Comparative Study on Coal Mine Safety between China and the US from a Safety Sociology Perspective

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Abstract

China and the US are of the two largest coal producer and consumer, but China lags far behind the US in regards of coal mine safety. After viewing the comprehensive attribute of safety science, by adopting historical and international comparison method, and following the aspects of coal mine safety, the two countries are compared in detail including safety production, safety investment and input, safety training and dissemination and safety regulation and legislation from a safety sociology perspective. Finally, by summarizing the features of totalistic and regulatory state, the necessity of the establishment of regulatory government was expounded for coal mine safety in China. By learning the advanced experiences from the US, the present status of coal mine safety in China was recognized, so as to provide references for the development of coal mine safety of China in future.

Keywords: safety sociology; perspective; the science of safety science; comparative study; coal mine safety; China; the US

1. Introduction

China is now the largest coal producer and consumer in the world with an estimated more than five million coal miners employed in the industry. As the dominant source of energy, China’s coal sector underlies China’s economic and social development. However, with the fatality rate 10 times higher than in other developing countries (i.e. India, Russia) and 100 times higher than in the US coal industry, coal mine safety is a serious problem and is regarded as a top priority for nationwide workplace safety.

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Likewise, the United States is one of the largest coal producers and consumers in the world, but with regards to coal mine safety production, the United States is far ahead of China. In recent years, the annual coal output in the US steadily remains 1.0 billion ton or so, with annual fatalities within 30 under control.

The frequent happening of mine disaster is largely due to inadequate management, weak enforcement of legislation and policies, lack of safety awareness among the mining communities, poor involvement of government, civil social organizations and the private sectors, and insufficient safety education, etc. These factors basically fall into the category of sociology. Therefore, it is feasible to study coal mine safety from a safety sociology perspective.

Based on the principles of Sino-foreign comparison method, this article is going to conduct a comparative research on coal mine safety between China and the US, to discover similarities and differences and recognize the present status of coal mine safety in China, and to learn from the advanced experience of the US, so as to provide insights for the safety development of coal mine in China.

2. Brief summary of safety sociology and comparative safety science

2.1. Safety sociology—an effective approach to the non-quantifiable research of complex safety problems

Safety sociology views safety science and technology as a social phenomenon and social constitution and regards “human, society, technology and nature” as a unified research object. Not only is how to apply engineering methods to technology to conduct the planning and management of sociology of its own being explored, but it probes into the coordination of the development of human, society and nature.

It is argued by many scholars that when investing the causes of safety accidents, the focus has now shifted away from technical level to other factors such as decision-making, supervisory factors and organizational culture. This change in emphasis has resulted in safety sociology frameworks and accident investigation schemes being developed that investigate and categorize the organizational factors and psychological precursors surrounding the accident in an attempt to develop a more complete understanding of the circumstances and hence aid in the development of effective prevention strategies. [1]

2.2. Comparative safety science—the breakthrough point of safety science research

From the perspective of defending human against potential external hazards, with the principle of creating favourable conditions to safeguard human health in the production, living and survival processes, comparative safety science is a safety science methodology of making a control study among events, objects, environment, human behaviours, social culture and knowledge of different spaces, thus revealing their similarities and differences, and providing references and mutual infiltration [2].

Mining remains one of the most hazardous occupations worldwide and underground coal mines are especially notorious for their high accident rates. This chapter provides a solution to address coal mine safety issues. Based on the principal line of time, some aspects of coal mine safety in China and the US are studied. The methodology used in this study consists of an integration of content analysis technique in G.Z.F Bereday’s comparative model, using the stages of (i) description, (ii) interpretation, (iii) juxtaposition and (iv) comparison for data collection and comparison, and “3E” principle in accident prevention-Engineering, Education and Enforcement, coupled with the auxiliary use of historical analysis, documentary and system analysis methods. [3]

3. The comparison of safety production conditions of coal mine in China and the US

3.1. A comparison of annual output
China’s coal reserves account for about 11% of the total amount worldwide and coal energy comprises 87.4% of the conventional energy. The US is rich in its coal reserves, it is estimated that the proven coal reserves of the US top the world. The development trend of the coal annual output since 2000 of the two countries can be seen in Fig. 1. (Source: Administration of Work Safety of China, US Mining Safety and Health Administration)

Fig.1 Comparison of coal reserves in China and the US in the past decade

Fig.1 shows that China's annual coal production keeps a rapid growth rate; the US’s annual output maintains stable at 1 billion tons, approximately 1/2 of China's average annual production.

3.2 Fatalities contrast

In the past 10 years, new achievement was reached in the safety production of China’s coal mine. The situation of national coal mine safety production is generally stable and is getting better, with death rate per million ton (DPRMT) declining, as shown in Figure 2. (Source: Administration of Work Safety of China, China Coal News, Coal Mine Safety Net)

Fig.2 Coal mining DPRMT in China in recent years
Table 1 shows the evolution of the number of fatalities coal mining industry between 2000 and 2009 in China and the US. In 2009, the number of fatalities in the US is 18, whereas that number is 2,631 in China, 146 times as many as that of the US. A decreasing trend in fatalities in China is noticeable in the figure, but the number of fatalities still count tens of times more than that of the US.

Table 1 Contrast of death toll and death rate per million ton (DRPMT) of coal mine in China and the US

| Year | Coal mining fatalities | Coal mining DPRMT |
|------|------------------------|-------------------|
|      | China                  | the US | China/US | China | the US | China/US |
| 2000 | 5,798                  | 38     | 153      | 6.096 | 0.040 | 152      |
| 2001 | 5,670                  | 42     | 135      | 5.070 | 0.040 | 127      |
| 2002 | 6,995                  | 27     | 259      | 4.640 | 0.028 | 166      |
| 2003 | 6,702                  | 30     | 223      | 4.170 | 0.031 | 135      |
| 2004 | 6,027                  | 28     | 215      | 3.080 | 0.027 | 114      |
| 2005 | 5,938                  | 23     | 258      | 2.810 | 0.021 | 134      |
| 2006 | 4,746                  | 47     | 101      | 2.041 | 0.040 | 51       |
| 2007 | 3,786                  | 33     | 115      | 1.485 | 0.029 | 30       |
| 2008 | 3,215                  | 29     | 111      | 1.182 |       |          |
| 2009 | 2,631                  | 18     | 146      | 0.892 |       |          |

Calculated from Table 1, the average number of annual fatalities in coal mine production in China is nearly 5,000 in the past decade, more than the total number of death toll in other coal mining countries worldwide. The local decreasing fatalities trend in China however should not be considered a robust indication of safety improvements in this industry, compared with developed countries, the index of DPRMT is still too high. [4]

4. The comparison of safety investment and input of coal mine safety in China and the US

The insufficiency of safety investment in coal mine is one of the main causes of safety accidents and safety input is among the “five factors” in the safety production. From the facet of safety value engineering in safety sociology category, coal mine safety investment refers to the cost of the total in all the human, materialistic and financial activities to guarantee the normal process of safety production and other operating activities in coal mines.

The US federal government authorizes the Mining Enforcement and Safety Administration (MESA) to take charge of the financial budget, through such integrated approach as enforcement and legal standard support by Mining Safety and Health Administration (MSHA) to safeguard the safety and health of miners. In 2000, the budget quota reached about 228 million dollars, an increase of 17% over that in the year 1994.

Since the 1980s, the former State Economic Commission of China had allocated a special fund of RMB 80 million to Coal Department as the special fund. From 1988, the special funds had been replaced with the “maintenance premium”—an extra charge of RMB 0.5 yuan on the selling of one ton of coal, keeping the total sum at RMB 50 million each year. In 1992, the “maintenance premium” had increased to RMB 1 yuan per ton. Special fund played an active role in the improvement of mining safety. Since 1993, with the expansion of the autonomy of coal enterprises, a severe shortage of coal mine investment had ensued. According to the 9th Five-Year Plan for National Economic and Social Development (1996-2000), RMB 4,200 million should be invested in the industry in total, or an average of RMB 840 million each year, whereas the actual amount that had been put into was merely RMB 400 million, less than half of the total amount as previously estimated. [5]
Besides, the investment of safety supervision in China is severely insufficient. The budget of safety supervision in China is only 1/60 as much as that of the US, whereas the number of employee is 5 times more.

5. The comparison of safety training and dissemination in coal mine industry in China and the US

Safety education plays an indispensable role in safety development and is the main route to the implementation of human resources strategy, technology innovation and the training of safety personnel.

The US attaches great importance to the safety training work of relevant governments, coal mine personnel and miners. The accident investigation reports and safety manuals in the 1970s in the US showed that 85% of the accidents were caused by the unsafe behaviours of miners. It is regulated by law that new miners must attend a training of less than 40 people and a 90d of post internship, offering 35 people’s off-job training every year thereafter. [6] Training is required in the event of miner replacement. According to the Federal Coal Mine Health and Safety Act, if miners are found not adequately receiving safety training, the Labour Minister or other representatives can announce the miner being a danger to other miners, require his immediate withdrawal from the coal mine and prohibit his entering to the coal mine until safety training is received by regulation. Training programmes and training arrangements of coal miners should be made under the requirements of laws and regulations and miner’s training qualifications must be recorded in each coal mine in the US.

According to the Article 26 of the Mine Safety Act of China, mining industry must carry out safety education and training to miners, and miners may not be allowed to take up a post of duty without proper safety training. The Article 40 stipulates that for any mining enterprise which is not properly conducting the training work, the labour administrative department is entitled to order the correction, require monetary penalties for all violations, and establish criminal penalties for knowing and wilful violations, and what’s more, administrative sanctions will be taken against severe cases. Relevant regulations about the employee training are also made in the Labour Law. [7]

The manipulability and binding force of the safety training term in the mining industry in the US is much stronger and safety trainings are enforced in accordance with law. While in China, the ratio of personnel who have received safety trainings in coal mines is quite low, especially in small ones, but they have not been subjected to civil penalties. The contrast of the two countries can be seen in Table 2.

Table 2 Contrast of safety training and dissemination in China and the US

| Country | Safety values and attitudes | Form | Popularity | Resources input |
|---------|-----------------------------|------|------------|-----------------|
| The US  | Positive attitude, "I want to be safe" | Diversified and well-targeted form with an emphasis on practice and pass through assessment | Voluntarily offer training at the outset of miners’ entering the coal mine; profound dissemination at the organizational level | Special financial budget available, specific safety training and education administration are established under MHSA |
| China   | Negative attitude, "Want me to be safe" | Being a mere formality; lacking pertinence. | Mandatory enforcement of safety training until accident happens. | Lack of resources, specific training fund and authorities are not available |

6. The comparison of legislation and supervision of coal mine safety in China and the US

Legislation and supervision is the mandatory enforcement measure. The achievement in coal mine safety in developed world is inseparable from its complete legislation and enforcement system. China has
also formulated a series of laws, regulations, and supervision in the safety production of coal mines, but the legal and supervision system framework remains to be perfect.

6.1 Contrast of established laws and regulations

Focusing on coal mine safety, the US has successfully enacted more than 10 laws. In 1891, the US Congress passed the first federal statute governing mine safety, marking the beginning of what was to be an extended evolution of increasingly comprehensive federal legislation regulating mining activities. The Federal Coal Mine Health and Safety Act of 1969, generally referred to as the Coal Act, was more comprehensive and more stringent than any previous federal legislation governing the mining industry. The Coal Act included surface as well as underground coal mines within its scope, required two annual inspections of every surface coal mine and four at every underground coal mine, and dramatically increased federal enforcement powers in coal mines. The safety standards for all coal mines were strengthened, and health standards were adopted. Then, the Congress passed the most supreme Federal Mine Safety and Health Act of 1977 (Mine Act), the legislation which currently governs MSHA’s activities. The Mine Act amended the 1969 Coal Act in a number of significant ways, and consolidated all federal health and safety regulations of the mining industry, coal as well as non-coal mining, under a single statutory scheme. The Mine Act strengthened and expanded the rights of miners, and enhanced the protection of miners from retaliation for exercising such rights. [8]

China’s first operational regulation on coal mine safety was issued in Oct. 1950. Since then, other laws, regulations and standards were successively promulgated on safety problems by coal mine industry and other relevant departments. Some momentous ones are listed as follows:

- Mining Safety Law of 1992 with a purpose of protecting the safety of coal mine and quarry workers.
- Coal Act of 1995 marked the ending of the legal history of China without special coal laws.
- Mine Safety Supervision Regulations of 2000 provided a legal basis for safety supervision and inspection of coal mine industry.
- Production Safety Law of 2002-the first comprehensive law with an emphasis on workplace safety.

The legislation systems of coal mine in the US is more complete, with a characteristic of strong operability and reasonable regulation. Laws in China are numerous to enumerate, but these laws are too superficial and ambiguous, with week operability. The current law system in China lacks legal punishment and is not effective in implementation. The contrast can be seen in Table 3.

Table 3 Contrast of legislation system in China and the US

|                | Integrity                              | Operability                                      | Supervision mechanism                      |
|----------------|----------------------------------------|--------------------------------------------------|--------------------------------------------|
| **The US**     | Whole system strict and integral;      | Clear and feasible legal clauses; specification  | Third party supervision-                    |
|                | supporting regulations and details of  | of organization, personnel and responsibilities;| Labor Department responsible for supervision task. |
|                | implementation available.              | technical regulations and standards up to the    |                                            |
| **China**      | "Production Safety Law" oriented;  | Standards far from meeting production needs,     | Unsound mechanism; “State supervising, local controlling, |
|                | the lack of sound supportive regulation| inadequate legal status of some provisions;      | corporate charging”, third party supervision not carried out. |
|                | resulting in a lack of operability in  | mining safety supervision system not established |                                            |
|                | practice and a poor restrictive effect | under Production Safety Law; safety standards not |                                            |
|                | on the safety production behaviors.    | included into law.                               |                                            |


6.2 Contrast of supervision system

After the most severe coal mine accident in 1907, US Congress established the Bureau of Mines as a new agency under the Department of the Interior in 1910. The Bureau is charged with the responsibility to conduct research and to reduce accidents in the coal mining industry. In 1913, the Department of Labor was founded, which is also responsible for occupational safety and safety production management. Founded in 1977, the Mine Safety and Health Administration (MSHA) is an agency of the US Department of Labor which administers the provisions of the Federal Mine Safety and Health Act of 1977 (Mine Act) to enforce compliance with mandatory safety and health standards as a means to eliminate fatal accidents, to reduce the frequency and severity of nonfatal accidents, to minimize health hazards, and to promote improved safety and health conditions in the nation's mines. Since then, the US has established a more complete supervision system. Mining is regulated by MSHA, which employs nearly one safety inspector who has no affiliation with any mine industry for every four coal mines. Underground coal mines are thoroughly inspected at least four times annually by MSHA inspectors. In addition, miners can report violations, and request additional inspections. Miners with such concerns for their work safety cannot be penalized with any threat to the loss of employment. [9]

In 1949, China established the Safety Supervision Administration under the Ministry of Industry. Contrary to the US, China’s safety inspectors in coal mines are the conversion of relevant personnel in coal industry and the monitoring agencies are subordinate division of safety production units at administrative level. Thus they are closely related to coal mines and are under interference by local protectionism, which can not be able to independently carry out the supervision work. Founded in 2000, the State Administration of Coal Mine Safety is in charge of the country’s coal safety. In 2005, the State Administration of Coal Mine Safety is transferred responsibility for carrying out its mandates to the State Administration of Work Safety. [10] The comparison of the two countries can be seen in Table 4.

Table 4 Situation of safety supervision agencies and personnel in coal mines in China and the US

| Agencies | Date of establishment | The number of staff | The number of supervisor | Affiliation relationship of the supervisor and coal mine |
|----------|-----------------------|---------------------|-------------------------|-------------------------------------------------------|
| The US   | Department of Labor-MESA-CMESA-Regional Supervision Administration | In 1978 | 23,17 (610) | No affiliation with coal mines |
| China    | State Economic and Trade Commission-State Administration of Coal Mine Safety-Regional Coal Mine Safety Office | In 2000 | 160 | 15 (2800) |

Note: ① Data of 2000; ② the number of safety supervisors in coal mine; ③ ombudsman of Coal Mine Supervision Administration; ④ authorized strength of safety supervisor in coal mine nationwide.

7. Comparison of totalistic state and regulatory state

Tang Tsou, China, put forward the term of totalistic state (1994), which summarized the relationship between society and economy in China in the 20th century. Totalism is a political system where the state recognizes no limits to its authority and strives to regulate every aspect of public and private life wherever feasible. Totalitarian regimes stay in political power through an all-encompassing propaganda disseminated through the state-controlled mass media, a single party that is often marked by personality cultism, control over the economy, regulation and restriction of speech, and mass surveillance.

As typical regulatory state, the US relies largely on market mechanism to allocate resources to pursue the enterprises’ independent operation, even if public services provided by government must be utilized,
the government procurement way is often adopted to achieve this end. Regulatory state emphasizes on separation of operations from policy making and greater use of free-standing regulators. Government’s intervention in economy is implemented by independent regulatory agencies, which are mainly operated by administrative staffs with expertise and professional regulation over industries in an open procedure in accordance with the law. [11] Contrast can be seen in Table 5.

Table 5 Contrast of totalistic state and regulatory state

| Range of intervention | Totalistic state | Regulatory state |
|-----------------------|------------------|-----------------|
| Nature of regulations | Administrative instruction | General law |
| Implementation of regulations | The regulated | Regulator and the regulated |
| Position of executor | Internal | External |
| Mode of execution | Paternalistic, through persuasion and administration penalties | Modernistic, through fine and criminal penalties |

Since the establishment of the first federal regulatory agency, regulatory agencies play an enhancing role in economic operation and social development in the US. From the paradigm of efficiency and governance, regulatory state (government) has become the inevitable choice for the development of modern countries to deal with issues in multitude arenas. In terms of mine safety issues, the government of China has to transform its original management mode. The outcome of this strategic adjustment to adapt to new situations is the shrink of interventionist government and the rise of regulatory government.

8. Conclusions

Through the above comparative analysis of coal mine safety in China and the US from all aspects in safety sociology perspective, some causes of the severe status quo of the safety production in China’s coal mine were explored and the successful experience should be drawn from the US for reference, to advance some proposals to improve China’s coal mine safety.

(1) China and the US are both countries of abundant coal resources and the coal resources still occupy a large proportion of the total energy consumption. The US coal industry has evolved out of the high accident frequency period; China's coal production safety has improved over the past 10 years, but the fatality rate is still tens of times than the developed world.

(2) Stable and sufficient financial budget is integral to the safety supervision and scientific research of coal mines. Special safety budgeting fund should be established in China’s coal mine sector and Chinese government should appropriate subsidies and strengthen safety investment and management in coal mine industry.

(3) Safety training in the US coal mine sector is a kind of voluntary one which emphasizes on the dissemination of safety culture in diverse forms. Coal mine safety education in China is carried out by compulsory enforcement. Perfection of safety training system and the regular updating of training contents are needed in China’s mining industry. China should enhance the quality building of coal mine personnel and cultivate staffs’ the awareness of safety production by the dissemination of safety of safety culture.

(4) Compared with the US, laws and regulations of coal mine are established relatively late in China and the system is imperfect and fragmented. Government should actively intervene to further enhance the surveillance and independence of supervision agencies to perfect the legal system in China.

(5) More than something inside an enterprise, coal mine safety has become a social problem coal mine safety production falls into the category of social regulation. Due to different social structure, China has a
stronger intervening impact on the production than the US. In recent years, safety supervision mode of China’s coal mine has gradually shifted from self-rectification to implementation by a third party, which represents a great progress. The replacement of the totalistic government must be a regulatory government to safeguard human, nature and production organization in a more automatic and sound way in coal mine sector.

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