics such as profitability or market share. Many safety researchers use the term "productivity" as a generic descriptor of an organization's desired operational outcomes, which is a rhetorical device employed in this study to facilitate discussions of operational performance without needing to discuss which operational outcomes were prioritized at each facility.

While all employees have the potential for getting sick or injured at work, it is production workers, those who create the organization's good or service, not managers or staff, who suffer the majority of occupational injuries and illnesses. In this article, the term "workers" refers to these production workers who are responsible for creating the organization's good or service.

A subset of the safety literature examines the impact of operational practices on safety outcomes. However, this research generally does not measure productivity. Instead, this research implicitly assumes that operational practices have achieved managerial goals and or increased productivity.

Numerous safety researchers have observed that adopting new operational practices can harm workers (e.g., Brenner et al. 2004, Lewchuck et al. 2001). When these observations are combined with the assumption that these practices improved productivity, the conclusion is that productivity is gained at the expense of safety (e.g., Pate-Cornell and Murphy 1996, Zohar 2002, Zohar and Luria 2005). This literature proposes that organizations prioritize either productivity or safety, but that they cannot place a high emphasis on both: safe production is an oxymoron. However, this presumed trade-off is untested, and accepting it means assuming that all new operational practices, even unsafe practices, positively impact operational outcomes.

In contrast, operations management research is generally done without acknowledging or measuring safety practices or outcomes. However, there is a strong supposition in this literature that human capital in the form of workers is a valuable resource that managers need to leverage to improve operational outcomes. Conventional wisdom is that best operational practices include empowering and training workers to work in teams and engage in continuous improvement efforts (see Flynn and Saladin 2001, de Menezes et al. 2010). Although rarely explicated or empirically addressed, the implicit assumption seems to be that, if workers are not safe, human capital is not being valued and cannot be leveraged.

In addition, there are several mainly exploratory studies that link operations and safety management

(Brown et al. 2000, Das et al. 2008, de Koster et al. 2011, Levine and Toffel 2010, Neumann and Dul 2010, Pagell and Gobeli 2009). Combining these limited findings with the concept of a safe workforce being a necessary condition to leverage human capital, one could tentatively conclude that safety and operational outcomes are positively correlated, although the need for confirmatory tests of the relationship remains as such.

Rather than proposing that managers must prioritize safety or production, the operations management literature implies that worker safety is a prerequisite for operational excellence, which conflicts with the assumptions embedded in the safety literature. This situation motivates our first research question:

> RQ1: What are the relationships between safety outcomes and operational outcomes?

2.2. Can Safety and Operational Practices Be Integrated?

While the two literatures diverge on the relationship between safety and productivity, they both support the development of integrated management systems (e.g., Granerud and Rocha 2011, Karapetrovic and Jonker 2003) that can be viewed as a merger of multiple stand-alone management systems into a single management system. However, the rationale offered for integrated management systems in the management literature is focused on creating efficiencies (e.g., Karapetrovic and Jonker 2003), while the safety literature posits that integration will improve safety performance with no mention of other areas of performance (e.g., Granerud and Rocha 2011). And while both literatures promulgate integration, there is little discussion of the practices these systems would actually entail.

Therefore, while safety and operations practice have generally been studied separately, there is the possibility that the practices an organization uses to manage safety and operations could be joined. *Joint management systems for operations and safety* (to be referred to as joint management systems for the remainder of the article) may exist.

For this research, an organization would have a joint management system if, at a *minimum*, they have a formal set of processes that allows for the shared measurement, monitoring, controlling, and continuous improvement of both operations and safety and they focus on following these processes at all times. Joint management systems are best understood from the perspective of the workers. In a joint management system, workers respond to a single system that is managed collectively by both safety and operational managers who share responsibility for safety and production or, alternatively, a single manager has responsibility for both safety and productivity. In the absence of such a system, workers must respond to two, sometimes conflicting management systems.

The literature suggests that safety and operational management systems should be integrated, but there is no empirical research to describe what joint management systems might entail, how their existence would impact safety or operational outcomes, and why an organization might engage in them. Therefore:

> RQ2: What elements of a joint management system matter for the management of a system to be safe and productive?

2.3. What Is the Role of Culture in Developing Safe and Productive Operations?

Critical to understanding the production system is an understanding of the organization's culture (Naor et al. 2010, Prajogo and McDermott 2011). An organization's overall culture is defined as the shared values and assumptions of members of the organization (Prajogo and McDermott 2011, Schein 2004). The overall culture can have multiple facets, such as operations, safety, and service. This research is interested not just in a *safety culture* or an *operations culture* but rather the integration of the two as experienced on the shop floor.

Culture is often tacit and unarticulated (DeJoy et al. 2004) and is shared across a diverse range of organizational members, making it difficult to research. Therefore, research focused on understanding organizational systems and values, as they apply to safety, has generally progressed by examining workers' perceptions of the safety culture (generally referred to as *safety climate*; e.g., DeJoy et al. 2004, Zohar 1980). Worker perceptions of the safety culture are often used in the literature as a proxy for the safety culture.

In this article, "culture" will refer to the shared values and assumptions of all organizational members as they relate to managing the production system to be safe and productive. When we refer to "safety culture" or "operations culture" we will be addressing organizational members' shared assumptions and values as they relate specifically to safety practices or operating practices. Finally, when we refer to "workers' perceptions of the safety culture" we will be addressing only the workers' shared perceptions of the importance of safety in the organization. Positive worker perceptions of the safety culture have been linked to improvements in safety outcomes such as injuries, illness, and near misses (Hofmann and Stetzer 1996, Johnson 2007, Oliver et al. 2002, Zohar 1980, 2002).

Research has started to examine which practices and programs are important predictors of worker perceptions of the safety culture. While this research is far from definitive, some trends are emerging. There is evidence that high quality work environments (HQWE; Barling et al. 2003) lead to better worker perceptions of the safety culture and outcomes. Definitions of HQWE vary, but generally a HQWE is marked by extensive training, a high degree of task variety, and significant autonomy for operational workers.

Role overload is one of the primary indicators of negative worker perceptions of the safety culture (Hofmann and Stetzer 1996, McLain 1995). If workers have slack, it is possible to prioritize both safety and productivity, but as slack disappears, workers take shortcuts and put their own safety at risk. Rewards, punishments, and other elements of the production setting have also been linked to worker perceptions of the safety culture and safety outcomes (Burns et al. 2006, Pate-Cornell and Murphy 1996, Smith-Crowe et al. 2003, Vredenburgh 2002)

Safety culture has been linked to a number of practices and shown to be a predictor of safety outcomes. However, safety culture is part of a broader culture aimed at the management of the production system. The safety culture construct is too restrictive to fully explain the relationships between safety and operational practices and outcomes. Therefore, our final research question:

> RQ3: What are the dimensions of culture that matter for the management of a system to be safe and productive?

3. Methods

This research is exploratory and uses qualitative methods, specifically, a series of 10 case studies. Field-based data collection allowed for the depth and breadth necessary to understand the relationship between safety and productivity as well as (i) what dimensions of culture mattered; (ii) the nature of joint management systems; and, equally important, (iii) why these two constructs were important (Eisenhardt 1989).

3.1. Study Participants

Purposeful non-random samples that are based on specific theoretical underpinnings are suggested for qualitative research (e.g., Eisenhardt 1989, Miles and Huberman 1994). Selection was done with the competing goals of controlling for extraneous factors and generalizability. For example, previous studies have shown that one of the drivers of discretion in managerial decision making is the regulatory environment (Abrahamson and Hambrick 1997). Therefore, all data were collected in a single Canadian province (Ontario) to reduce confounds that could be created by different regulatory and enforcement regimes. Because worker perceptions of the safety culture can vary across plants even in the same firm, the unit of analysis was the facility rather than the company. This study also was limited to facilities that either transformed and/or moved physical products.

To achieve breadth, facilities were targeted that varied widely along dimensions that were identified as important by the literature. The literature suggests that HQWE environments (e.g., Barling et al. 2003) and the skill and training of the workers (e.g., DeJoy et al. 2004, Shah and Ward 2003) are critical determinants of both safety and operational outcomes. Therefore, the skill level of workers at the sampled facilities varied greatly from basically no training required to do the job to multiple years of training to reach proficiency. The literature also suggests that the way in which products are made and the level of variety in tasks and outcomes (e.g., Kaminski 2001, Pagell et al. 2000) influence worker outcomes. Therefore, the sample contains make-to-stock, make-to-order, and engineer-to-order organizations. Facility size (e.g., Zacharatos et al. 2005) has also been linked to worker outcomes; hence facility employment ranges from 80 to 900. Finally, the sample contains both unionized and non-unionized plants, following previous safety research that controlled for the presence or absence of a union (e.g., Kaminski 2001).

Overall, sample selection was based on factors highlighted in prior literature with the final sample comprised of 10 production and distribution facilities from nine companies. Eight of these facilities are traditional manufacturing settings where physical materials are moved and transformed. Two of the facilities are distribution centers that mainly move physical goods using highly repetitive high volume processes. See Table 1 for more details.

3.2. Data Collection and Interview Protocol

Four primary sources of data were collected at each facility. First, operational practices, safety practices, culture, context, and operational outcomes were determined from interviews with managers and union representatives. A minimum of four managerial interviews were conducted at each facility. A semi-structured interview protocol was used for each interview (available from authors) with overlapping questions between managers to allow triangulation. At each facility:

1. The senior operations manager in the facility provided information on operational and human

Table 1 Sample Description

Facility	Synopsis	Workers	Union?	Operational Performance	Safety Performance
Metals	Large smelter operations. Part of global organization in metals business (continuous)	600	No	**Somewhat above average:** Average on quality and lead time, above average on utilization in capital intensive industry	**Above average** • **WSIB data:** all significantly above average •**Survey:** top management average, direct supervisors above average
Plastic	Medium-sized plant that produces plastic films for a multi-national parent company (batch)	145	No	**Somewhat above average:** Above average on quality and customization, average on cost and customization	**Above average** •**WSIB data:** all significantly above average •**Survey:** both significantly above average •**Other:** no lost time accidents reported over last 8 years
Water	Small plant producing water purification systems. Part of larger organization but only plant in this business (job shop)	80	No	**Above average:** Above average profits and able to compete on cost, quality, and delivery	**Above average** •**WSIB data:** all significantly above average •**Survey:** both significantly above average
Furniture	Large plant, part of a global organization that produces high quality office furniture (batch)	500	No	**Above average:** Above average on most metrics; Shingo certified	**Above average** •**WSIB data:** all significantly above average •**Survey:** both average •**Other:** won industry safety award in year of data collection
Smelter	Large smelter operations. Part of global organization in metals business (continuous)	550	Yes	**Somewhat below average:** Quality average but plant not in control, cannot produce to schedule and has frequent equipment breakdowns.	**Average** •**WSIB data:** all average •**Survey:** both average
Systems	Medium-sized plant that builds assembly systems for auto manufacturers. Only production facility in company (job shop)	220	No	**Somewhat below average:** Average quality and delivery but not profitable and moving some production to Mexican facility	**Somewhat below average** •**WSIB:** average on incidents, below average on days lost •**Survey:** both average •**Other:** joined industry safety group because no safety systems; safety costs increasing
Simple DC	Large-sized distribution center that is one of numerous Canadian facilities (continuous sorting lines)	800	Yes	**Below average:** Meets daily delivery deadlines with below average quality and not cost competitive	**Below average** •**WSIB:** all significantly below average •**Survey:** both significantly below average
Complex DC	Large-sized distribution center that is one of numerous Canadian facilities (continuous sorting lines)	900	Yes	**Somewhat below average:** Meets daily delivery deadlines with below average quality and costs	**Below average** •**WSIB:** all significantly below average •**Survey:** both significantly below average
Printing	Medium sized plant that prints low volume books (batch)	225	No	**Below average:** Very fast but not cost competitive/profitable and with marginal quality	**Below average** •**WSIB:** all significantly below average •**Survey:** both significantly below average
Fireplaces	Medium sized facility that makes metal fireplace inserts (line)	300	No	**Somewhat below average:** Poor quality, barely average on costs and delivery.	**Below average** •**WSIB:** Lost time has gone from significantly below average to significantly above average, while at the same time no lost time and total injuries (which were always significantly below average) have increased dramatically. •**Survey:** significantly below average •**Other:** Ministry of Labour Inspector permanently on site due to previous safety violations

resource (HR) practices, the culture, safety practices, and operational outcomes.
2. The senior HR manager in the facility provided information on HR practice, as well as some basic operational practices, culture, safety practices, and operational outcomes.
3. The senior safety manager in the facility provided information on safety practices and outcomes as well as the culture.
4. A direct operational supervisor was interviewed about operational and safety practices as they were actually implemented in the facility.
5. In unionized plants, a representative of the union was interviewed about the general operational and safety practices at the facility as well as the culture.

The inclusion of each of these informants was motivated by the literature. Operations and safety managers are central to the adoption of practices and accountable for the outcomes critical for this study. HR was included because both the safety and managerial literature provide evidence that HR policies and practices help in creating safe and productive operations (e.g., Ahmad and Schroeder 2003, Barling et al. 2003). Direct supervisors were interviewed because the literature shows that within a facility, supervisors often differ from senior plant management on safety practices and emphasis (e.g., Zohar and Luria 2005).

Second, *safety outcome data* were provided by the Workplace Safety and Insurance Board (WSIB) of Ontario, Canada, who provided 10 years' worth of data for each facility that covered injuries (both no lost time and lost time incidents), number of days on benefits, number of musculoskeletal injuries, and permanent injuries. For each year on each metric the facility was rated as significantly above/below average if its score was three or more standard deviations from its specific industry's average on that metric for that year. The analysis focused on the three most recent years, with previous years used mainly to help identify patterns or validate respondent comments on past performance.

Like the safety outcome data, the operational outcome/productivity data were also based on comparisons to similar plants. Respondents compared the plant to competitors and, when appropriate, other plants in the same network, focusing primarily on the dimensions of operational performance (e.g., cost or quality) that were most important to the facility. The convention in the safety literature of referring to all forms of operational performance as "productivity" proved valuable here in that it allowed discussions of operational performance in general without needing to discuss which dimensions were most important at each facility. All discussions of outcomes are then relative to industry, not to other members of the sample.

Third, the workers' perceptions of the safety culture were determined by a survey that was administered to approximately 30 workers at each plant. The surveys were conducted in a manner so that responses were confidential both to the researchers and to managers. Finally, all of the facilities were toured. As numerous authors have noted (e.g., Wu and Pagell 2011), facility tours provide important insight into how work is done and allow observers to validate some managerial responses.

All primary data collection was conducted on site by two members of the research team who recorded all interviews that were later transcribed. Individual interviews generally lasted between 60 and 90 minutes. Each researcher also took notes to record impressions, critical insights, and observations from the facility tour, with the two researchers comparing their notes immediately after the visit. The interview protocol was updated after each site visit, which is a foundation of qualitative theory development (Glasser and Strauss 1967).

Thus, data collection included multiple respondents, multiple data sources, including secondary data, multiple researchers, a transcribed record of the conversations, and the opportunity to view the production facilities. This design explicitly captured the perspectives of multiple stakeholders and controlled for potential biases from a single data type or from a single researcher (Eisenhardt 1989, Yin 1994).

3.3. Coding and Analysis

Coding and analysis were performed after all of the data had been collected to reduce the potential for confirmation bias influencing the results (Miles and Huberman 1994). Because the coding and analyses processes required expertise in both operations and safety management, a total of nine researchers participated in various stages of the process, four with an operational background and five with a safety background.

Coding for each construct was based on triangulating multiple data types and responses to create a facility-level response. Each act of coding involved at least one researcher from each background. Moreover, each act of coding was then checked by a third researcher (the same person checked all cases) with an issue of interpretation only considered resolved after all three researchers reached consensus. Each case was then effectively coded by three people who had to reach consensus as to the organization's use of a practice, the level of adoption, and outcomes.

After all 10 cases were coded analysis was conducted in two phases: within-case analysis to answer the research questions for each individual case and

cross-case analysis to determine patterns for the entire sample. The majority of the within-case analysis was done by three members of the research team (two with operational backgrounds and one with a safety background) using a number of typical qualitative data analysis tools, including pattern matching hypotheses building, and examining contradictory results (Miles and Huberman 1994, Yin 1994). Here, as in coding, the researchers followed an iterative process that included third-party checking followed by resolution by consensus.

Next, cross-case analysis was done to identify patterns in the entire sample (Yin 1994). Typical qualitative data analysis tools, especially pattern matching, model building, and looking for contradictory evidence, were used to determine the answer across the entire sample. The initial process included activities such as trying to group cases based on similar answers, comparing the attributes of cases with different answers, and examining the relationships between constructs across cases. Tentative answers were tested for validity by examining the number of individual cases they could accurately explain. The answers to each individual research question included the following:

1. A list of key findings
2. A list of the key constructs used in answering the question
3. A set of propositions to further clarify the answer
4. Models/figures that visually showed the relationships
5. All of the data used to reach conclusions.

After achieving consensus on the answers to the individual research questions, a single integrative answer covering all research questions was derived from the data following a similar process. The consensus answers to the individual research questions as well as the overall integrative answers were then shared with the entire research team to once more check for validity. Finally, the results were shared with the project's external advisory board (comprised of the project sponsor and representatives of companies and unions) to provide feedback on the accuracy and saliency of the findings. Therefore, this process provided numerous checks for the validity of the answers to the research questions.

4. Results

A key strength of qualitative research is the potential to go beyond finding evidence of a relationship to reveal "how and why" that relationship might exist (Yin 1994). The literature recognized that culture could be an important construct (e.g., DeJoy et al. 2004), and it was in all 10 cases. However, previous research only discussed culture at an aggregate level without providing a detailed understanding of what dimensions of culture would matter when simultaneously examining the management of safety and operations.

Similarly, the literature raised the possibility that joint management systems could exist, but provided no further insight on the dimensions of these systems. In four of the facilities, practice was best characterized by considering safety and operational practices as a single set of joint practices. Therefore, it was necessary to develop an understanding of culture and joint management systems to do the cross-case analysis.

4.1. Culture

Culture captures an organization's values, and in this research the interest lies in what is valued in terms of managing the production system. These values can encompass safety, productivity, or a combination of both. Determining these values required an inductive approach because the dimensions of culture that mattered were not known, and respondents may claim to value safety mainly out of a desire to appear legitimate. Rather than directly asking, "Do you value safety?" respondents were asked numerous questions to capture their priorities, their definition of working safely, and their response when facing a trade-off. The researchers combined these data with data from the workers and observations from the plant tour to identify each plant's values. The cross-case analysis then determined which values mattered across the entire sample. Table 2 defines the four main dimensions of culture identified from the cross-case analysis.

Each organization was then coded on each of the four key dimensions of culture. While each dimension is assumed to be a continuum across the entire population, the reality of qualitative data is that it is not well suited for continuous coding, so each case was coded as low, medium, or high on each dimension of culture. This level of precision proved to be reasonable, as almost every facility was clearly identifiable as operating at one endpoint or the other on most dimensions of culture. It is also reasonable to assume that the dimensions could be combined independently into a broad array of cultures. However, in this sample all facilities, save Smelter, group into one of the two dominant cultures (see Table 3).

The first dominant culture is the *supportive culture for safety and operations*. Facilities with this culture are committed to safety, are disciplined in how work is done, are participatory, and have a prevention focus. These facilities tend to take a long-term perspective when managing both safety and operations. The second dominant culture is the *day-to-day output-oriented*

Table 2 Four Dimensions of Culture

Dimension	Description
Facility is committed to working safely	The organization is committed to safety as an integral part of operations. Safety is a core value for the behavior of employees in this facility. The strength of this statement varies with whether safety is **a** priority vs. **the** priority
Facility is disciplined in how work is done	Rules/processes are created and followed as a means to achieve business and safety outcomes. This is in contrast to adhocracy, fire wagon management, and turning a blind eye to procedures for the sake of short-term expediency
Employees participate in managing their work environment	Workers are engaged as stakeholders in the organization and thus have input into the execution of the work
Facility has a prevention focus	The facility is managed in a proactive/preventative fashion with a goal of zero variance

culture. Facilities with this culture are not committed to safety, are relatively undisciplined, encourage little or no participation, and have a reactive focus. These facilities have a short-term focus on meeting daily production goals.

Subsequent analyses for Smelter tested its fit with the day-to-day culture, the supportive culture, and on its own. In the end, Smelter had the most in common with facilities in the day-to-day culture. Therefore, Smelter was classified as having a day-to-day culture.

4.2. Joint Management Systems

One of the attributes coded in each case was the presence or absence of a joint management system for safety and operations. Four cases were coded as having joint management systems while six were not. Determining the elements associated with a joint management system required an inductive approach because the practices that mattered were not known. Pattern matching techniques were used to determine what practices were common to organizations that did or did not have a joint management system.

This system can have its genesis in either an OHS or an operational management system. In three organizations (Metals, Plastics, and Furniture), the joint management system started as an OHS management system focused on preventing accidents via measuring, monitoring, and continuously improving safety with the active participation of both managers and workers. Water took a different path to reach a very similar outcome. Here, the lean production system included safety as the paramount metric of operational effectiveness. This metric had the effect of making safety a critical component of all operational decision making and improvements.

The critical attribute of these systems was not that the processes existed, but rather that the facility focused on these processes and expected them to be followed. The following quote from the Complex DC, which did not have a joint management system and did not follow their set processes, makes this distinction clear.

> There are a lot of things they're not supposed to do … when we have jams on the conveyors. … They're not supposed to walk on the conveyor because they can fall near the chute. But they do it sometimes. … Otherwise they'd be shutting down the system, [for] half an hour. … Sometimes it's quicker to take shortcuts [and] I would say supervision may turn a blind eye because they need to get the part going. … Sometimes they do what it takes to achieve their numbers, … even if that means bypassing or altering the known procedures or policies.

Table 4 defines the elements of a joint management system.

4.3. Relating Facility Practices to Performance

A major objective of this research was to explore factors that might explain relationships between culture, practices, and performance. Cross-case analysis allowed the research team to arrange the 10 cases in different ways to assess potential patterns and relationships. Numerous groupings were tried; the cases were organized by safety performance, operational performance, type of culture, use of certain practices such as lean, and contextual elements such as size, industry, and nature of work. *A priori,* insightful arrangements were defined as those that could help explain at least seven cases; arrangements that could not explain at least seven cases were not further explored. However, arrangements generally explained either one or two cases (not insightful) or nine or ten cases (insightful).

None of the arrangements by context provided insight. Facility size was not related to either practices or outcomes. More interestingly, the nature of the work also was not predictive of practices or outcomes. Some facilities where work was extremely hazardous (e.g., Smelter) adopted the same practices as those whose work was generally low risk, while organizations with the same risk profile (i.e., Smelter and Metals) adopted different practices and had different cultures. Elements of the industry's competitive environment, such as the pressure to reduce costs, were not predictive of culture or practice. Both supportive and day-to-day cultures were present in settings where there were significant pressures to cut costs or complete work quickly. No insight was gained by focusing on contextual variables.

Table 3 Two Dominant Cultures

Construct	Metals	Plastic	Furniture	Water	Smelter	Complex DC	Systems	Simple DC	Printing	Fireplaces
Overall culture	Supportive	Supportive	Supportive	Supportive	Day to Day (*)	Day to Day	Day to Day	Day to Day	Day to Day	Day to Day
Committed to safety	Highly committed	Highly committed	Highly committed	Highly committed	Committed	Not committed	Not committed	Not committed	Not committed	Not committed
Culture-disciplined	Disciplined	Disciplined	Disciplined	Disciplined	Disciplined (*)	Not disciplined	Not disciplined	Not disciplined	Not disciplined	Not disciplined
Participation	Some participation	Highly participatory	Some participation	No participation	Some participation	No participation	Negative participation (†)	No participation	No participation	No participation
Prevention	Prevention	Prevention	Prevention	Prevention	Mainly reactive	Reactive	Reactive	Reactive	Reactive	Mainly reactive

*Although Smelter does not clearly fit cleanly into one category or the other, its culture had more in common with the day-to-day output-oriented culture and was classified as such. The analysis was conducted with Smelter in both groups to verify this choice.

†At systems workers were unsupervised, so in a sense they had very high levels of participation. However, they were also untrained and unsupported.

Supportive culture for safety and operations is one that is committed to safety, is disciplined in how work is done, has a prevention focus, and is participatory. These organizations tend to take a long-term perspective when managing both safety and operations.

Day-to-day output-oriented culture is not committed to safety, not disciplined, has a reactive focus, and is not participatory. These organizations have a short-term focus on meeting operational (production) goals.

Other arrangements based on practices and outcomes were quite consistent. Groups based on safety outcomes (from WSIB data), operational outcomes (from management interviews), worker perceptions of the safety culture (from the survey data), and type of culture and existence of joint management system (both from analyses) all led to nearly identical groupings and conclusions. As Figure 1 shows, the most productive facilities were also the safest. And these same facilities were perceived by their workers to have above average safety cultures. Finally, facilities with supportive cultures also used joint management systems. Meanwhile, the six facilities with lower performance on both safety and productivity had day-to-day cultures and lacked joint management systems.

The safety literature posits that prioritizing production over safety leads to the adoption of practices that put worker safety at risk. The operational literature generally implies a different relationship; it finds that to increase productivity, an organization must provide a safe work setting. The results of the cross-case analysis suggest that in a sense both suppositions are correct. The sample contains six facilities that support the supposition that prioritizing productivity harms safety (see Figure 2). In contrast, four facilities support the notion that there is a positive symbiotic relationship between managing safety and managing operations (see Figure 3).

4.4. Conflicting Priorities

In the presence of a day-to-day output-oriented culture, safety practices are managed separately from managing operations, which generally leads to the prioritization of getting work done (production) over doing work safely. The culture and priorities are often a reaction to an external environment pushing for lower costs and faster production. When organizations respond to the external environment with a day-to-day output-oriented culture, safety practices will generally not go beyond meeting regulatory standards; they are, moreover, subordinate to getting work done even if formal process are ignored or rules are broken and are developed and managed separately from managing the day-to-day operations.

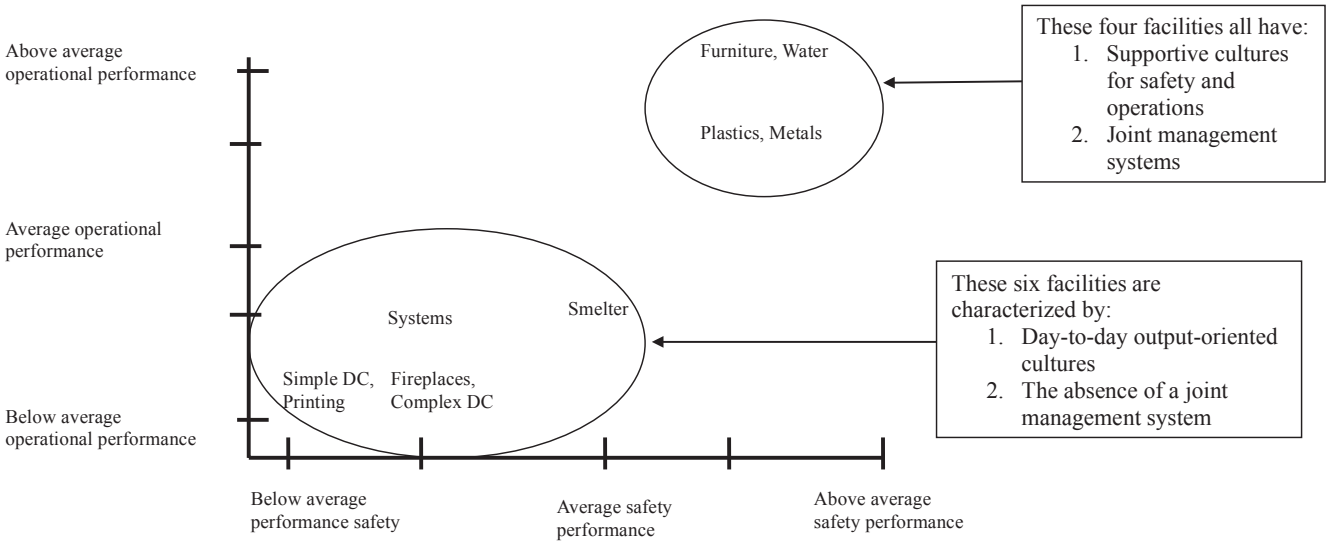
Managers in these facilities describe their management style using terms like "ad-hoc" or "on the fly." These facilities focus on getting work out the door today, with relatively little planning for tomorrow. Moreover, even if they have formal management systems, they tend not to be used. For instance, a manager at Complex DC said the following about ISO 9000:

> We are ISO certified, so our processes are all written. … We are supposed to do what we say and say what we do. There are times, of course, when certain things are tweaked [sic] to get results.

Table 4 Elements of a Joint Management System

Element	Description
A process focus and strict adherence to rules	In a joint management system, formal processes for all jobs exist and the processes are followed to do work. Part of the formal processes encompasses continuous monitoring and measurement to enable continuous improvement
Accountability	In a joint management system, everyone is accountable for safety, operations managers have responsibility for safety, and violations of safety rules are disciplined
Design of work	In a joint management system, (re)design of work explicitly considers safety, hazard control principles and ergonomics at the same time as the engineering associated with operating changes, such as automation
Communication	In a joint management system, managers frequently communicate the importance of safe work and that working safely is an important priority for the plant
Human resource management	In a joint management system, a key human resource management activity will be to include safety as part of selection, promotion, and performance appraisal for managers and supervisors

Figure 1 Grouping the Plants



Companies graphed based on data in Table 2

Figure 2 Prioritizing Operations over Safety

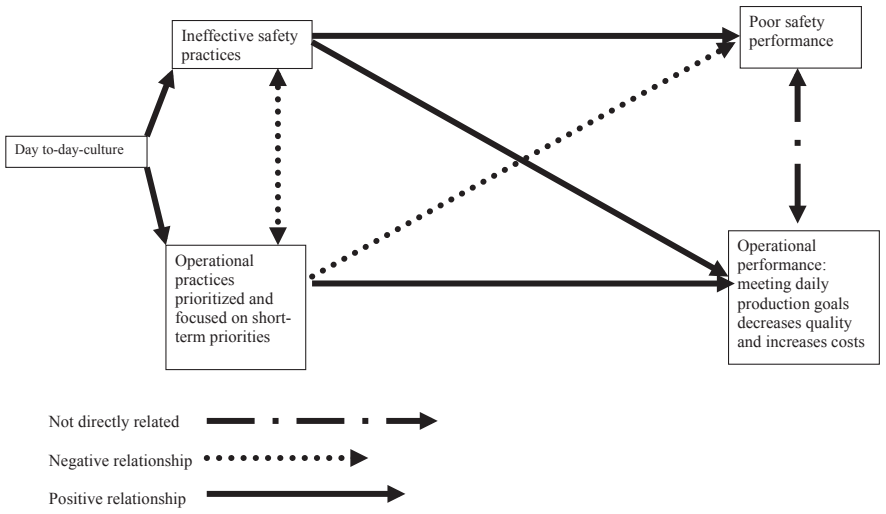
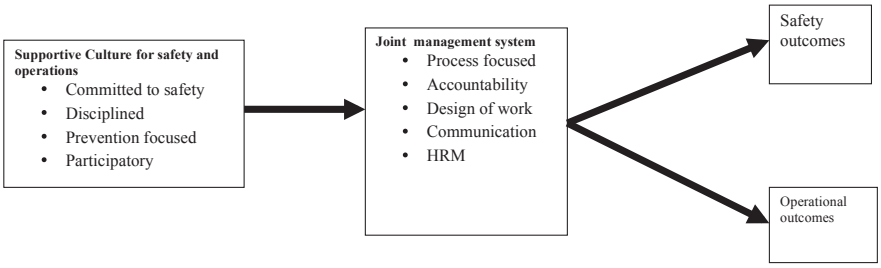


Figure 3 Safety and Operations Have a Positive Symbiotic Relationship



The production emphasis at these facilities is putting worker safety at risk. A manager at the Complex DC explicitly recognized this:

> We are the kind of guys that get things done even if it means disregarding procedures. … There are some things that these guys shouldn't be doing, but it's with good intention to service a customer. … But you know what, you are now turning up the risk level, so to speak.

A manager at another facility in this group used the term "cowboys" to describe how both managers and workers would do whatever it took to meet production goals. The term was used with pride, even though the actions that helped meet production goals were risky for workers and had previously led to serious injury.

Finally, at Smelter the management had instituted a practice called See, Understand, Plan and Act (SUPA), which the workers jokingly, but consistently, called "Safety Unless Production Affected." In all of these facilities, management was prioritizing getting work done over working safely, suggesting that prioritizing production over safety leads to the adoption of ineffective safety management practices and, at best, average safety outcomes.

Most importantly, all of the low operational performers fell into this group. A careful examination of the data indicated that giving priority to production and deemphasizing safety under the auspices of improving operational outcomes provided ephemeral, at best, operational benefits.

For instance, at both of the distribution centers, formal rules and processes were ignored when there was pressure to get packages out of the door. However, in the process of getting work done quickly, not only were people put at risk but they also had a high level of defects, with numerous shipments being loaded on the wrong truck and packages being broken. The shortcuts they took to meet daily delivery goals hurt quality (i.e., misdirected and broken packages), reduced safety, and increased the costs of safety and poor quality. This pattern of shortcuts was repeated across this group.

Thus, this group of facilities reflected the characterization and findings of safety researchers such as Zohar (2000), with efforts to increase productivity putting workers at increased risk. However, efforts to boost productivity were also harming quality and other outcomes (Das et al. 2008) and yielded, at most, average operational performance.

4.5. Symbiosis

The second group of facilities (i.e., Furniture, Metals, Plastics, and Water) faced many of the same external pressures as the first, but rather than responding with a reactive culture and practices focused on the short term, these organizations adopted a longer term perspective and made simultaneous improvements in productivity and safety. Plastics took this commitment the furthest, making safe work fundamental to the plant's license to operate:

> If you can't do it safely you will not be allowed to do it, and you can lose the freedom to operate.

In the presence of a supportive culture for safety and operations, across time facilities developed joint practices that positively linked the management of operations and safety. For instance, Furniture was using lean production tools to improve operations and safety:

> When it comes to the state of our factory we do audits, 30-point inspections to make sure that the health and safety and environmental factors in and around the work stations are addressed, from a clean clear organized 5S perspective.

When discussing why operational managers (including line supervisors) were ultimately responsible for safety, the plant manager at Metals noted that when the safety function used to have primary responsibility for safety, safety was not prioritized by operational managers:

> Well what that did was it let management off the hook because it's the safety guy's problem, it's not my problem. … But now we have it here

> where the (operational) manager is in charge of safety, we have a health and safety person as a resource to help us analyze data, do stuff, but it's, it's our issue. … Give it to the safety guy and then, you know, it's out of sight of our mind type thing, right?

These plants are serious about process management, give operations managers and supervisors responsibility for safety, and combine sound operations and safety principles in areas such as process design and hazard avoidance. This reflected an overall organizational commitment to follow processes and to enforce rules regardless of how much stress there was on the plant to produce. Management at Metals described their process focus as follows:

> Certainly if you are talking health and safety and any of those other things, … it's all "follow the practices, follow the procedures." When you start freelancing, that's where we end up getting into problems.

In each of the four organizations, it was difficult, if not impossible, to truly separate safety and operational management. This was most evident at Water, where the primary performance metric for their operational system was safety, followed by operational metrics such as quality, delivery, and cost. This facility actually lacked the traditional safety management function, and instead safety was woven into everything that was done in operations. Both short- and long-term production practices leveraged a joint management system that simultaneously improved safety and operational outcomes.

Similarly, Plastics maintained an experienced, well-trained core of workers who worked safely, even when being pushed to be more productive. Downsizing and cost pressures did not affect the involvement of the workforce in continuous operational and safety improvement. Managers stressed that working safely freed up time to manage the operating aspects of the business. Part of their operational success was due to the frequent small improvements to improve productivity. However, safety also was being inspected and audited frequently to improve safety outcomes with a prevention-based philosophy.

A positive relationship between safety and operational performance exists in these facilities even though three of four plants in this group had production environments that could be considered adverse (e.g., intense international competition or dangerous work). The strong preventative management culture combined with shared systems creates processes where management is able to prioritize safety and productivity.

5. Discussion and Propositions for Future Research

Previous safety research has tended to overlook operational outcomes while previous operational research has tended to overlook both safety practice and safety outcomes. These oversights are troubling given that the workers involved in creating goods or services are the workers who are most likely to get injured. This study works to address this gap by simultaneously addressing safety and operational practices and outcomes.

The cross-functional nature of the research team's expertise, the research design that leveraged numerous multiple types and sources of data, and the analysis designed to mitigate the influence of any single researcher's biases lend credence to the results. However, this research has limitations. The most significant limitation is common to many qualitative studies: the results are unlikely to be completely generalizable. Thus, the constructs identified and models proposed need to be verified in future research using a much larger sample. Moreover, the bifurcation of the sample into two basic groups may not occur in the broader population, despite the observation that these groups were not related to size, industry, or relative danger of the work. Similarly, the bifurcation of the sample does not allow tests to determine if disciplined processes for safety and production that were managed separately or sequentially would do as well as joint processes, though the literature on integrated management systems would suggest that this is not likely (e.g., Karapetrovic and Jonker 2003).

All of the union facilities are also low performers, suggesting that symbiosis may be difficult to achieve in a union environment. However, the literature suggests a more complex relationship. Freeman and Medoff (1984) note that unions often form in response to poor working conditions, and the operations management literature concludes that the performance implications of unionization are nuanced (Pagell and Handfield 2000). Future research also needs to address the role of unions in creating safe and productive operational settings.

One of the strengths of the design is the archival data used to address safety performance, but the productivity data are perceptual and cross-sectional in nature. Future research that examined both safety and operational performance across time and using objective measures would add deeper insight especially into causality. Finally, the sample was limited to facilities that manufactured and distributed tangible products, which may limit the findings' applicability to service settings. Future research should address these limitations.

While the relationships proposed in the previous section need to be validated, the results show that

some organizations are capable of creating operational settings that satisfy multiple stakeholders, while others create operational settings that put workers at risk for seemingly ephemeral operational gains. Future research will be needed to determine how common such symbiotic facilities are and what can be done to move organizations away from assuming that working safely means being unproductive.

The analysis demonstrated that culture is closely related to the safety and operational practices adopted and the outcomes achieved. The analysis also indicates that organizations can create joint management systems, which can lead to improved operational and safety performance. The fact that these systems are built on best practices that should be familiar to managers and researchers with both operational and safety backgrounds should also be heartening. However, it is their integration that drives deeper synergies. The cases indicate that a joint management system will not require adopting truly new practices, but, instead, a rethinking of responsibilities, priorities, and rewards. Future research will need to explore both the content and implications of joint management systems in greater detail.

We offer the following propositions to guide future research:

Proposition 1. *The culture of the organization is a key determinant of the relationship between operational and safety practices.*

Proposition 1a. *Facilities with a supportive culture for safety and operations will manage safety and operations using a joint management system, which allows for the simultaneous measurement, monitoring, and continuous improvement of operations and safety. In these plants there is a positive relationship between operational practices and safety practices.*

Proposition 1b. *Facilities with a day-to-day outcome-oriented culture will prioritize production over safety and be focused on getting work done regardless of the official processes or rules. In these plants operational practice takes precedence over ineffective safety practice.*

Proposition 2. *Organizations with a joint management system will have a positive relationship between safety and operational outcomes.*

Proposition 3. *Organizations that lack a joint management system will meet daily production targets at the expense of safety and operational outcomes.*

Proposition 4. *Organizational context (e.g., dangerous work, industry competitiveness, and pressure to reduce costs) in and of itself does not predict operations or safety practices or the relationship between safety and operational outcomes.*

Finally, the results make it clear that safety needs to be considered a core operational priority alongside cost, quality, delivery, flexibility, and innovation. The results demonstrate that safety, while traditionally treated as a separate function and studied as a standalone outcome, is really a critical component of operations management. This does not mean that safety functions or research on safety should disappear, but is does imply that operations management researchers can learn from the respondents who noted that, when safety is shunted off into a separate silo, it is not addressed. If safety is critical for operational excellence, safety needs to be considered as a dimension of operational performance in operations management research.

Creating a safe facility that is also competitive requires discipline and the adoption of numerous practices to measure, monitor, and, ultimately, continuously improve the operation. In support, a HR management system must be in place to emphasize training, empowering, and appropriately incentivizing workers and managers. These managerial activities should be familiar to operations managers and researchers as they form the basis of numerous "best practice" management systems such as lean. However, it should also be noted that, while the practices required to harness the power of lean are familiar, failure rates from the adoption of these managerial systems are very high (Koenigsaecker 2005). Thus, despite the best managerial intentions, it is likely that many organizations will struggle to create a safe production system.

6. Conclusions

The results show that safe production need not be an oxymoron. The analysis demonstrates that it is possible for organizations to develop joint management systems that simultaneously measure, control, and improve both safety and operations. When they do so, they are able to be safe *and* productive. Safe and productive organizations represented a significant portion of our sample and were found across multiple industries, some of which are inherently dangerous or facing intense competitive pressures. These findings are expected to be generalizable to other facilities in developed economies. However, this outcome is predicated on a culture that is committed to working safely, is disciplined, and has a prevention focus. This outcome also requires that the managers with responsibility for getting work done are also responsible and held accountable for working safely.

The culture of the plants in the remaining portion of the sample is reactive, undisciplined, and focused on today's output. In these plants, the managers and

workers with responsibility for safety, when they exist, are not the same as those responsible for getting work done. As a result, accountability for safety is either diffused or missing, creating tensions and generally favoring getting work done over being safe. In these organizations actions taken to get work done can put quality at risk, increase costs, and harm workers. Collectively, organizations can make a convincing business case for safety, but many struggle to see how.

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