Discussion Paper, Series A, No.2014-277

"Mine safety and Industrial accidents at the Générale des Carrières et des Mines, in Katanga, Democratic Republic of Congo"

John Ngoy Kalenga

11.2014

Graduate School of Economics &
Business Administration
Hokkaido University
Kita 9 Nishi 7, Kita-Ku, Sapporo 060-0809, JAPAN

"Mine safety and Industrial accidents at the Générale des Carrières et des Mines, in Katanga, Democratic Republic of Congo"

John Ngoy Kalenga[1], Candidate at Graduate School of Economics and Business Administration, Hokkaido University, Sapporo, Japan.
Address: Kitaku, Kita 9 Nishi 7, Sapporo 060-0809 Japan. Tel: (+81) 011-706-2792, Fax: (+81) 011-706-4947.

Abstract

This paper focuses on the workplace accidents of Gecamines in a comparative perspective. Copper industry has been the cornerstone of Congolese economy since the colonial era. Katanga province is well known for its reserves of copper and cobalt. Many accidents occurred in mining operations of Gecamines. We collected data of accidents from 1957 to 2008 during the fieldwork at Gecamines. Data of this study included only the accidents that required the miner to be absent from work for at least four calendar days. This study aims to determine factors of the accidents at Gecamines in order to suggest the policy to prevent the occurrence of accidents. The results show that miners at Gecamines were more exposed to the risk of accidents than their colleagues of similar industries in Australia, Canada and the United States of America. The average frequency, severity and number fatalities per year of Gecamines were 48, 3, and 9, respectively. These statistics were higher than those of the aforementioned three countries. Gecamines cared for the injured miners thus increasing the operating cost. These results imply that mine safety and working conditions at Gecamines should be improved to reduce the occurrence of accidents. The reduction of accidents should be achieved by training of miners and instauration of inspectors in charge of safety.

Keywords: Mine safety, accidents, Gecamines, Katanga, Copper industry, Autoregressive model.

1. Introduction

[1] PhD Candidate at Graduate School of Economics and Business Administration, Hokkaido University, Sapporo, Japan. Email: jnkalenga@econ.hokudai.ac.jp

This paper investigates mine safety and accidents from 1957 to 2008 of the Générale des Carrières et des Mines (Gecamines). Gecamines is a Congolese state-owned company that produces copper, cobalt and zinc as the main products. The mining industry contributes 25 % to Congolese gross domestic product. The quantity of output is well known while the issue of industrial mining safety and injuries has not been investigated by researchers. This work aims to identify determinant factors that lead to accidents at Gecamines in order to reduce them. The fifty years of activities cover two successive periods of the company's ownership. From 1906 up to 1967, the Union Miniere du Haut Katanga (UMHK) was a Belgian mining firm operating in Katanga province (D'Ydewalle, 1960). In 1967 the Congolese government nationalized the assets and liabilities of the UMHK by creating the Gecamines (Saquet, 2000). This study investigates the following research questions: What are the principal determinants of accidents at Gecamines? How can Gecamines reduce the number of accidents? How safe were working conditions at Gecamines in comparison to international experience? We build on the hypothesis that lost workdays are mainly due to accidents. Gecamines can improve safety on work place by reducing lost work hours in order to prevent accidents.

The mechanization of extraction and refining processes at the UMHK increased dramatically the fatality rates and accidents between the two World Wars (Dibwe, 2001). Congolese miners were not well trained to handle industrial machines in copper and cobalt production. Thus, industrial Katanga has been known as the land of death due to unsafe working conditions in copper industry.

The department of safety of UMHK was created to reduce the number of accidents and to create a safe work place. This department has changed its structures successively. In 1957 it was a service named the Work Safety Organization (Katanga, 1957). In 1973 it became the Direction of Work Safety composed of services (Gecamines, 1973). The restructuring of Gecamines in 1984 created three groups including Gecamines exploitation, Gecamines development, and Gecamines Commercial. The Direction of Work Safety belonged to the Gecamines Exploitation Group because work accidents occur mainly in extraction, concentration and refining activities (Gecamines, 1985). In 1994 Gecamines reunified the three groups together and the Direction of Work Safety

maintained its statute as a direction (Gecamines, 1995). In 1998 the direction changed into the Department of Hygiene and Work Safety (HST) that extended the structure of the department into divisions and services (Gecamines, 1998). The administration restructuring in 2012 changed the department of Hygiene and Work Safety into the Direction of Work Safety in order to reduce the labor force (Gecamines, 2012).

All employees prefer to be safe in their work. Whenever it is possible they try to avoid any risk and danger that expose them to accidents, unless they have a dangerous profession. Although the expectation of people is to work in safe conditions, accident can and do occur. The United Nations International Labor Organization (ILO) reported that more than 300,000 employees die every year in accidents that occur at workplace (Duffey and Saull, 2003).

The mining industry is a high risk activity that requires huge financial resources and long years of patience before the project generates the return on investment for its shareholders. Mining is known as one of the most hazardous work environments in the world. For instance, in the United States of America the risk to be killed and injured is six times and double in mining than in other general industries respectively (Dhillon, 2010). The indicators of industrial safety that include frequency rates, severity rates, fatality rates, and time lost rates are higher in mining than in other industries (Sari, et al., 2004). A work accident or occupational accident is an incident that occurs in the course of work. It may lead to physical or mental harm such as injury, disease, or death (Cheremisinoff, 2001). The Congolese labor legislation considers the commuting accidents (accidents on the way to work and while returning home after work) as work accidents (Congo, 2002). A fatal accident at work is an accident that leads to the death of a victim immediately or sometime after the occurrence of accident.

The Congolese regulation requires mine operators to report to the National Institute of Social Welfare, a department of Ministry of Labor, all severe accidents that require the victim to rest for four days and more. Gecamines applies the criterion of four days to distinguish severe from minor accidents.

2. Materials and methods

Gecamines maintained a chronological data of accidents in internal reports and

documents which were kept at the Direction of Work Safety. These empirical data were not opened for public access because of the confidential character of information they contained. This study analyzed only the accidents that required the miner to be absent from work for at least four calendar days which was the criterion applied at Gecamines in analysis of severe work accidents. We collected data of work accidents during our field works in March and September 2012. Our choice of Gecamines was motivated by the availability of complete, detailed and reliable archives of work accidents. This study analyzed chronological data of accidents at Gecamines for fifty one years.

The European Statistics on Accidents at Work (ESAW) in its scope of data collection considered only work accidents that have four lost days due to absence from work, excluding the day of the accident. This implied that only if the victim resumed work on the fifth working day after the date on which the accident occurred should the incident be included (Eurostat, 2012). The European Union criterion of data collection was similar to that we applied to data collected at Gecamines for analysis in the present study.

We compared the frequency, severity and fatality rates of Gecamines with other countries where mining industry plays an important role in their economies. Before doing a direct comparison it should be reminded that all nations do not make their data of accidents and fatalities publicly accessible. We selected three countries including the United States of America, Australia and Canada. The Mine Safety and Health Administration, an office of the Department of Labor in the United States of America keeps a reliable data base of national accidents and fatalities. Data of fatalities occurred in operations of extraction and processing of metal and nonmetal minerals in the United States of America were retrieved from this data base for the period 1993 to 2008 in order to make the comparison with those of Gecamines. Data of frequency, severity and fatalities in Australia were collected from the annual reports of the Western Australia Ministry of Mines. Data of fatalities in Canada were related to the province of Manitoba alone.

3. Risk estimation studies for the Gecamines

Gecamines extracts copper and cobalt ores in open pits and underground mines within its mining concession. The prospection activities are conducted by using drilling machines. In open pits extractive machines, transportation and loading machines are employed. In underground mines explosives and digging machines are used in operations of excavation. The extracted ores are first washed, followed by floatation to the concentrators. Concentration and metallurgical activities are performed in Gecamines's

plants to produce metals of copper, cobalt and zinc which are the main products of the company. Training of workers to use these machines correctly is essential to avoid human errors that constitute the principal cause of accidents. Figure 1 shows the number of persons employed at Gecamines and total accidents with four days lost from 1957 to 2008.

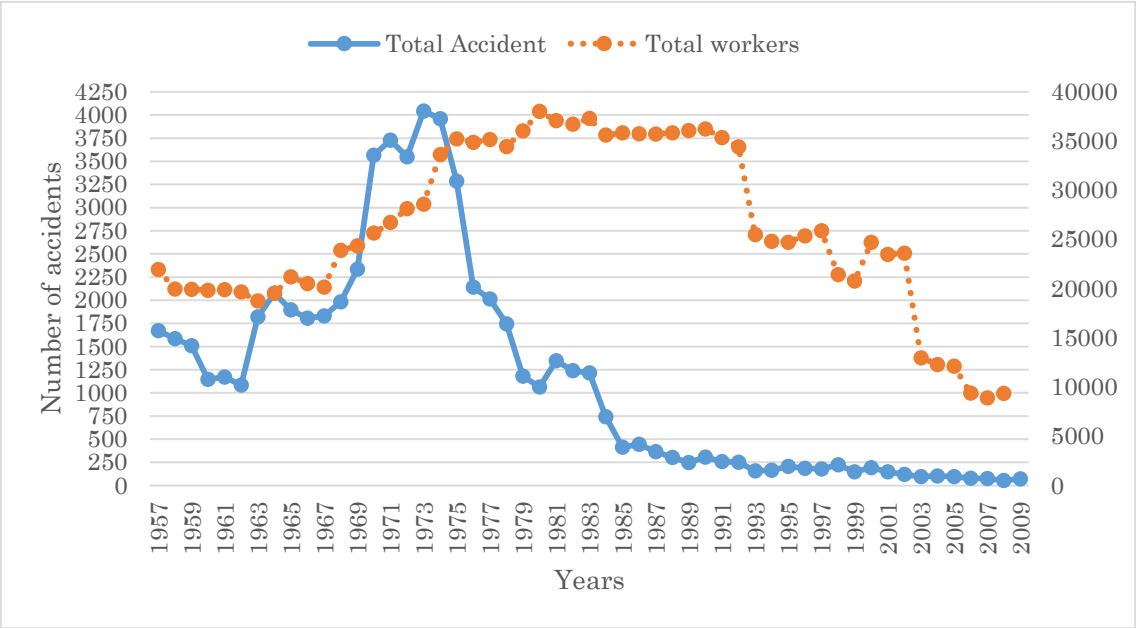


Figure 1 Total number of accident and workers from 1957 to 2008.

Gecamines initiated different strategies to evaluate and prevent the number of injuries. The firm develops indices based on quantitative analysis of accident and injury to measure mine safety trends and detect any failure in safety guidance. The following three basic indices including Accident Frequency Rate (AFR), Accident Severity Rate (ASR) and Accident Fatality Rate (AFR) are indicators used in many companies.

AFR = (Total number of accidents divided by total number of man-hours worked) multiplied by 1000000.

ASR = (Total number of days-lost divided by total number of man-hours worked) multiplied by 1000.

AFR = (Total number of death divided by total number of man-hours worked) multiplied by 1000000.

AFR shows the relation of number of specific accidents to the number of man-hours worked. It is calculated by dividing the number of accidents (multiplied by 1,000,000) during a year by the number of man-hours worked by all persons exposed to the accident

risk during the year. Figure 2 depicts the accident frequency rate at Gecamines from 1957 to 2008.

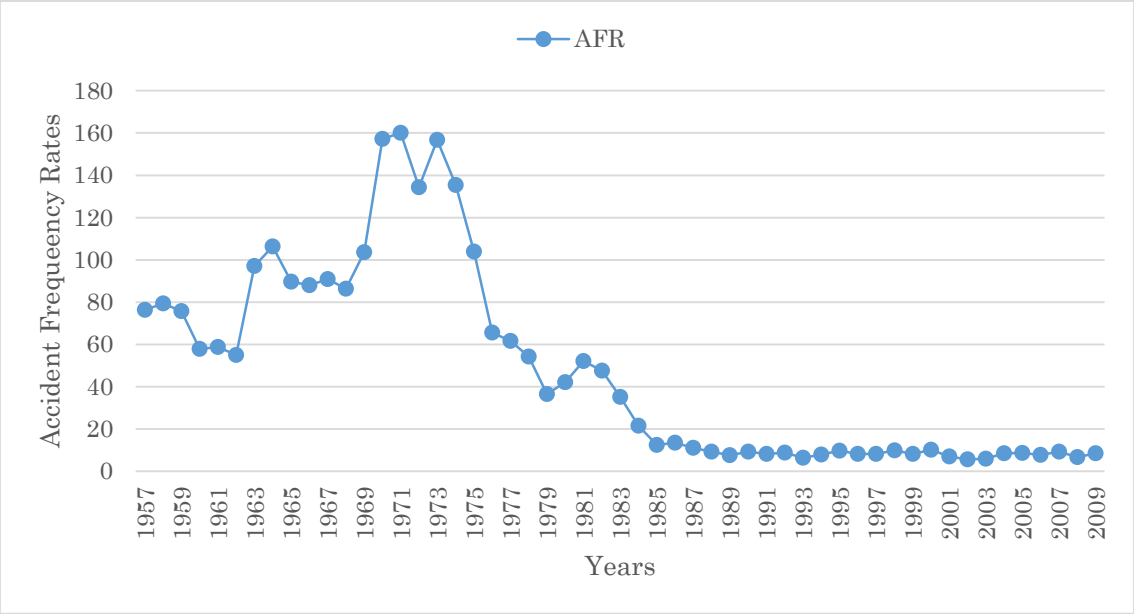


Figure 2 Accident frequency rates from 1957 to 2008.

Figure 2 shows the peak of the accident frequency rate in 1971 and 1973. The occurrence of accidents makes the work place a dangerous environment for employees. One of the strategies to reduce the high frequency rates of accidents at Gecamines was the creation in 1975 of the division of work inspection to check on a regular basis the working conditions and to remind workers about the security measures when they perform their daily tasks. In the following year of 1976, a new division of work security was created to further reduce the rate of accidents. Besides, efforts to prevent accidents within the company focused on the training of workers to avoid unsafe actions and behavior. The results of these efforts and strategies showed a sharp decline of the frequency rate as depicted in figure 2 above.

ASR depicts the loss undergone by the company from incapacity produced by occupational accidents. The severity rate is calculated by dividing the number of work days lost due to accidents by the number of hours of working time for all of the persons exposed to the risk of accidents. Figure 3 shows accident severity rates of Gecamines from 1957 to 2008.

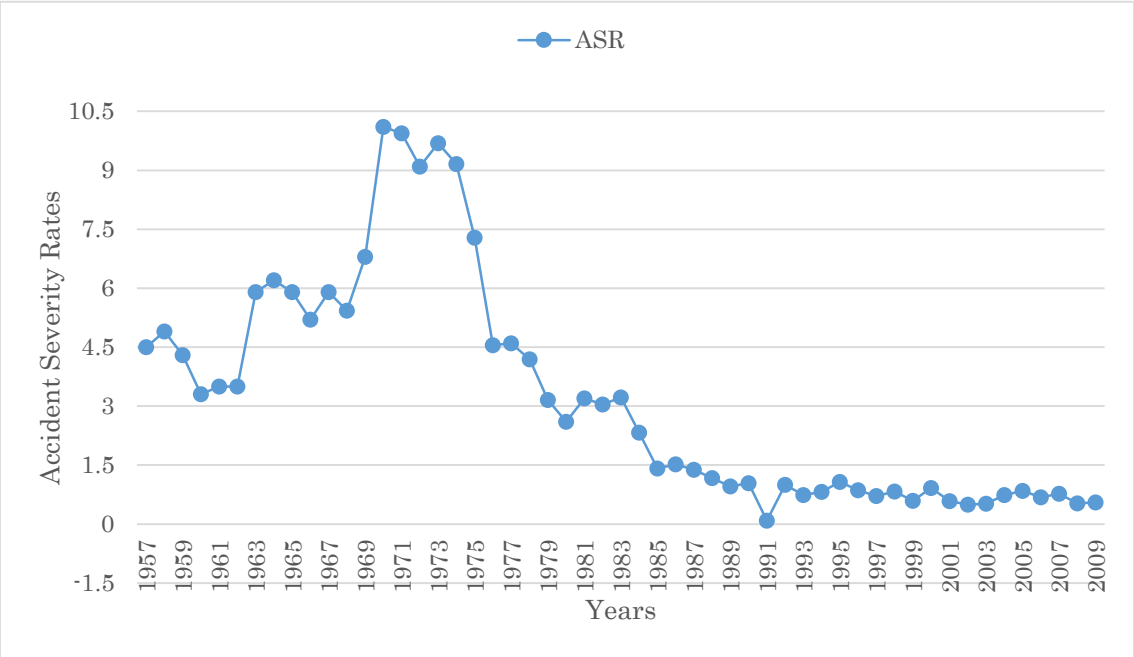


Figure 3 Accident severity rates from 1957 to 2008.

According to the ASR trend in figure 3, the years 1971, 1972, 1973, 1974 and 1975 have higher rates than the other years because of the first expansion plan to achieve the highest level of output in 1974. During these five years important investments have been made in the acquisition of new equipment that required the training of workers to handle it safely. Pressure exercised on workers to increase output resulted in unsafe actions of workers that increased the number of accidents. The year 1972 shows the highest number of fatal accidents in the history of Gecamines with 29 workers killed at the work place (Gecamines, 1972). The number of fatal accidents of Gecamines from 1957 to 2008 is depicted in figure 4 below.

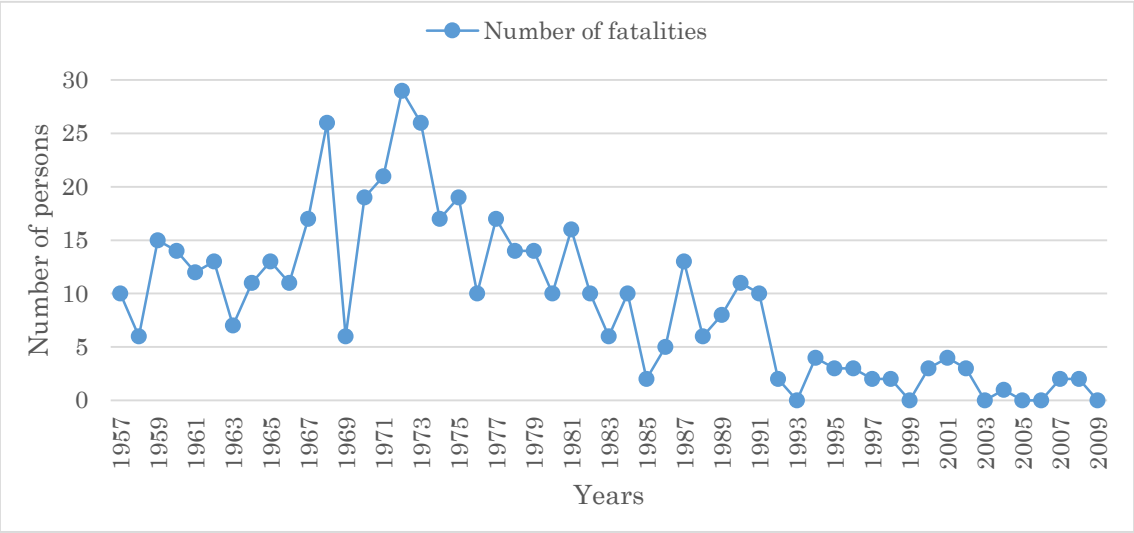


Figure 4 Fatalities at Gecamines from 1957 to 2008

Fatal accidents at Gecamines have killed 485 workers during the period of 51 years investigated in this study. The trend of fatalities during the ten years before nationalization seems to be relatively lower than the ten years after the change of ownership of the company in favor of the Congolese government. It is risky to conclude that working conditions of Union Miniere du Haut Katanga were safer than at Gecamines unless a comparison of all indices prove it. The result of econometric analysis will shed light on this issue in the following section.

4 Discussion

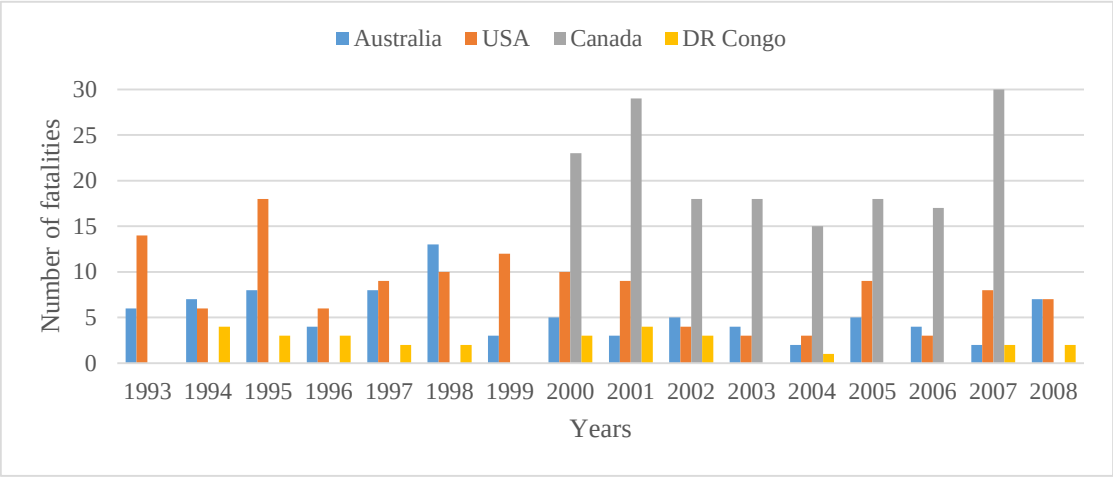
We divided the trends of frequency, severity, and fatality rates of Gecamines into five periods. First, from 1957 to 1966 under the UMHK, the averages were 78.39, 4.72 and 11, respectively. It should be reminded that managers were Belgian experts which implied that these experts knew how to minimize risk of exposure to accidents. In 1958, Shinkolobwe underground mine where uranium was extracted experienced a serious accident with injured miners over two hundred. This mine was closed the following year in 1959. Second, from 1967 to 1976 with the nationalization of the company in 1967, the majority of Belgian managers left Gecamines. The management transition would have increased risk to the accidents. These indicators reached their avarage peaks in 1973 and 1971 with 119.39, 7.79, and 19, respectively. The rise of frequency, severity and fatality rates resulted from production pressure conseticutive to the ultimate expansion plan of

1970 by the management committee. Production pressure deterioratied the working conditions of employees of Gecamines. Third, from 1977 to 1986, Gecamines applied new policies to reduce the accidents at the work place. Individual Safety Equipment kit was provided to every employee to reduce the risk of exposure. In addition, a team of inspectors was created to make sure that all employees abide by rules and policies of safety whithin the Gecamines. The trends of indicators started to decline with averages of 37.61, 2.93, and 10, respectively. Fourth, from 1987 to 1996, Gecamines's output collapsed in 1991, thus, reducing extratcion and refining operations. The indicators reached the averages of 8.56, 0.96 and 6, respectively. Fifth, from 1997 to 2008, about two-third of Gecamines mines and plants are exploited in partnership with private companies. Many accidents are not reported at Gecamines. Indicators reached their lowest levels with 7.92, 0.68 and 1.5, respectively. Myriam Elenge found that the injured miners in artisanal mining in Katanga were cared for by their colleagues and half of them were absent from their work for at least three calendar days (Elenge, et al., 2013). The result of this sudty is similar to that of Elenge in terms of number of days of absence to workplace after the occurrence of accident. In contrast to artisanal accidents where injured miners were cared for by their colleagues, in industrial accidents the injured workers are cared for by Gecamines.

We compared the trends of frequency and severity rates of Gecamines and western Australian mining industry. We found that Gecamines's rates were lower than those of Western Australian mining industry for metal and nonmetal sectors. It is true that Gecamines alone does not represent the whole picture of Congolese accidents at the work place. The statistics of Gecamines show that the company has achieved a good level of safety in 1976 when the severity rates reached 2.8. If we compare the average severity rate of 3.25 shown in Table 1 above to 17.85 for the period where data have been available in Western Australia, it is plausible to interpret that injured workers at Gecamines took fewer days of absence from work than did the workers of Australian mining industry. The comparison of the average frequency rates of 47.98 for Gecamines in Table 1 above and 6.17 from data of Western Australian mining industry ; we found that miners of Gecamines were seven times more exposed to risk of accident than their Australian colleagues. This implies that working conditions were worse at Gecamines in comparison

to the safety level at the work place in Australia.

The fatality rate has been considered as a good indicator to the quality of coal mine safety management. Haimiao investigated the impact of production pressure on the number of fatalities in Chinese coal mining. They found that production pressure increased the number of fatalities (Haimiao and Hong, 2013). This result is similar to the Gecamines case during the first half of 1970s with high number of fatalities because of production pressure. Figure 5 shows the trend of the number of fatalities of Gecamines and other countries.



Graph 5 Comparison of number of fatalities in global mining industry

Figure 5 depicts the number of fatalities in four countries. It should be recalled that the average number of fatalities at Gecamines was 9.15 as shown in Table 1 of descriptive statistics. The average number of fatalities has been 5.37 for Australia, 8.18 for the United States of America, and 21 for Manitoba province of Canada, respectively. It should be reminded that Canada had the highest number of deaths at the work place in comparison to the other countries. Gecamines has a lower number of deaths at the work since 1993 because the output of copper and cobalt has collapsed during this period. The average number of fatalities during the period of good performance was about 9 per year which means that working conditions of Gecamines were not safer than the other countries.

5 Conclusion

This paper investigates the determinants accidents and working conditions at Gecamines in comparison with the international experience in mining industry. A work place accident as an incident that occurs in the course of work can lead to physical or mental harm such as injury, disability and death. Work accidents of Gecamines were analyzed by autoregressive model for the samples of fifty one years. The econometric results revealed that the lost work hours and output pressure were determinants to the occurrence of accidents during the period studied.

The indicators of industrial safety including frequency rates, severity rates, and fatality rates had two major trends at Gecamines. Their trends were increasing during the first decade of nationalization reaching the peak in 1973 and then the reverted trends were observed from 1975 when Gecamines implemented policies that reduce unsafe actions of workers in order to improve safety at work place.

The overall results show that Gecamines has improved safety in mining operations by reducing the levels of indicators. The comparison of Gecamines's experience with related industries in Western Australia, Canada and United we found that miners of Gecamines were more exposed to the risk of accidents than their foreign colleagues in metals and nonmetals industries.

Gecamines should maintain a regular training program in favor of miners in underground and open pit mines to increase their awareness about the danger in extraction operations. A team of inspectors should be assigned to check and ensure that workers in mines and refining plants put on their individual safety equipment and their actions are handled within the safety guidelines of management.

6 Acknowledgment

The author would like to acknowledge the funding of Hokkaido University Sustainability Weeks 2011 Fund and the KAKENHI Fund C-24330384 & C-21530324 of Professor Tetsuhiko TAKAI to conduct fieldwork. The author would like to thank Mr. Devon Dublin for reading the draft of manuscripts and Mr. Balyahamwabo Tulinabo Christian for assistance with econometric analysis. The author used the primary sources of Gecamines, thanks to Mr. Kadiongo Nsapu, Director at Division of Personal Administration of Gecamines, who facilitated the access to archives and documents of

Gecamines in March and September 2012.

7 References

1. Bhattacherjee, A., Ramani, R. V., and Natarajan, R., 1994. Time series analysis of coal mine accident experience. Journal of Safety Research 25, 229-234.
2. Cheremisinoff, N. P., 2001. Practical Guide to Industrial Safety: Methods for Process Safety Professionals. Marcel Dekker, Inc., New York.
3. Congo, R. D. d., 2002. Loi No 015 du 16 Octobre 2002 portant Code du Travail, Journal Officiel de la Repubique Democratique du Congo. CEDI, Kinshasa, pp. 46-47.
4. D'Ydewalle, C., 1960 L'Union Miniere du Haut Katanga de l'age colonial a l'independance. Plon, Paris.
5. Davidson, R., and MacKinnon, J. G., 1993. Estimation and inference in econometrics. Oxford University Press, New York; Tokyo.
6. Dhillon, B. S., 2010. Mine Safety: A Modern Approach Spinger, London.
7. Dibwe, D. M., 2001. Histoire de conditions de vie de travailleurs de l' Union Miniere du Haut Katanga / Gecamines (1910-1999). Presses Universitaires de Lubumbashi, Lubumbashi.
8. Duffey, R. B., and Saull, J. W., 2003. Know the Risk: Learning form Errors and Accidents: Safety and Risk in Today's Technology. Butterworth - Heinemann, Amsterdam.
9. Elenge, M., Leveque, A., and Brouwer, C. D., 2013. Occupational accidents in artisanal mining in Katanga, D.R.C. . International Journal of Occupational Medicine and Environmental Health 26.
10. Enders, W., 2004. Applied econometric time series. J. Wiley, Hoboken, N.J.
11. Eurostat, 2012. European Statistics on Accidents at Work (ESAW) Summary Methodology. Publications office of the European Union 2012, Luxembourg, pp. 65.
12. Gecamines, 1972. Direction de la Securite de Travail: Statistiques des accidents du travail. Gecamines, Lubumbashi.
13. Gecamines, 1973. Direction de la Securite du Travail: Statistiques d'accident de travail. Gecamines, Lubumbashi, pp. 1.
14. Gecamines, 1985. Direction de la Securite du Travail: Statistiques des accidents du travail. Gecamines, Lubumbashi, pp. 2.
15. Gecamines, 1995. Direction de la Securite du Travail: Statistiques des accidents du travail. Gecamines, Lubumbashi, pp. 1.
16. Gecamines, 1998. Departement d'Hygiene et de la Securite du Travail: Statistiques

des accidents du travail. Gecamines, Lubumbashi, pp. 1.

17. Gecamines, 2012. Organnigramme de la Gecamines, 2012. Gecamines, Lubumbashi.
18. Greene, W. H., 2000. Econometric analysis. Prentice Hall, Upper Saddle River, N.J.
19. Haimiao, Y., and Hong, C., 2013. Production output pressure and coal mine fatality seasonal variations in China, 2002-2011 Journal of Safety Research 47, 39-46.
20. Katanga, U. M. d. H., 1957. Organisation de la Securite de Travail: Statistiques Accidents de travail. Union Miniere du Haut Katanga, Lubumbashi, pp. 1.
21. Kpodar, K., 2007. Mannuel d'initiation au Stata (version 8). Centre d'Etudes et de Recherches sur le Developpement International (CERDI) Clermont-Ferrand, pp. 97.
22. Saquet, J. J., 2000. De l'Union Miniere du Haut Katanga a la Gecamines. L'Harmathan, Paris.
23. Sari, M., Duzgun, H. S. B., Karpuz, C., and Selcuk, A. S., 2004. Accident analysis of two Turkish underground coal mines. Safety Science 42, 675-690.
24. Sen, A., 2007. On the distribution of Dickey-Fuller unit root statistics when there is a break in the innovation variance. Statistics & Probability Letters 77, 63-68.
25. Wonnacott, T. H., and Wonnacott, R. J., 1990. Introductory Statistics for Business and Economics. John Wiley & Sons, New York, pp. 475.