X. Emerging Models of Employment Relationships in China: Challenges and Opportunities

Human Resources and Safety Performance in China's Coal Mining Firms

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Abstract

This paper investigates both theoretically and empirically the key factors that impact occupational safety and health (OSH) performance in China's coal mining firms. Based on a unique dataset containing 200 accidental observations at the establishment level, we examine the effects of human resource practices, workers' unsafe behaviors, and the firm ownership structure on the casualties, and found supporting evidence for our propositions. Almost all the fatal accidents can be attributed to human factors, which are in turn closely related to HRM issues. Future research should focus more on the dynamic process of HRM-OSH within the firm.

We must do everything to eliminate "bloody coal" and "bloody GDP!"
—Yizhong Li, Commissioner of State Administration of Work Safety, 2005

Introduction

It is now a well-known fact that China has experienced a rapid economic development over the past three decades, with an annual GDP growth rate of 9.3%. This trend has significantly accelerated since 2003, and the annual GDP growth rate, on average, has been well above 10%.[1] The rapid economic development is largely driven by coal consumption, as 75% of total energy consumption in the national economy is coal.

High costs have been paid for this economic achievement, especially in terms of occupational safety and health (OSH) in the workplace. According to statistics released by the State Administration of Work Safety (SAWS) and the State Administration of Coal Mine Safety (SACMS), two government watchdogs of OSH in Mainland China, work-related accidents have resulted in more than 100,000 deaths annually in China since the beginning of the new millennium. The coal mining industry alone has approximately 6,000 worker deaths per year.[2] It is difficult to estimate, and thus to study, the number of nonfatal workplace injuries, both physically and psychologically. OSH issues have long been socially and politically sensitive, and OSH data are highly incomplete in public reports. Nonetheless, we have already seen the bloody picture that China's fast economic growth has brought about. That is why Yizhong Li made elimination of "bloody coal" and "bloody GDP" his top priority when he was sworn in as Commissioner of State Administration of Work Safety in 2005.

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Under Li's leadership, stringent regulations for work safety have brought about a decline in the number of fatal accidents in general and among coal mining workers in particular since 2006 (Kong, Cai, and Guo 2010; Guo 2007). In spite of this noticeable success, however, OSH performance and records in China's coal mining industry are still far from acceptable. The coal mining industry is still the sector with most frequent accidents and most severe safety situation in China. In terms of productivity and death rate per million tons of coal production, China leads not only in developed countries such as the United States, Canada, and New Zealand, but also in less developed countries such as South Africa, Russia, and India (Zhang 2007).

Government regulators, company management, and scholars are seriously challenged in investigating the factors and mechanism associated with the poor safety records; therefore, it is difficult for them to significantly ameliorate hazardous workplace conditions in China's coal mining firms. In fact, OSH issues in the workplace are a challenging concern within the area of organizational and managerial sciences worldwide.[3] During the course of economic globalization since 1980s, workers' rights to safety and protection have largely eroded. Policy makers in most countries, who believe in the doctrine of neoliberal economics, together with capitalists and their agents, actively destruct or hamper the safety networks in various degrees and squeeze or simply cut off most OSH investments in the workplaces (Mogensen 2006). As a result, the organizational safety production environment has continually deteriorated everywhere, and China is no exception. Not only that, it seems that Chinese workers and their managers are more prone to engage in unsafe behaviors in the workplace as a result of complicated reasons related to human resources issues.

This study is one of our successive endeavors to establish the incentive mechanism and human resources management systems to combat unsafe behaviors in coal mining firms, through empirically analyzing the human factors that directly or eventually caused fatal accidents in coal mining workplaces. In the following sections, we briefly review the literature, build our theoretical model, examine empirical evidence, and discuss our conclusions.

Literature Review

Given the advantage of Chinese scholars in closely observing human resource practices in coal mining firms, their judgment about the HR effectiveness with respect to OSH in the coal mining industry is informative and enlightening. They argue that the HR practices are, to a large extent, far from scientific, systematic, and efficient in encouraging safe behaviors and preventing accidents in the workplace. They also label those HR practices as old-fashioned in routine personnel issues, rigid in staffing management, lacking in long-term incentives, and inefficient in performance appraisal. Most important, there exists a serious shortage in investment in employee training, and OSH training in particular, in almost all the coal mining firms (Li 2006; Shen and Song 2007).

Some Chinese scholars who investigate the major causes of common fatal catastrophes have adopted an institutional economics framework (Lin and Chen 2006). For example, Zhang (2004) blamed unclear property rights in coal mining industry, and his conclusion was echoed by another economist (Mao 2006). Mao attributed frequent accidents to coal mine ownership rights not being well protected. While small and medium township and village mines (TVMs), mostly privately operated, have contributed an increasing proportion of annual death toll since 1970s (Guo 2008), we should not ignore the fact that the large, state-owned mines (SOMs) are not immune to significant fatal accidents (Qin 2010; Pan 2010). Dong (2005) focused on the principal–agent relationship in coal mining firms and pointed out that the simple, single-line principal–agent relationship could not make coal mine companies behave like a real firm in the market. The agent is concerned only about compensation, which is directly related to coal production; he invests as little attention as possible in safety investment and safety management, thereby making accidents inevitable.

On the other hand, some scholars explored the determinants of fatal accidents at the micro level and focused on internal managerial practices within coal mining firms (Hua and Zhang 2005). It is widely recognized among those scholars that managerial mistakes, wrong decision making, and human and environmental factors cause unsafe working conditions as well as unsafe behavior, which, in turn, cause frequent accidents (Chen, Qi, and Tan 2005; Guo, Ma, Wang, and Gao 2006; Han and Yu 2006; Li 2006; Liu 2006; Teng, Song, and Sun 2005; Xiao 2007; Xu and Peng 2006).

During the first decade of the 21st century, an increasing number of scholars explicitly examined the relationship between HRM practices and unsafe behavior and the accidents causing injuries and deaths in the workplace. Zacharatos, Barling, and Iverson (2005) conducted two studies investigating the link between high-performance work systems and occupational safety. They found that such innovative human resources practices are positively related to occupational safety at the organizational level, in which trust in management and perceived safety climate seemed to play a mediating role. Earlier, Weyman, Clarke, and Cox (2003a) argued that miners' risk-taking attitudes were directly associated with management commitment to safety, and also with specific jobs that bear very different characteristics within the organization (Weyman, Clarke, and Cox, 2003b). Ariss (2003) at the same time emphasized the importance of coal mine workers' participation in creating a corporate culture for safety production.

Foreign scholars' research inspired domestic counterparts in the same direction. Cao (2007) argued that motivation, communication, rewards and punishments, safety education and training, and performance feedback all influenced a coal mine worker's safety perception, which, in turn, impacted his choices about safety behavior. Fang, Zie, Huang, and Li (2004)[4] provided empirical evidence that safety education, safety communication, and labor–management relations are likely to affect safety records. The role of communication, monitoring, incentives, and corporate culture in safety production were studied by Peng and Huang (2001). We tend to agree with Fu and Nie (2006) that most miners' knowledge, skills, and attitudes do not enable them to meet safety requirements at the organizational level. As such, to combat OSH problems, coal mining employers have to recruit and tend to a qualified labor force who fit with safety production organization by establishing a new HRM system.

Unfortunately, most of the aforementioned studies do not provide sound empirical evidence; instead, many are merely qualitative arguments. Studies by Chen (2006) and Guo (2008) are two exceptions, but we focus on more recent observations of 200 recorded fatal accidents at the establishment level, and we investigate the relationship between HRM practices and OSH measures.

The Framework

According to SAWS and SACMS, nearly 100% of fatal accidents in China's coal mining firms are directly or indirectly caused by negligence by either management or workers who had engaged in unsafe behaviors. Thus, we need to build an integrated framework at the firm or establishment level that can map channels and connections by which various human resource factors lead to unsafe behaviors that that in turn cause accidents.

Technically, any accident in the workplace is caused by an unexpected release of energy (e.g., gas or coal-dust explosion, fire, physical pressure, etc.) or triggered by an accumulated hazard. But these seemingly inartificial immediate factors are closely related to either the unsafe working conditions or unsafe behavior, whereas the former is to some extent preventable with human efforts.

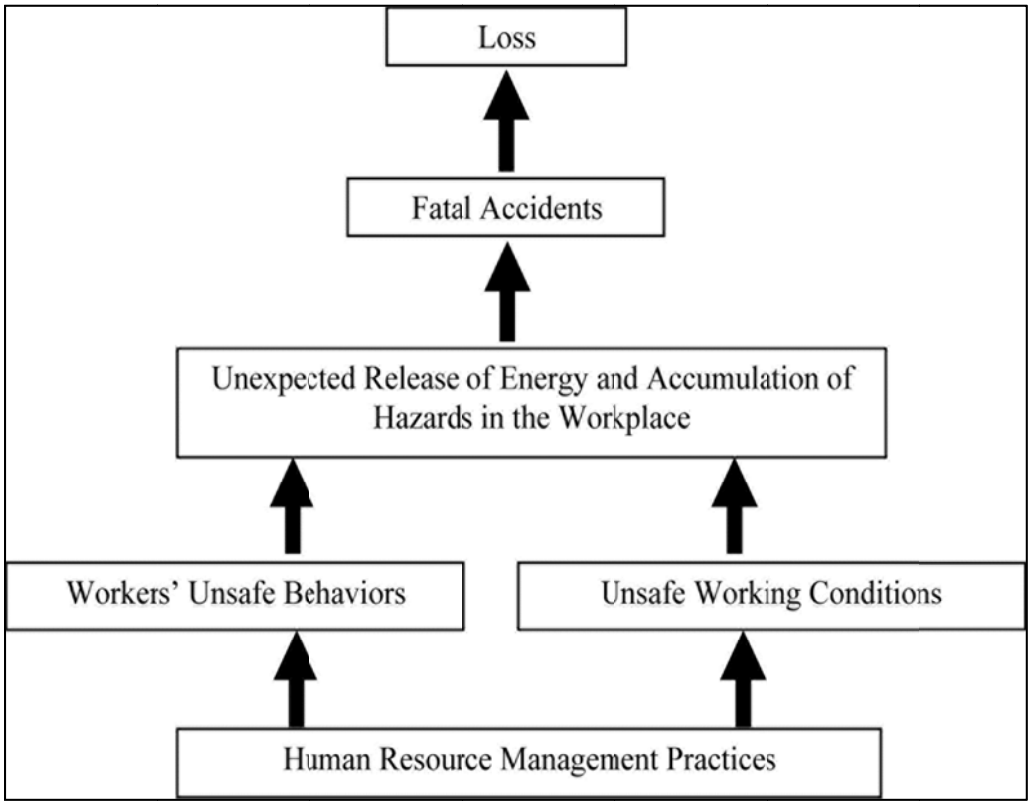
Both management (at various tiers) and front line miners might engage in unsafe behaviors. For management, they have a strong incentive to put production targets before safety standards, given the national energy consumption structure and coal market conditions. To dig an extra ton of coal out of mining wells means additional revenue for the employer; and production expansion could also enhance the political standing of those who are working in SOMs. As such, manager would probably comply with government safety regulations to the least degree possible so that their production records—as well as economic and political interests—are not jeopardized. Naturally, they would invest as little as possible in safety equipment, safety measures, and safety training, or in creating a safety culture in the workplace. Accordingly, coal mining employers and their agents do not consider workers' well-being as something important. The universal production-related reward system plus cost-oriented human resources practices are clear manifestation of this type of objective function.

On the other hand, Chinese coal mining workers are located in the lower, if not the lowest, segment of labor market. Most of them are migrant workers from the countryside, especially those who work in local SOMs and TVMs. In general, their social and economic conditions are poor. They are usually less educated and lack adequate training—and thus the necessary knowledge and skills to follow the safety procedures. Yet they also have a weak perception about the importance of safety (there's an old Chinese saying that "all

miners are buried alive"). In sum, in order to support their families, these workers simply don't have any choice but to accept the dangerous working conditions. They intentionally or unintentionally engage in unsafe behavior under enormous economic pressures and a performance-based pay system.

According to Heinrich's accident-causing chain theory, any accident occurs as a result of a series of mutual causal-result factors (like dominos in a line) (Heinrich 1931). It is logical to think that any interruption in the chain will halt the successive events, thus preventing accidents in the workplace. Put differently, if we could map all the human resources variables and put them in the right place in the chain, we would be able to provide coal mining companies with a framework to combat unsafe behavior and other factors that lead to accidents.

FIGURE 1
Theoretical Model of the Study



Empirical Study

We built a unique dataset containing detailed information on the human factors of typical fatal accidents from 1950s to the new millennium in China. First we conducted a content analysis of each accident and assigned codes representing the reasons for the accident. Then we performed statistical analysis to examine how these factors affect OSH.

Sample

We collected data from three archives. The first source is the official books published by SAWS and SACMS: *Collection of Most Severe Accidents, 2000–2003* and *Collection of Most Severe Accidents, 2004–2005* (China Labor and Social Welfare Press) and *Collection of Most Severe Coalmining Accidents* (Coal Industry Press), respectively. The first two books consist of the reports on 41 especially severe5 accidents from 2000 to 2005. The third book consists of 17 reports on severe accidents between 1950 and 2000, with over 50 deaths per

accident. The second source is Accidents in China's Coal Mining and Professional Analysis, Books I & II (China Coal Industry Press, 2002). We chose 112 cases involving all types of coal mining accidents between 1978 and 2002. In addition, reports on more recent accidents come from the official website of SAWS and SACMS (http://www.chinasafety.gov.cn/newpage/). We gathered information for 22 especially severe accidents between 2006 and 2010, and one severe accident in 2007. We also added seven severe accidents before 2006. Our total sample size was 200, and each case comes from various units of different coal mining firms.

Variables and Scales

Dependent variables. Four variables were used to indicate OSH performance: death toll, death rate per million tons of coal production, the ratio of the death toll to total number of employees, and direct economic loss.

Independent variables. These variables were firm and accident idiosyncratic variables, ineffective HRM practices, and workers' unsafe behaviors. Firm and accident idiosyncratic variables include firm ownership and timing of the accident. In regard to ownership, a coal mining firm can be a state-owned major one, a state-owned local one, a collective, or a privately owned firm. The history of China's coal mining firms can be divided into three time periods.

- The first time period is 1950–1979, when public ownership and national planning are the primary control patterns of the government. It was believed at that time that only through public ownership and national planning could the government take control of the national economy and restrain behaviors that could harm public health, safety, and well-being (Wang 2004).
- The second time period is 1980–1999. Since the reform and opening up of China in the late 1970s, the pattern of national control has changed. Public ownership and national planning were gradually replaced by market forces. However, government supervision still remained.
- The third time period is 2000 through the present. On December 30, 1999, China's State Council established SACMS, which is under the direct leadership of China's State Economic and Trade Commission. SACMS is in charge of safety supervision, and it investigates coal mining accidents. Its establishment symbolized enhanced supervision by the government.

Ineffective HRM practices are defined as a combination of management disorder (dummy variable) and lack in training or education (dummy variable). The original scale is 0, 1, and 2, with 2 indicating that the HRM problems are most severe in HRM. "Lack in training or education" is indicated by three key words: lack of safety education, lack of new worker training, and lack of onsite worker training. If one, two, or three of the three key words are coded as 1, then "lack in training or education" is coded as 1 as well; otherwise, it is coded 0. Workers' unsafe behaviors are defined as a combination of "disobeys rules or regulations or disciplinary measures" (dummy variable), "does not bring self-rescuer in coal mines" (dummy variable), and "lack of safety knowledge" (dummy variable). Similarly, the original scale is 0, 1, 2, and 3, with 3 standing for the most severely unsafe behaviors. If the key term "disobeys rules or regulations" is coded as 1, or the key term "disobeys disciplinary measures" is coded as 1, or both happen, then "disobeys rules or regulations, or disciplinary measures" is coded as 1 as well; otherwise, it is coded 0.

Procedure

Content analysis is a technique that makes inferences by "systematically and objectively identifying special characteristics of messages" (Holsti 1969). In this study, we conducted content analysis according to the following four steps.

- In the first step, key words and variables were defined. Two authors carefully studied three typical sample accident cases to conceptualize and categorize variables and key words. After choosing key words and variables separately, we compared our choices and discussed any disagreements or ambiguities. A comprehensive template was formed, consisting of information in four parts: accident description (e.g., date, time, type, death toll), firm description (e.g.,

province, city, firm size), accident causes (e.g., management disorder, lack of training), and accident aftermath (e.g., fine, number of responsible people).

- The second step was a pilot study in which one author and one coder coded ten accident cases separately. According to the coding results, we adjusted and added some variables and their categories. Space for add-ons was left for each case in the template so that some case-specific features could be added during the coding process.
- The third step was to code all the accident cases. Three Ph.D. candidates from a university in Beijing, China, and one author did the coding work. The coders were first trained to grasp the purpose of our content analysis, the nature of the textual material, and the coding standard and scheme. Some demographic variables (e.g., firm name, ownership, death tolls) could be directly written down. For key terms, such as ineffective management and management disorder, we treated them as dummy variables. If the key term was specifically mentioned, it was coded as 1; otherwise, 0. Specific explanations for certain variables or key terms were written down. By discussing the coding methods, coders were able be consistent in their use of the template and method. Before formal coding began, they practiced several cases to ensure accuracy.
- The fourth step was to check the reliability of the results. Twenty-five percent of the cases were assigned to all four coders. The consistency of the coding results was satisfactory among the coders. When differing results were found, coders worked together to agree on a final decision.

Results

First we conducted a descriptive analysis on key variables (Table 1). The mean value for the death toll is 42.11, and most of the accidents were classified as severe or especially severe. The death rate per million tons of coal production has a mean value of 4.42, which is rather high. Every 100 tons of coal is produced with the cost of more than four peoples' lives. The death toll per total number of employees has a mean of 0.11, indicating more than 10% of employees in the coal mine died in every accident.

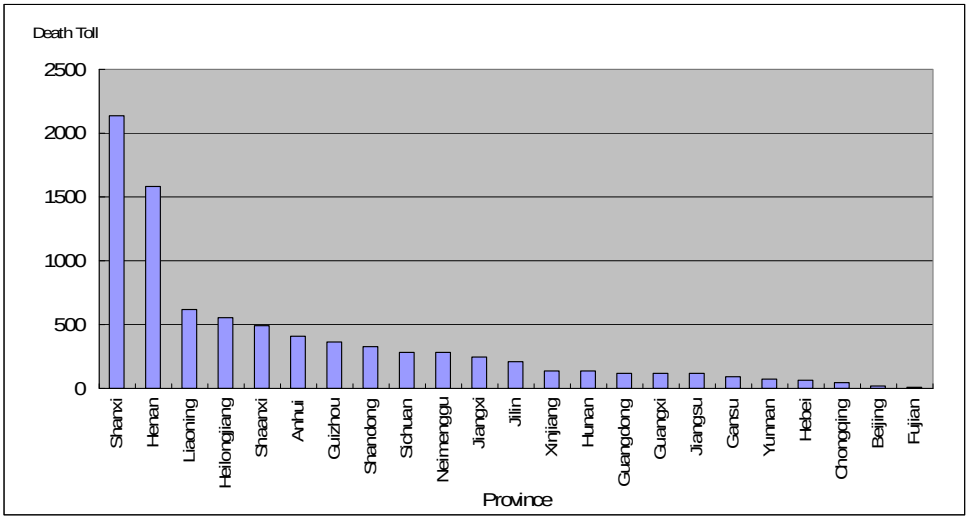
TABLE 1
Descriptive Analysis for Key Non-Categorical Variables

	N	Minimum	Maximum	Mean	Std. deviation	Sum
Death toll	200	1	684	42.11	61.00	8422
Death rate per million tons of coal production	179	0.003	89.00	4.42	9.77	791.69
Death toll per total number of employees	112	0.0001	0.48	0.11	0.13	12.31
Direct economic loss	146	0.82	5312.00	629.41	1087.11	91894.41
Production capacity	179	0.50	600.00	69.57	105.28	12453.13
Total number of employees	112	20.00	8897.00	2039.63	2467.02	228438.00

We found that OSH performance is related to the time period of accidents, firm district, and type of accident. Twelve accidents occurred in the first time period, with an average death toll of 170.75 per accident, which is the highest among all three periods. In the second period, 115 accidents occurred, with an average death toll of 23.50 per accident. In the third period, 73 accidents occurred, with an average death toll of 50.29 per accident.

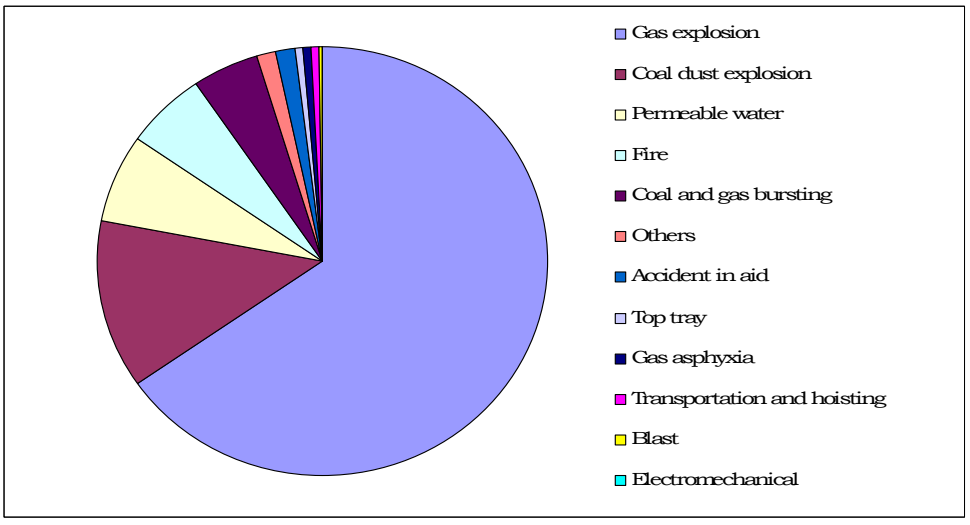
Different locations have different OSH performance. As shown in Figure 2, Shanxi, with the capital of Taiyuan, has the largest number of deaths (2,134, or about one quarter) among all the provinces in China. Henan comes next, with a death toll of 1,579.

FIGURE 2
Death Tolls in Coal Mining Accidents Across Provinces of China



In regard to types of accident, gas explosion accidents rank the first among all types, with a death toll of 5,453—nearly three quarters of all deaths in our sample. Coal dust explosion accidents rank the second, with a death toll of 1,085 (Figure 3).

FIGURE 3
Death Tolls by Type of Coal Mining Accident



Next we conducted frequency analysis on the reasons for coal mining accidents. The reasons include managerial and workers' unsafe behaviors. Table 2 illustrates the frequency analysis of managerial factors.

TABLE 2
Frequency Analysis of Managerial Factors

Reason for accident	No. of cases	Frequency
Inadequate safety technology and equipment	132	66.0%
Management disorder	122	61.0%
Incompetent management	93	46.5%
Taking risks in production	74	37.0%
Inadequate training and education	74	37.0%
Illegal production	72	36.0%
Irrational production layout	67	33.5%
Putting production targets before safety standards	66	33.0%
Incompetent management in group companies	64	32.0%
Indifference to former accidents	51	25.2%
Negligence in duty	48	24.0%

Nearly two thirds of the accidents are attributable to management reasons, such as management disorder and incompetent management. Management disorder is classified into subcategories (Table 3): disorder in labor and organizational management, safety management, aeration management, electromechanical management, gas and coal dust management, technology management, equipment management, *Yitongsanfang* management (management in aeration, prevention and cure in gas, coal dust, and fire), and general management. 38.52% percent of accidents fall into at least two of the subcategories.

TABLE 3
Specific Categories of Management Disorder

Management disorder category	No. of cases	Frequency
General management	30	24.60%
Aeration management	29	23.77%
Safety management	28	22.95%
Electromechanical management	20	16.39%
Technology management	17	13.93%
Gas or coal dust management	15	12.30%
labor and organizational management	15	12.30%
Equipment management	10	8.20%
Yitongsanfang management	9	7.38%

Training and education are the most common HRM-related factors in the cases. Ineffective training and education exist in 37% of all accidents. Inadequate safety education was found in 27.5% of cases, while inadequate new worker orientation and training occurred in 15.5%. (for example, in Xieyi Coal Mining Firm, Anhui Province, inadequate training was the major reason for an accident on June 23, 1995. Among new workers, 98 of them were recruited to the firm on May 25, 1995, and were immediately sent into underground coal mines without any orientation and training. The other 390 workers had a training period of only days.) Inadequate onsite training was found in 23.5% of cases. Workers in specialized positions (e.g., gas explosion worker, gas examiner) do get training adequate to meet their safety needs.

Incompetent management includes, among other things, problematic management, ineffective management, lack of management overall, and lack of implementation of management rules. For example, an accident happened in Hejiashe Coal Mining Firm in Liulin District, Shanxi Province on December 2, 1996.

At the time, there was no stable leadership team—managers were changed several times. The managers did not have clear responsibility with regard to management of the firm, and they failed to address existing hazards. Incompetent management in group companies is also a managerial factor (group company refers to a larger company that the coal mining firm belongs to). To minimize management costs, group companies often contract out their subsidiary firms to individuals. After that, they do not take any measures to manage the firms.

Other managerial factors also account for the accidents. Illegal production includes exploitation in closed mines, or mines without certificates and licenses, and illegally buying and selling powder, etc. Irrational production layout is a manifestation of improper working conditions. Putting production targets before safety standards means managers put economic interests first and neglect worker safety and well-being. That is because in some areas of China, coal mining firms are the mainstay of economic development; they contribute significantly to income, employment, and taxation in the local area.

Indifference to former accidents occurred at the Chenjiashan Coal Mining Firm in the Tongchuan Bureau of Mines, Shaanxi Province. On November 24 and 25, 2004, a working area caught fire. Managers did not address the situation and continued production at nearby work areas, which caused a severe fatal accident three days later.

We next calculated the frequencies of workers' unsafe behaviors. Here we should mention a specialized type of worker. Specialized work in coal mining industry refers to work that may affect the safety of operators, other workers, and the surroundings. Examples include workers such as gas examiners, electric technicians, etc. Due to the uniqueness and danger of their job, the behavior of these workers can have a greater impact on occupational safety than that of frontline employees. As shown in Table 4, workers in specialized positions who disobey rules or regulations account for nearly one quarter of all accidents. Other factors related to unsafe behavior include inadequacy and turnover (leaving jobs) of specialized workers and those without job certificates, all of which mean that workers are not capable in accomplishing job tasks in a safe way. Inadequate training cannot satisfy workers' technical and safety needs.

TABLE 4
Frequency Analysis of Unsafe Behaviors
by Workers in Specialized Positions

Reason for accident	No. of cases	Frequency
Disobeying rules or regulations	45	22.50%
Incompetent workers	34	17.00%
Lack of job certificate	28	14.00%
Inadequate training	21	10.50%
Leaving position (turnover)	18	9.00%

Table 5 summarizes the frequency analysis of frontline mining workers' unsafe behaviors. Nearly one half of accidents were attributed partially or wholly to workers who disobeyed rules or regulations, such as incorrectly operating equipment, or who disobeyed rules banning smoking, bringing lighters to underground mines, and sleeping—or even cooking—in the mine. Low quality and lack of safety knowledge reflects the fact that firms often illegally recruit many temporary workers. The lack of self-rescue equipment is also an unsafe behavior. Some firms do not have enough self-rescue devices; others have them only for image protection when being checked for compliance.

TABLE 5
Frequency Analysis of Frontline Mining Workers' Unsafe Behaviors

Reason for accident	No. of cases	Frequency
Disobeying rules or regulations	96	48%
Low quality and shortage of safety knowledge	53	26.50%
Low level of safety consciousness	47	23.50%
Lack of self-rescue equipment	22	11%

Next we conducted regression analysis on OSH performance. We first regressed on the death toll; the results are shown in Table 6. Model 1 checked the effects of firm and accident idiosyncratic variables. These variables explain 33.1% of the variance of death toll ($F = 19.234$, $p < 0.001$). Ownership does not have a significant effect on death toll. Time period 1 is significantly related to death toll ($\beta = 0.459$, $p < 0.001$), and time period 2 is significantly negatively related to death toll ($\beta = -0.223$, $p < 0.001$). That means accidents between 1950 and 1979 had a higher average death toll, while accidents between 1980 and 1999 had a lower average death toll, which is in line with our prior descriptive analysis. In Model 2, ineffective HRM practices were positively related to death toll in accidents ($\beta = 0.127$, $p = 0.031$). In Model 3, workers' unsafe behaviors had significant effect on death toll ($\beta = 0.181$, $p = 0.003$).

Then we put firm and accident idiosyncratic variables, ineffective HRM practices, and workers' unsafe behaviors together into Model 4. Those can explain 36.6% of the variance of death toll ($F = 15.834$, $p < 0.001$). Workers' unsafe behavior still had a significant effect on death toll ($\beta = 0.154$, $p = 0.018$). However, the relationship between ineffective HRM practices and death toll was not significant ($\beta = 0.072$, $p = 0.247$). Therefore, worker safety behaviors mediate the relationship between ineffective HRM practices and death toll.

TABLE 6
Regression Results on the Death Tolls

	Model 1	Model 2	Model 3	Model 4
State-owned major	0.016	0.015	–0.025	–0.019
State-owned local	0.058	0.056	0.025	0.028
Collective	0.003	0.003	–0.035	–0.029
Time period 1	0.459***	0.465***	0.424***	0.433***
Time period 2	–0.223***	–0.213***	–0.241***	–0.233***
Ineffective HRM practices		0.127*		0.072 n.s.
Workers' unsafe behaviors			0.181**	0.154*
R^2 (adj. R^2)	33.1% (31.4%)	34.7% (32.7%)	36.2% (34.2%)	36.6%(34.3%)
F change	19.234	17.12	18.215	15.834

N = 200
*p < 0.05, **p < 0.01, ***p < 0.001

Similarly, we conducted regression analysis on the death rate per million tons of coal production (Model 5), direct economic loss (Model 6), and the ratio of death toll to the total number of employees (Model 7). Results are shown in Table 7. We found no significant effects of ineffective HRM practices and workers' unsafe behaviors on dependent variables in either model. Some reasons for this are as follows: The measurement of the death rate per million tons of coal production is not accurate—some coal mining firms did not report their actual production capacity, so we use ratified production capacity for those missing

values. Also, direct economic loss might be related with other variables, such as technical conditions and accident type. Finally, the sample size is not adequate in Model 7.

Only firm and accident idiosyncratic variables have significant effects in these models. For example, in Model 5, the ownership of state-owned major coal mining firms is significantly negatively related to death rate ($\beta = -0.409$, $p < 0.001$), and so is the ownership of state-owned local ones ($\beta = -0.235$, $p < 0.5$). In Model 6, the ownership of state-owned local coal mining firms is positively related to direct economic loss ($\beta = 0.204$, $p < 0.5$), and time period 2 is positively related to direct economic loss ($\beta = 0.304$, $p < 0.001$). In Model 7, state-owned local and collective coal mining firms have a lower ratio of death toll over the total number of employees than private coal mining firms.

TABLE 7
Regression Results on the Death Rate per Million Tons of Coal Production, the Ratio of Death Toll to Total Number of Employees, and Direct Economic Loss

	Model 5	Model 6	Model 7
State-owned major	-0.409***	–0.037	–0.708
State-owned local	–0.235*	0.204*	-0.385***
Collective	–0.048	0.035	-0.095***
Time period 1	0.118	0.057	0.061
Time period 2	0.009	0.304***	–0.065
N	179	145	112
R^2 (adj. R^2)	12.9% (10.4%)	14.3% (11.2%)	49.8% (46.4%)
F change	5.135	4.631	14.758

Cases with missing values were deleted (pairwise) for regression analysis.
*p < 0.05, **p < 0.01, ***p < 0.001

Conclusion and Discussion

This endeavor is the first to systematically investigate accident causes based on content analysis of accident cases. It empirically analyzes the human factors that directly or eventually cause fatal accidents in coal mining workplaces. Managerial factors serve as the major reasons. Almost every accident was caused by human factors. Ineffective HRM practices lead to unsafe working conditions in the workplace, and thus affect OSH performance. To change the poor safety performance record in China's coal mining industry, managers should take responsibility and make more efforts in training and education, recruiting and assigning competent workers, and building a harmonious relationship with workers. Workers' unsafe behaviors can also influence OSH performance. Worker disobedience of rules or regulations, lack of safety knowledge, and lack of self-rescue equipment are linked with higher death tolls. Also, ineffective HRM practices can induce workers' unsafe behaviors, which, in turn, invites accidents. Therefore, HRM practices should be targeted to preclude the unsafe behaviors of workers.

Our study shed some light on the relationship between ownership and OSH performance. Although no significant difference was found in death tolls among different types of ownership, state-owned firms have a lower death rate per million tons of coal production than collective and private ones. State-owned and collective local firms have a lower ratio of death toll per total number of employees than private firms. On the whole, SOMs have better safety performance than TVMs, and the reasons are as follows: Compared to TVMs, SOMs have relatively stronger economic power and are able to utilize more resources to ensure safety. They have clear organizational settings and have units specializing in OSH (e.g., training departments and rescue departments). In addition, they are more strictly supervised by national institutions and care more about firm reputation, as some of them are listed firms.

This study used a theoretical model to analyze mechanisms of coal mining accidents. To prevent accidents in the workplace, all the human resources practices should systematically be put in the right place.

Our study has important practical implications for managers and supervision institutes. Managers should pay close attention to HRM practices and other managerial factors. This study also has limitations, however. Without a control group of coal mining firms with good safety records, we cannot detect the real effects (magnitude) of human factors. Future research should focus more on the dynamic process of HRM and OSH within the firm. More research should examine how and why the type of ownership effects worker safety. Further examination should be conducted on the mechanism through which HRM impact OSH (e.g., employee motivation, knowledge, skills, abilities, and the workplace environment). Likewise, different levels of analysis should be considered (e.g., individual, organizational, group levels in hierarchical linear modeling).

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Endnotes

[1] All the macroeconomic measures in this paper are calculated based on the related statistics issued by the State Bureau of Statistics (http://www.stats.gov.cn/tjsj/).

[2] These death toll numbers are calculated from the annual reports by the State Administration of Work Safety and the State Administration of Coal Mine Safety (http://www.chinasafety.gov.cn). Considering the fact that some coal mining employers have a strong incentive to cover up fatal accidents in order to avoid legal as well as economic penalty, we treat these official reports as underestimates.

[3] According to the ILO Statistics (http://www.ilo.org/global/Themes/Safety_and_Health_at_Work/), there were about 27,000,000 accidents that resulted in 16,000,000 incidents of work-related diseases and injuries, which in turn claimed at least 2,000,000 lives worldwide each year, of which 22,000 were children.

[4] It is not completely accurate to classify these scholars as domestic, since some of them are working overseas.

[5] An especially severe accident is one in which more than 30 people are killed, more than 100 people are severely injured, or an economic loss of over 100 million yuan is caused. A severe accident is one in which 10 to 30 people are killed, 50 to 100 people are severely injured, or an economic loss of 50 to 100 million yuan is caused. A big accident is an accident in which 3 to 10 people are killed, 10 to 15 people are severely injured, or an economic loss of 10 to 50 million yuan is caused. A normal accident refers to an accident in which fewer than 3 people are killed, fewer than 10 people are severely injured, or an economic loss of less than 10 million yuan is caused.

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