# การศึกษาคุณลักษณะและการเลือกใช้กิจกรรมด้านความปลอดภัย ในงานก่อสร้างอาคารขนาดกลางและเล็ก

# A STUDY ON CHARACTERISTICS AND SAFETY PROGRAM SELECTION IN MEDIUM AND SMALL CONSTRUCTION PROJECTS

ศิวัตม์ กมลคุณานนท์

Siwat Kamonkuananon

Faculty of Industrial Technology, Uttaradit Rajabhat University

corresponding author e-mail: siwat3003@gmail.com

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การวิจัยครั้งนี้มีวัตถุประสงค์ 2 ประการคือ 1) เพื่อศึกษาคุณลักษณะของกิจกรรมด้านความปลอดภัยในโครงการก่อสร้างอาคารขนาดกลางและเล็ก และ 2) เพื่อหาปัจจัยที่มีอิทธิพลต่อการเลือกกิจกรรมด้านความปลอดภัยในมุมมองของบุคลากรภาครัฐและเอกชน โดยคัดเลือก15 กิจกรรมความปลอดภัยตามข้อกำหนดของกรมสวัสดิการและคุ้มครองแรงงาน พิจารณา 3 ด้านคือ ผู้รับผิดชอบ ระยะเวลา และค่าใช้จ่าย โดยการสอบถามกลุ่มนายช่างควบคุมงานก่อสร้างในเขตจังหวัดอุตรดิตถ์ แพร่ และน่าน จากการศึกษาคุณลักษณะกิจกรรมด้านความปลอดภัยพบว่า 1) กิจกรรมการวิเคราะห์อุบัติภัยของงานใช้ผู้รับผิดชอบน้อยที่สุด 2) กิจกรรมการฝึกปฐมพยาบาลใช้ระยะเวลาของกิจกรรมเร็วที่สุด แต่กิจกรรมการวิเคราะห์อุบัติภัยของงานใช้ระยะเวลาของกิจกรรมนานที่สุด 3) กิจกรรมคณะกรรมการความปลอดภัยใช้ค่าใช้จ่ายน้อยที่สุด แต่กิจกรรมกระบวนการทำงานที่ปลอดภัยใช้ค่าใช้จ่ายสูงที่สุด การเลือกกิจกรรมด้านความปลอดภัยพบว่า มุมมองภาครัฐเลือก 5 กิจกรรมแรกคือ 1) การใช้อุปกรณ์ป้องกันภัยส่วนบุคคล 2) การปฐมนิเทศ 3) การประชุมกล่องเครื่องมือ 4) การยกย่องและให้รางวัล และ 5) การวางแผนเมื่อเกิดเหตุฉุกเฉิน สำหรับมุมมองภาคเอกชน คือ 1) การใช้อุปกรณ์ป้องกันภัยส่วนบุคคล 2) กิจกรรมกฎด้านความปลอดภัย 3) กระบวนการทำงานที่ปลอดภัย 4) การปฐมนิเทศ และ 5) นโยบายด้านความปลอดภัย เมื่อเปรียบเทียบปัจจัยที่มีอิทธิผลต่อการเลือกกิจกรรมด้านความปลอดภัยพบว่า ภาครัฐจะเลือกกิจกรรมที่มีลักษณะเชิงป้องกัน ในขณะที่ภาคเอกชนพิจารณาค่าใช้จ่าย ความสะดวกในการจัดกิจกรรม และภาพลักษณ์ขององค์กรเป็นสำคัญ

**คำสำคัญ**: กิจกรรมด้านความปลอดภัย ความปลอดภัยในงานก่อสร้าง การจัดการด้านความปลอดภัย

**Abstract**

The two objectives of this research are 1) to study the characteristics of safety programs selection in medium and small construction projects, and 2) to find factors influencing safety programs selection in the perspective of public and private personnel. The research was conducted by selecting 15 safety programs according to the Regulations of the Department of Labor Protection and Welfare and then considering three factors, i.e., responsible persons, duration, and expenses, through interviews with construction personnel in Uttaradit, Phrae, and Nan provinces. According to the study of the characteristics of safety programs, it was found that 1) job hazard analysis used the lowest amount of responsible persons, 2) the shortest period was spent on first aid programs while the longest period was spent on job hazard analysis, 3) the smallest amount of expenses were spent on safety committees while the largest amount of expenses were spent on safe work procedures. For selecting safety programs, under the public sector's perspective, they selected the first five activities; 1) personnel protective equipment, 2) safety orientation, 3) toolbox meeting, 4) safety promotion, and 5) emergency planning. From the perspective of the private sector, they selected 1) personnel protective equipment, 2) safety rules, 3) safe work procedures, 4) safety orientation, and 5) safety policy. When comparing factors influencing the selection of safety programs, the public sector had a perspective towards preventive program selection while the private sector had the perspective towards factors of expenses, convenience on program arrangements, and sectoral image.

**Keywords**: safety programs, safety in construction, safety management

## Introduction

In the accident and illness statistics from working, classified by severity and business type by the Social Security Office in 2015, the construction business was classified in a high severity accident group compared with other business types (Social Security Office, 2015). Moreover, there are many and frequent safety issues found in action of construction workers, of which the most unsafe action that occurs is smoking in flammable and prohibited areas due to an unsafe working habit, convenience, urgency of task, lack of tools, and overloaded tasks (Limsila, 2011). According to a study of the elements of poor construction safety management in China, the behavior

of contractors on safety management were of grave concern, including the lack of provision of personal protection equipment, regular safety meetings, and safety training. The main factors affecting safety performance include poor safety awareness of top management, lack of training, poor safety awareness of project managers, reluctance to input resources to safety and reckless operations (Tam et al., 2004).

Safety management is important to reduce accidents and injuries during construction. Moreover, they should know the factors which cause accidents. The study of safety management in a small construction company in Saraburi province found 6 factors of low-level working operation as follows; off duty safety management, work inspection according to the plan, conscious remind and encourage, worker health control, safety training, and safety rules management (Worasakdapisan, 2014).

From the safety study of Heinrich (1978), it was found that construction accidents had two main causes, which were unsafe acts and unsafe conditions. If there was safety management along with the construction, the risk and severity would be decreased. The occurrence of an accident would affect four things which were mind, law, reputation, and finance (Hadikusumo, 2010) and that safety programs could prevent accidents leading to productivity increases, production cost decreases, profit increases, and workers motivated to perform their jobs (Simaroj & Chaleomjirarat, 2011).

Responsible persons, time duration, and expenses in each safety programs are the key factors for selecting suitable safety programs. This study interviewed public and private personnel in Uttaradit, Phrae, and Nan provinces in order to establish appropriate protocol for selecting safety programs that can be further applied effectively to medium and small construction projects, considering the mentioned key factors.

## Research Methods

This research had two parts. Part 1, a focus group interviews with five construction safety experts who had more than seven years experiences in construction safety management was held by the researcher to consider the following three topics; (1) selecting 15 safety programs and sub activities, (2) managing resources, and (3) finding good characteristics of safety programs.They selected 15 activities as follows; (1) job hazard analysis, (2) safety orientation, (3) safety training, (4) accident investigation, (5) first aid program, (6) emergency plan, (7) safe work procedures, (8) safety

committee, (9) safety promotion, (10) tool box meeting, (11) personal protective equipment(PPE), (12) safety policy, (13) workplace inspection and audit, (14) selection of subcontractor, and (15) safety rules (Department of Labor Protection and Welfare, 2001).

For providing resource detail and good characteristics of safety programs, the researcher discussed with 3 experts in the topics of personnel, duration, and expenses in each of the safety programs for entire coverage and also for analysis of the good characteristics in each safety programs.

After 15 safety program characteristics were acquired, the researcher used the collected data to design the interviewing questionnaire for an opinion survey of the sample groups which were the personnel from both public and private sectors, to find the interest of using safety programs in medium and small construction projects and also find factors influencing on further safety program selection.

Part 2, the analysis was to find factors influencing safety program selection. In this part, the researcher used the questionnaire that was verified in content correctness and language from conferences that were held with a related similar group for 20 people and then testing with target (30 people) and brought the result for the reliability scale test with coefficient of Cronbach's alpha to find the tool reliability before the actual use (Wanichbuncha, 2010).The statistical coefficient of Cronbach's alpha test had a value of 0.86 (more than 0.7) which indicated reliability of the questionnaire (George & Mallery, 2003).

Personnel were surveyed in Uttaradit, Phrae, and Nan provinces. There were 40 samples of personnel from the public and 40 samples from private sectors (total 80 samples in three provinces). Scores from 1-5 were given by the personnel (the most at the level 5 and the least at the level 1). These scores were used for the selection of safety programs.

## Results

(i) Good characteristics of a safety program

From 15 safety programs, the analysis of resources usage of safety programs in the project is shown in Table 1.

**Table 1** Resource usage in safety program of the project

| No. | Safety program | Authoritarian | Duration (Day) | Cost (Baht) | Remark |
|---|---|---|---|---|---|
| 1 | Job hazard analysis | S/E/F | 67–137 | (700 - 1,100)+x+y | x=cost of Job hazard analysis y=cost of preventing activity |
| 2 | Safety orientation | S/E/H/L | 10–20 | 4,000 - 4,600 | |
| 3 | Safety training | S/E/H/L | 19–25 | 4,700 - 5,400 | |
| 4 | Accident investigation | P/S/E/F/H | 17–25 | 1,500 - 1,900 | |
| 5 | First aid program | S/E/F/L | 6–8 | (4,100 - 4,400)+x | x=cost of first aid training |
| 6 | Emergency plan | P/S/E/F/L | 19–33 | (4,300 - 4,600)+x | x=cost of mock up program and modifying plan |
| 7 | Safe work procedures | P/S/E/F | 21–40 | (3,800 - 4,600)+x+y | x=cost of providing PPE y=cost of providing tool & equipment |
| 8 | Safety committee | P/S/E/F/H | 17–35 | (900 - 1,200) | |
| 9 | Safety promotion | P/S/E/H | 39 | (1,000 - 1,800)+x | x=cost of awards |
| 10 | Tool box meeting | S/E/F/H | 7–11 | 1,300 - 1,400 | |
| 11 | Personal protective equipment | P/S/E/F | 18–25 | (1,600 - 2,200)+x | x=cost of PPE for training |
| 12 | Safety policy | P/S/E/H | 19–54 | (1,900 - 4,700)+x | x=cost of activity and information board |
| 13 | Workplace inspection and audit | P/S/E/F | 18–27 | (1,400 - 1,800)+x | x=cost of modifying workplace |
| 14 | Selection of subcontractor | P/S/E/L | 12 | 2,400 - 6,900 | |
| 15 | Safety rules | P/S/E/H | 18–28 | (400 - 700)+x+y | x=cost of information board y=cost of plan modifying |

**Remark** P = Project manager, S = Safety officer, E = Engineer
F = Foreman, H = Headman, L = Expert

In terms of resource usage in a safety program, it was found that the job hazard analysis used the lowest number of responsible persons. The first aid program spent the shortest period while job hazard analysis spent the longest period; the safety committee spent the smallest amount of expenses while safe work procedures spent the largest amount of expenses.

From the resource usage in safety program analysis result, it was possible to analyze the good characteristics of safety programs in 7 categories as shown in Table 2.

**Table 2** Good characteristics of safety programs

| No. | Safety programs | The characteristics | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Less staff required | Less expenses | Less time spent | Program organizing | Convenience | Preventive activity | Less equipment used |
| 1 | Job hazard analysis | ● | ● | | | | ○ | ● |
| 2 | Safety orientation | ○ | | ● | | ● | ○ | ○ |
| 3 | Safety training | ○ | | ○ | ○ | | ● | |
| 4 | Accident investigation | | ● | ○ | | | | ● |
| 5 | First aid program | ○ | | ● | | ● | ○ | |
| 6 | Emergency plan | | | | ● | ○ | ○ | |
| 7 | Safe work procedures | ○ | | | | | ● | |
| 8 | Safety committee | | ● | ○ | ● | ○ | ● | ● |
| 9 | Safety promotion | ○ | | | | | ○ | ○ |
| 10 | Tool box meeting | ○ | ● | ● | ● | | ● | ● |
| 11 | Personal protective equipment | ○ | | ○ | ○ | | ● | |
| 12 | Safety policy | ○ | ○ | | ○ | | ● | |
| 13 | Workplace inspection and audit | ○ | | ○ | | | ○ | |
| 14 | Selection of subcontractor | ○ | ○ | ● | | ○ | ○ | ● |
| 15 | Safety rules | ○ | ○ | ○ | ○ | | ● | |

**Remark** ● = Very good characteristic
○ = Good characteristic

From the analysis of good characteristics of safety program, it was found that the first three activities which had most very good characteristics were toolbox meeting, safety committee, and job hazard analysis, respectively, while the workplace inspection and audit did not have any very good characteristic but there were three good characteristics.

(ii) Public and private personnel perspectives of safety program selection

From the surveys of construction personnel in public and private sectors, the results are shown in Table 3.

**Table 3** The level of interest in safety program from public and private sector perspective

| No. | Safety program | Government | | | Private | | |
|---|---|---|---|---|---|---|---|
| | | $\bar{X}$ | S.D. | Rank | $\bar{X}$ | S.D. | Rank |
| 1 | Job hazard analysis | 3.55 | 0.68 | | 3.65 | 0.58 | |
| 2 | Safety orientation | 4.20 | 0.69 | 2 | 4.10 | 0.63 | 4 |
| 3 | Safety training | 3.80 | 0.82 | | 3.95 | 0.75 | |
| 4 | Accident investigation | 3.80 | 0.69 | | 3.45 | 0.50 | |
| 5 | First aid program | 3.75 | 0.54 | | 3.85 | 0.66 | |
| 6 | Emergency plan | 3.85 | 0.58 | 5 | 3.90 | 0.71 | |
| 7 | Safe work procedures | 3.60 | 0.67 | | 4.30 | 0.65 | 3 |
| 8 | Safety committee | 3.80 | 0.82 | | 3.75 | 0.63 | |
| 9 | Safety promotion | 3.90 | 0.78 | 4 | 4.00 | 0.64 | |
| 10 | Tool box meeting | 4.15 | 0.74 | 3 | 3.90 | 0.84 | |
| 11 | Personal protective equipment | 4.95 | 0.22 | 1 | 4.35 | 0.66 | 1 |
| 12 | Safety policy | 3.70 | 0.56 | | 4.10 | 0.71 | 5 |
| 13 | Workplace inspection and audit | 3.75 | 0.71 | | 4.05 | 0.81 | |
| 14 | Selection of subcontractor | 3.35 | 0.48 | | 3.80 | 0.82 | |
| 15 | Safety rules | 3.65 | 0.66 | | 4.35 | 0.66 | 2 |

From Table 3, it was found that there are two from first five safety programs which obtained high interest rates were personal protective equipment and safety orientation. This indicated that the public and private sectors preferred personal protective equipment and safety orientation to be used in their construction sites because these safety programs were inexpensive and could help to reduce accidents and injuries.

(iii) Reasons influencing safety program selection.

Regression analysis was performed to explain the two related variables that influenced safety program selection. The linear correlation with regression equation as $y = a + bx$ (Panpinij, 2009) was found to be suitable; where y referred to the engaging of safety program selection and x referred to the reason of safety program selection.

The reasons influencing safety program selection of public and private personnel are shown in Tables 4 and 5 (Sig. ≤ 0.05).

**Table 4** Reasons influencing the first five selected activities under public personnel perspective

| Safety program (first five factors) | Sig. ≤ 0.05 | | Cause |
|---|---|---|---|
| | Sig. | Part | |
| 1.Personal protective equipment ($\bar{X}$=4.95) | X8=0.028 | 0.350 | - workers attractive activity |
| 2.Safety orientation ($\bar{X}$=4.20) | X8=0.028 | 0.405 | - workers attractive activity |
| | X3=0.016 | 0.351 | - less time spent |
| | X4=0.028 | 0.295 | - program organizing |
| | X6=0.028 | 0.288 | - preventive activity |
| | X5=0.002 | 0.485 | - convenience |
| 3.Tool box meeting ($\bar{X}$=4.15) | X1=0.024 | 0.334 | - small expenses |
| 4.Safety promotion ($\bar{X}$=3.90) | X8=0.039 | 0.163 | - workers attractive activity |
| 5.Emergency plan ($\bar{X}$=3.85) | X8=0.006 | 0.405 | - workers attractive activity |
| | X3=0.016 | 0.351 | - less time spent |
| | X6=0.044 | 0.288 | - preventive activity |

The reasons that influencing safety program selection in the public sector were the workers attractive activity, less time spent, and preventive activity.

**Table 5** Reasons influencing the first five selected activities from the private personnel perspective

| Safety program (first five factors) | Sig. ≤ 0.05 | | Cause |
|---|---|---|---|
| | Sig. | Part | |
| 1. Personal protective equipment ($\bar{X}$=4.35) | X10=0.001 | 0.497 | - able to use in every projects |
| | X5=0.032 | 0.301 | - convenience |
| 2. Safety rules ($\bar{X}$=4.35) | X5=0.002 | 0.432 | - convenience |
| | X9=0.003 | 0.411 | - sectoral image |
| | X1=0.004 | 0.399 | - small expenses |
| | X6=0.019 | 0.317 | - preventive activity |
| | X4=0.031 | 0.289 | - program organizing |
| 3.safe work procedures ($\bar{X}$=4.30) | X1=0.016 | 0.313 | - small expenses |
| 4.Safety orientation ($\bar{X}$=4.10) | X1=0.001 | 0.381 | - small expenses |
| | X9=0.005 | 0.316 | - sectoral image |
| | X4=0.007 | 0.300 | - program organizing |
| | X10=0.008 | 0.291 | - able to use in every projects |
| 5.Safety policy ($\bar{X}$=4.10) | X5=0.001 | 0.443 | - convenience |

The reasons influencing safety program selection under private sectors perspective were less expenses, finished in a day, simple process activity, progressively executable in every project, and building confidence to the sectors and stakeholders.

Different factors influenced safety program selections in both sectors are shown in Table 6.

**Table 6** Reasons influencing on safety program selection in public and private personnel comparison

| Public personnel factors | Private personnel factors |
|---|---|
| 1. workers attractive activity | 1. small expenses |
| 2. less time spent | 2. convenience |
| 3. preventive activity | 3. program organizing |
| | 4. sectoral image |

Comparing the reasons influencing safety program selection in the public and private sectors, it was found that the public sector had a perspective towards preventive programs selection while the private sector had a perspective towards factors of expenses, convenience on programs arrangements, and sectoral image.

## Discussion

Comparing the reasons influencing safety program selection, found that the public sector had a perspective towards preventive programs, awareness building, attractive of workers, and short-period activity which agreed to the research of Ahmed et al., (1999). It was found that the project owners were mostly concerned about safety work and job hazards while personnel were mostly concerned about the risk of paying indemnity for delayed work. Private sector personnel had a perspective towards expenses, convenience, and organizational image because the safety programs were directly affected cost in the private sector (Ahmed et al., 1999). This agreed with the research of Limpakornkul (2006) that the construction costs were hardly decreased so the contractors usually ignore for expense of safety programs. Moreover, a study of safety problems in a construction department in Malaysia which found that the construction working accidents occurred from a lack of safety knowledge, budget shortages undermining safety management that should be encouraged, supported and

improved by allocating budget to safety management for efficient safety training (Tan & Nadeera, 2014).

When considering and comparing factors influencing safety programs selection with Domino Theory (Heinrich, 1978), it was found that the perspective of public personnel was towards preventive programs which compared with the safety management as the second domino piece (fault of the person) that would decrease the fault of the person preventively and safety working awareness to workers. Otherwise, the private personnel had a perspective towards value, expenses, and organization image which was the business perspective to accomplish the project with least cost with emphasis on safety management on the third domino piece (unsafe acts and unsafe conditions).

Therefore, in medium and small construction projects in the public and private sectors, personnel should consider selecting safety programs. Construction organizations in rural areas of Thailand can apply to use these data to select the safety programs which are suitable in their organizations. They can start using safety programs rapidly in the case that they know their faults of safety management that are shown in Table 2. Moreover, in a case where they can find reasons for the causes of accidents, they can select the safety programs shown in Tables 4 and 5 to improve their safety management.

## Conclusion

In this research, the researcher analyzed 15 safety programs and found three characteristic issues as follows; job hazard analysis used the lowest number of responsible persons while safety committee used the highest number of responsible persons. First aid program spent the shortest period while job hazard analysis spent the longest period; safety committee spent the smallest amount of expenses while safe work procedures spent the largest amount of expenses.

The good and appropriate characteristics of safety programs in construction projects consist of seven parts as follows; personnel amount, expenses, duration, activity process, convenience, preventive activity, and equipment. All 15 safety programs had different good characteristics which were suitable for the individual working situation in each construction site.

The first five activities selected from the public sector's perspective were (1) personnel protective equipment, (2) safety orientation, (3) toolbox meeting, (4) safety promotion, and (5) emergency plan. For the perspective of the private sector, they selected (1) personnel protective equipment, (2) safety rules, (3) safe work procedures, (4) safety orientation, and (5) safety policy. There were two activities common to the first five activities in the both sectors which were personal protective equipment and safety orientation. These activities should be applied in every project to manage safety, prevent accidents, and save construction cost.

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## References

Ahmed SM, Ahmed RD, Saram DD. Risk Management Trends in the Hong Kong Construction Industry: A comparison of contractors and owners perceptions. *Journal of Engineering, Construction and Architectural Management*, 1999; 6(3): 225-234.

Department of Labor Protection and Welfare.*Providing Safety Plan in Construction Working Manual*.Bangkok: Department of Labor Protection and Welfare; 2001.

George D, Mallery P. *SPSS for Windows Step by Step: A Simple Guide and Reference11.0 Update*. 4th ed. Boston: Allyn & Bacon; 2003.

Hadikusumo BHW. *Overview of Health and Safety in Safety and Health Management in Construction*. Bangkok: AIT; 2010.

Heinrich HW. *Industrial Accident Perception*. 2nd ed. London: McGraw-Hill; 1978.

Limpakornkul S. *A Study of Safety Budgeting Process in Thai Construction Projects*.Master Degree in Civil Engineering. Engineering: Asian Institute of Technology; 2006.

Limsila K. Unsafe acts of high-rise building construction worker.*16th National Civil Engineering Academic Conference*: Chonburi, Thailand; 2011.

Panpinij S. *Scientific Research Techniques*. Bangkok: Wittayapat; 2009.

Simaroj W, Chaleomjirarat W. *Factory Engineering and Safety Management*.29thed.Bangkok: Publisher of Technology Promotion Association (Thailand-Japan); 2011.

Social Security Office. *Accident and Illness Statistics from Working Classified By Severity and Business Typein 2015*. 2015. Available at: http://www.sso.go.th/. Accessed August 28, 2016.

Tam CM, Zeng SX. Deng ZM. Identifying elements of poor construction safety management in China, *Safety Science*, 2004; 42(7): 569-586.

Tan CK, Nadeera AR. Case Studies on the Safety Management at Construction Site, *Journal of Sustainability Science and Management*. 2014; 9: 90-108.

Wanichbuncha K. *Statistics for Research*. 5th ed. Bangkok: Chulalongkorn University Book Centre; 2010.

Worasakdapisan A. *Safety Management in Small Construction Business in Saraburi Province*. Master Degree. Civil Engineering: Suranaree University of Technology; 2014.