Research Article

Construction Accidents in Thailand: Statistical Data Analysis

Chaiporn Vongpisal*
Department of Materials Handling and Logistics Engineering, Faculty of Engineering, King Mongkut's University of Technology North Bangkok, Bangkok ,Thailand

Nantakrit Yodpijit
Department of Industrial Engineering and Center for Innovation in Human Factors Engineering and Ergonomics, Faculty of Engineering, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand

* Corresponding author. E-mail: chaiporn.v@eng.kmutnb.ac.th DOI: 10.14416/j.ijast.2017.02.005
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Abstract
This research aims to explore the accident causation in Thailand's construction industry. Macroergonomics and Human Factors Analysis and Classification System (HFACS) were employed to investigate accidents in the construction industry. A total of 1,252 construction accident cases from 31 companies from 2006 to 2014 were analyzed and reported. Findings indicate that accidents occurred more frequently with young and middle ages (25–54 years old) in a large-scale construction company. Based on the reported cases, several major factors were found to predict root causes of accidents, including cuts, falls from height, and awkward working postures. Most construction accidents were associated with unsafe acts (88.97%) and preconditions for unsafe acts (72.92%). It is implied that improvements for changes in human behaviors, together with environmental and personnel factors are critical to increase the safety at the construction site.

Keywords: Construction, Macroergonomics, HFACS, Accidents causation, Prevention

1 Introduction

Construction industry is one of the most dangerous industries in many parts of the world, as measured by workers' compensation, work-related injuries and fatalities. Safety in construction is complicated phenomenon since it has an unique work system and involves many stakeholders. The National Statistics Office of Thailand indicates that the construction industry poses the highest risk of major injuries and fatalities to workers as compared to that in other industries. Recently, Workman's Compensation Fund in Thailand has indicated that 9,725 construction workers filed for some forms of industrial accidents. In 2011, 80 were found dead, 47 were permanent disabled, and 9,148 were injured., Workplace accident prevention can be made plausible if people know their work system (including personal, technological, environmental, and organizational factors) well enough to identify hazards and risks.

Sociotechnical systems, or what's so-called Macroergonomics, is a top-down human factors/ ergonomics approach for designing human-machine work systems including organizational structures. Macroergonomics is a recognized sub-discipline of human factors engineering and ergonomics, focusing on human-organization interface technology. In practice the ultimate goal of the discipline is to improve human performance, safety, health, and overall productivity. The Traditionally, it focuses primarily on the individual

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or subsystem level, including human-machine interface, human-environment interface, human-software interface, and human-job interface technologies. The root of traditional macroergonomics research involves the relationships among personnel, technological, environmental and organizational characteristics and their interactions.

The Human Factors Analysis and Classification System (HFACS), as originally proposed by Reason's "Swiss Cheese" model in 1990 [1], has been developed to define the latent and active failures. HFACS can be employed as an analysis tool to investigate accident causation [2]. The framework has been developed and refined with real case studies under human factors/ ergonomics and safety theories. In general, HFACS consists of four levels of failure, each of which corresponds to one of the four layers in Reason's model. These include: 1) Unsafe Acts - errors and violations, 2) Preconditions for Unsafe Acts - environmental factors, personal factors and conditions of operators, 3) Unsafe Supervision - inadequate supervision, planned inappropriate operations, failed to correct problems, and supervisory violations, and 4) Organizational Influences - resource management, organizational climate, and organizational process.

2 Methodology

2.1 *Data collection and analysis*

Records on construction accidents were collected from 31 construction companies from 2006 to 2014. The total of 1,252 significant accidents were analyzed and reported in this study. This research project uses both quantitative and qualitative approaches to understand the nature of changes in construction accidents in Thailand and its trend. Statistical data from several major published papers were obtained for quantitative analysis. To make qualitative analysis more understandable, the qualitative information were transformed to quantitative as shown in a bar chart format.

2.2 *Implementation of macroergonomics*

The traditional research on macroergonomics involves sociotechnical systems, the relationships among personnel, technological, environmental and organizational characteristics and their interactions (see Figure 1). Hendrick and Kleiner [3] states that the design of work system structure should take into consideration of three major sociotechnical subsystems affecting the optimal work system design, -personnel subsystem, technological subsystem, and external environments, Macroergonomics puts an emphasis on organizational design and management factors within sociotechnical systems. In addition, Macroergonomics Analysis of Structure (MAS) characterizes macroergonomics as an organizing process where two main subdisciplines of human factors engineering and ergonomics are the focal issues [4].

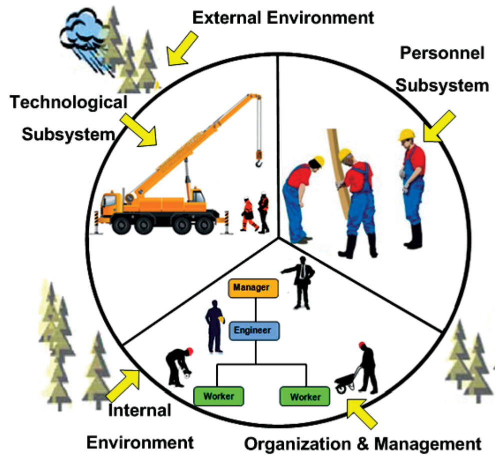

Figure 1: Macroergonomics Model. (Modified from [3].)

An analysis and design of work system as known as Macroergonomics Analysis and Design (MEAD) is a ten-phase framework used to conduct the assessment of work system and improvements [3], [5]. This framework includes 1) Initial Scanning - Perform mission, vision, principles analysis, Perform system scan, Perform environment scan, and Specify initial organizational design dimensions; 2) Production System Type and Performance Expectations - Define production system type, Define performance expectations, Specify organizational design dimensions, and Define system function allocation requirements; 3) Technical Work Process and Unit Operation - Identify unit operations, and Flowchart the process; 4) Variance Data - Collect variance data, and Differentiate between input and throughput variances; 5) Construct Variance Matrix - Identify relationships among variance, and Identify key variances; 6) Variance Control Table and Role Network - Construct key variance control table, Construct role network, Evaluate effectiveness, and Specify organizational design dimensions; 7) Function Allocation and joint Design - Perform function allocation, Design technological subsystem changes, and Prescribe final organizational design; 8) Roles and Responsibilities - Evaluate role and responsibility perceptions, and Provide training support; 9) Design/redesign - Design/redesign support subsystems, Design/redesign interfaces and function, and Design/redesign the internal physical environment; and 10) Implement - Implement, Perform evaluate, and Iterate.

2.3 *Applications of HFACS*

2.3.1 Human Factors Analysis and Classification System (HFACS)

Several frameworks have been proposed for integrating the diverse perspective and models of accident causation. One of the accident causation models by Reason [1] has come close to the almost universal acceptance. In addition , the Swiss cheese model of accident causation developed by Reason [1] is vigorous enough to address latent failure with the causation of events in an accident investigation. The Human Factors Analysis and Classification System (HFACS) has been developed to define the latent and active risks in the Swiss cheese industry. As such, HFACS was used as an accident investigation and analysis tool in this study.

This research project includes two levels of HFACS-Unsafe Acts and Preconditions for Unsafe Acts. The unsafe acts of construction accidents can be classified into two categories: errors and violations [1]. Errors (skill-based, decision, and perceptual) refer to the mental or physical activities of individuals that fail to achieve their intended goals. Humans make errors by their very nature. The unsafe acts is the dominant cause of most accident records. On the other hand, violations (routine and exceptional) represent the willful disregard for the rules and regulations that follow work instructions/procedures (see Figure 2).

Many studies have suggested that unsafe acts of individuals are directly linked to nearly 80% of all accidents. However, simply focusing on unsafe acts may result in limited understandings on its cause. Thus, to better probe the investigation on why the unsafe acts took place, this research project analyzed preconditions of unsafe acts, which includes the condition of the operators, environmental and personnel factors. See more details in Figure 3.

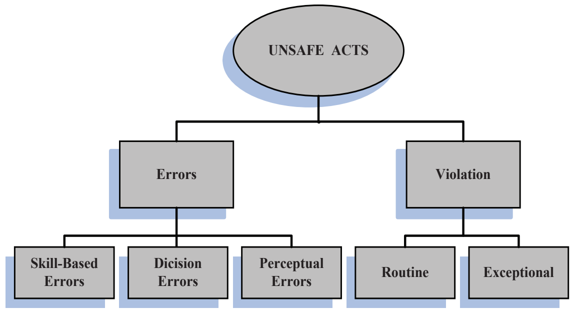

Figure 2: Unsafe act level.

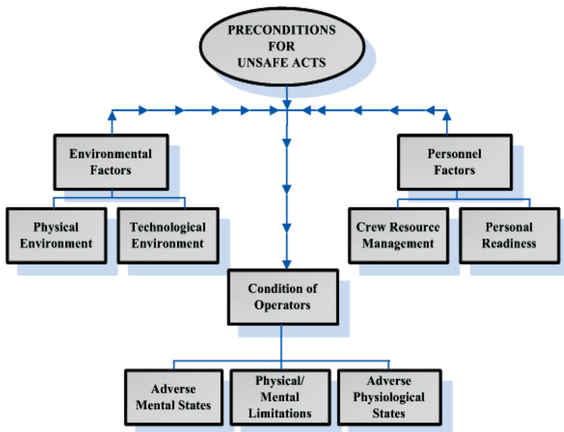

Figure 3: Preconditions of unsafe acts level.

3 Results

3.1 *Hazard and Risk*

Workplace hazards can come from a wide range of sources. General examples include any substance, material, process, practice, etc., that has the ability to cause harm or adverse health effect to a person under certain condition. A methodology for planning and evaluating process of construction for safety is very important. First, one must understand hazards existing in the construction industry. The actual nature of hazards in construction can be classified into three practical terms: 1) dormant/latent hazard - when the hazard presents; 2) armed hazard - can cause harm, and 3) active hazard - causing injury, death, and property damage by releasing unwanted energy, substance, or biological agent. In addition, a dormant/latent hazard is a design problem that causes a failure resulting from a misuse. For example, the bathroom is a dormant/ latent hazard. The armed hazard is created by a change of circumstances and is ready to cause harm (i.e., the floor may be more slippery when getting wet). The active hazard is an armed hazard triggered into action. For example, when the floor is stepped on, the water makes less friction between the heels and the floor and, more likely, make one get tripped and fall. Second, the identification of hazards in the construction industry is needed to address to prevent losses and accidents. Seven types of hazards include 1) natural hazards, i.e., gravity, slope, atmosphere, limitations on human performance, etc.; 2) structural/mechanical hazards, i.e., rotation, compression, tension/spring, vibration, etc.; 3) electrical hazards, i.e., spark/arcs, voltage/amperage, ground, capacitance, etc.; 4) automated system hazards - caused by computer hardware and software; 5) chemical hazards, i.e., combustion/fire, corrosion, toxic substance, degradation; 6) radiant energy hazards, i.e., heat, light, radio frequency, x-ray, etc.; and 7) biological hazards, i.e., allergens, infectious agents, agents causing disease in humans, factors affecting physical and mental fatigue in human, etc.

Risk is a chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard. It may also apply to a situation with property or equipment loss. Factors that influence the degree of risk include 1) how much a person is exposed to a hazardous thing or condition, 2) how the person is exposed (e.g., breathing in a vapor, skin contact), and 3) how severe are the effects under the conditions of exposure. In practical terms, risk assessment can be made at the workplace to identify hazards (i.e., things, situations, processes, etc.) that may cause harm, particularly to people. After hazard identification is made, one can evaluate how likely and severe the risk is, and then decide what measures should be in place to effectively prevent or control the harm from happening.

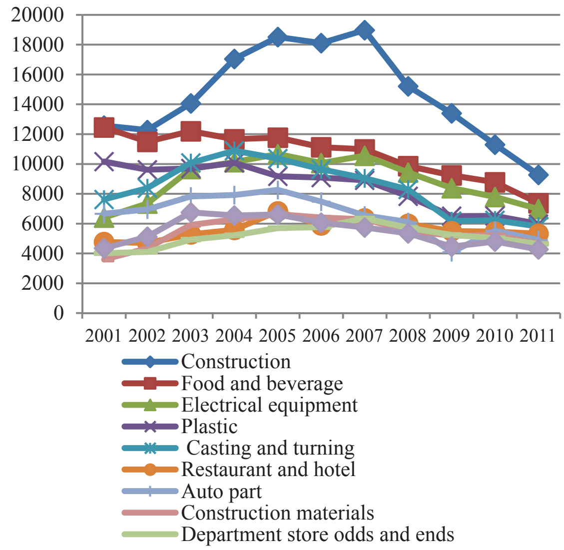

Figure 4: Accidents by type of industries in Thailand during 2000 to 2011.

3.2 *Construction accident characteristics and their trends*

To the recorded data on work-related accidents and incidents in Thailand from the years 2001 to 2011, the construction industry has been on the top list of the most hazardous work sectors among 131 industries (see Figure 4).

Based on the statistical data published from 1996 to 2011 from 7 countries (Japan, Singapore, USA, South Korea, Malaysia, Hong Kong, and Taiwan), construction is the most hazardous industry. It has been reported with has the greatest number on work-related accidents and incidents as given in Table 1 [46] (Appendix).

From Table 1 (Appendix), 11% of work-related injuries,3,865,657 of 30,589,397 workers) has been found in the construction industry (see Figure 5). In addition, the rate of severe work-related injuries in the construction industry is much higher than other industries. Approximately 19% of work-related fatalities have been found in the construction industry (see Figure 6).

Based on the accidental records of 31 construction companies, a total of 1,252 cases of workplace accidents were found. There are 1% of deaths, 1% of permanent disables, 23% of over 3 days away from work, and

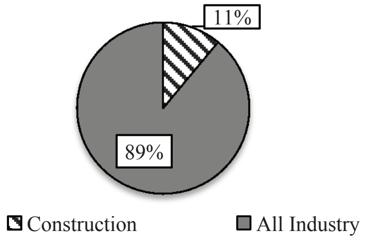

Figure 5: Rate of work-related injuries.

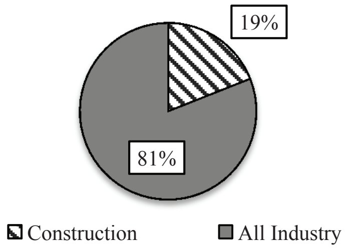

Figure 6: Rate of work-related fatalities.

75% of equal or less than 3 days away from work (See Table 2).

Table 2: Summary of workplace accidents from 31 construction companies

Severity of injuries	Number of Victims (person)		
	Male	***Female***	***Total***
Fatal Injuries	16	-	16
Permanent Disables	13	3	16
Temporary Disables (>3 Days)	239	47	286
Temporary Disables (<=3 Days)	792	142	934
Total	1,060	192	1,252

One-way ANOVA is used to compare the rate of work-related accidents and incidents of the construction industry in Thailand with that in other 7 countries. It is found that the rate of work-related accidents and incidents of the construction industry among 8 countries is significantly different at 95% confidence level, as shown in details below. Figure 7 illustrates the rate of work-related accidents and injuries on average among 8 countries. In addition, A Mann-Whitney pairwise comparison among the means of the rate of work-related accidents and incidents of the construction industry in all 8 countries is made (see Table 3 and 4).

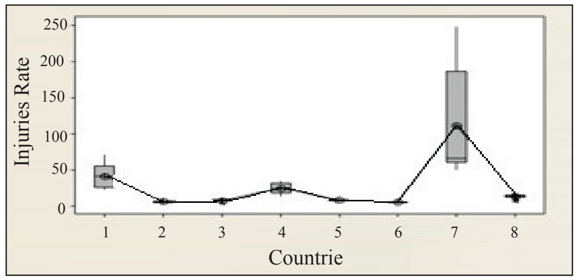

Figure 7: An average of rate of work-related accidents and injuries among 8 countries.

Table 3: Analysis of Variance

One-way ANOVA: Injury Rate versus Countries

Source	DF	SS	MS	F	P
Countries	7	145769	20824	30.07	0.000
Error	120	83094	692		
Total	127	228863			

S = 26.31 R-Sq = 63.69% R-Sq(adj) = 61.57%

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev
1	16	41.25	15.29
2	16	5.81	1.20
3	16	7.36	1.12
4	16	24.03	7.00
5	16	8.61	2.24
6	16	4.97	0.93
7	16	110.90	72.40
8	16	12.81	2.63

Pooled StDev = 26.31

Grouping Information Using Fisher Method

Countries	N	Mean	Grouping
7	16	110.89	A
1	16	41.25	B
4	16	24.03	B C
8	16	12.81	C D
5	16	8.61	C D
3	16	7.36	C D
2	16	5.81	C D
6	16	4.91	D

Means that do not share a letter are significantly different.

Fisher 95% Individual Confidence Intervals
All Pairwise Comparisons among Levels of Countries
Simultaneous confidence level = 50.03

Table 4: A pairwise analysis of work-related accidents and injuries among 8 countries

Compare	Median	P-value
1 vs 2	41.25 vs 5.81	0.0000*
1 vs 3	41.25 vs 7.36	0.0000*
1 vs 4	41.25 vs 24.03	0.0018*
1 vs 5	41.25 vs 8.61	0.0000*
1 vs 6	41.25 vs 4.97	0.0000*
1 vs 7	41.25 vs 110.90	0.0001*
1 vs 8	41.25 vs 12.81	0.0000*
2 vs 3	5.81 vs 7.36	0.0009*
2 vs 4	5.81 vs 24.03	0.0000*
2 vs 5	5.81 vs 8.61	0.0001*
2 vs 6	5.81 vs 4.97	0.0479*
2 vs 7	5.81 vs 110.90	0.0000*
2 vs 8	5.81 vs 12.81	0.0000*
3 vs 4	7.36 vs 24.03	0.0000*
3 vs 5	7.36 vs 8.61	0.1871
3 vs 6	7.36 vs 4.97	0.0000*
3 vs 7	7.36 vs 110.90	0.0000*
3 vs 8	7.36 vs 12.81	0.0001*
4 vs 5	24.03 vs 8.61	0.0000*
4 vs 6	24.03 vs 4.97	0.0000*
4 vs 7	24.03 vs 110.90	0.0000*
4 vs 8	24.03 vs 12.81	0.0001*
5 vs 6	8.61 vs 4.97	0.0000*
5 vs 7	8.61 vs 110.90	0.0000*
5 vs 8	8.61 vs 12.81	0.0002*
6 vs 7	4.97 vs 110.90	0.0000*
6 vs 8	4.97 vs 12.81	0.0000*
7 vs 8	110.90 vs 12.81	0.0000*

P = 0.05 significant difference

3.3 *Macroergonomics findings*

Based on the Macroergonomics model, details of four major elements are explained as follows:

3.3.1 Personnel subsystem

The current study found that males and females have almost the same rate of accidents, 20 and 17% respectively (see Figure 8). Construction operators, 170 males and 34 females with the age of 25–34 years, have the highest rate of workplace accidents due to skill-based errors (see Figure 9). Additionally, construction operators, 190 males and 36 females with

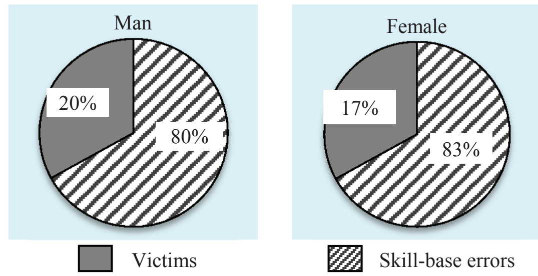

Figure 8: Workplace accidents due to skill based errors made by males and females.

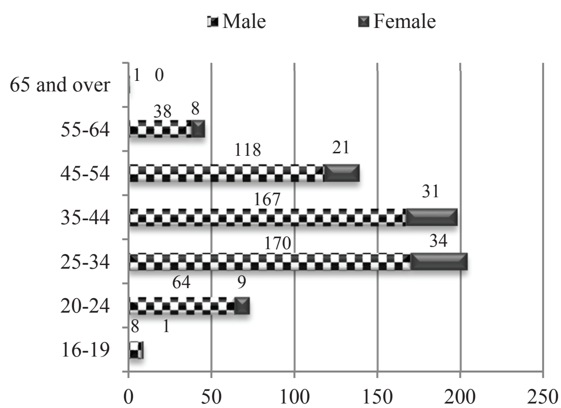

Figure 9: Workplace accidents due to skill based errors among construction operators in different age groups.

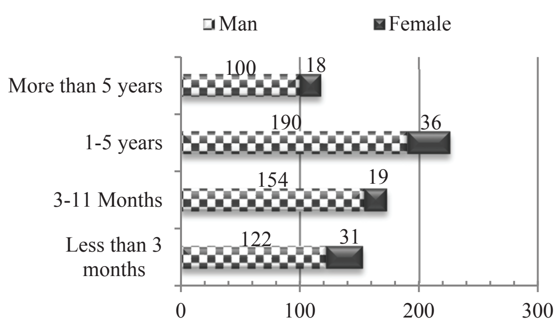

Figure 10: Workplace accidents among construction operators in different length of service.

1–5 years of work experiences, are at the highest risk of workplace accidents (see Figure 10). Construction operators, 27% males and 23% females, have the highest rate of workplace accidents due to violations (see Figure 11). Construction operators, both males and females with age of 25–54 years, are at the highest risk of workplace accidents (see Figure 12).

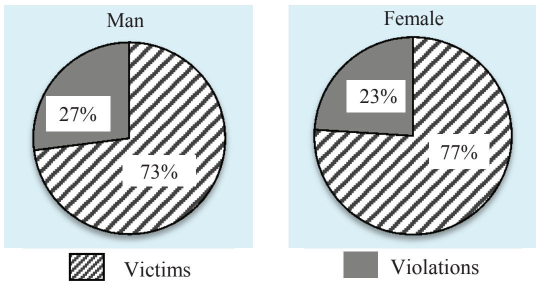

Figure 11: Workplace accidents due to violations made by males and females.

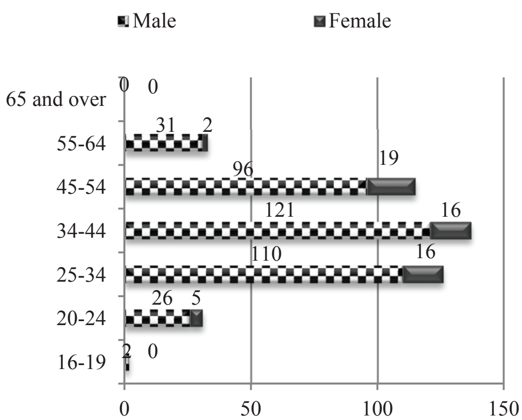

Figure 12: Workplace accidents due to violations among construction operators in different age groups.

Two types of unsafe acts from operators- errors and violations have been found as major causes of accidents in construction industry of Thailand. Errors made by operators represent their mental or physical activities of individuals that fail to manage their goals or planned procedures. On the other hand, violations refer to the acts of breaking rules, laws, or regulations of obligations or promises. Not surprisingly, given the fact that humans, by their very nature, make errors, these unsafe acts dominate most accident databases. Overall, male operators are at higher risk than female counterpart for construction workplace accidents.

3.3.2 Technological subsystem

There is a small contribution of technological subsystem (mainly from maintenance and repair services) to workplace accidents in construction safety. Most software programs are being used in large-size companies in the construction industry of Thailand.

Table 5 shows agents of accidents in the Malaysia's construction industry. Agents such as nails, knives, materials scraps, and hammers are sharp objects/items in the working environment category caused most accidents (Agent 4 with 495 cases of accidents).

Table 5: Agents of construction accidents

Agent	Reported Cases
1. Hand Tools	241
2. Equipment	79
3. Buildings, Floor, Stair, and Wall Openings	69
4. Sharp Objects/Items	495
5. Work Postures	34
6. Vehicles	13
7. Gas	6
8. Boiler and Pressure	4
9. Electricity	34
10. Toxic/Chemical Substances	31
11. Working Environments	195
12. Human and Animal	39
13. Others	12

3.3.3 Internal and external environments

External environments refer to the growth of economy. It is found that the growth of economy indicated by GDP value had a direct impact on the rate of workplace accidents in the construction industry. Therefore, it is suggested that the rate of workplace accidents among construction operators increases when GDP increases. Even though the number of accidents appear to decrease, overall losses continue to grow, especially when compared to other countries [6].Tables 6 and 7 illustrate GDPs of Thailand and rates of work-related injuries in construction industry during 2007–2011.

Table 6: Thailand GDP during 2007–2011

	2007	2008	2009	2010	2011
GDP Value Million THB	263,388[9]	266,943[9]	271,297[9]	303,008[9]	281,877[9]
Number of Injuries	18,979[8]	15,207[8]	13,396[8]	11,295[8]	9,275[8]
Number of Employees	332,290[7]	342,898[7]	377,721[7]	361,183[7]	355,186[7]
Injury rate per 1,000 Employees	57.1*	44.4*	35.5*	31.3*	26.1*

Source: modified from [7]–[9].
* calculated value

Table 7: Rates of work-related injuries in construction industry of Thailand during 2007 to 2011

Severity of Injuries	2007	2008	2009	2010	2011
Fatal Injuries	112	83	86	79	80
Disables	134	131	130	107	47
Nonfatal Injuries	18,733	14,993	18,733	12,733	9,148
Total	18,979	15,207	13,396	11,295	9,275

Source: modified from [7].

3.3.4 Organizational design and structure

Organizational design refers to the design of an organization's work system structure and its working process to achieve ultimate goals of the organization. Three major dimensions of the organizational structure of a work system are complexity, formalization, and centralization. In this study, the characteristics of organizational design are addressed below. In sum, the small construction company with low complexity, low formalization and high centralization poses the highest risk of workplace accidents (see Table 8).

Table 8: Organizational Characteristics

Size	Complexity	Formalization	Centralization
Large	High	High	Low
Medium	High	Medium	High
Small	Low	Low	High

3.4 *HFACS findings*

Results from unsafe acts and preconditions of unsafe acts listings of HFACS are given in Table 9.

Table 9: Results unsafe acts and precondition of unsafe acts

HFACS Category	n	(%)
Preconditions for Unsafe Acts	913	(72.92)
Environmental factors	394	(31.46)
Personal factors	247	(19.73)
Conditions of operators	277	(22.12)
Unsafe Acts	1114	(88.97)
Errors	670	(53.51)
Violations	444	(35.46)

Note: that HFACS levels may add up to more than 100% as more than one category at a given level can be identified for each case.

These unsafe acts and preconditions of unsafe acts findings revealed that recent construction accidents often involved the adoption of work methods and procedures such as for inappropriate equipment use and poor work system design. The data obtained suggetsed that using inappropriate equipment and being under poor work system design circumstance can result in injuries, deaths and property losses.

4 Conclusions and Discussions

Findings show that the number of accidents in construction industry remain very high as compared to that in other industries due to the unique characteristics of its work system especially the organizational influences. It has been found that major construction accidents are resulted from unsafe acts (88.97%) and preconditions for unsafe acts (72.92%) as given in Table 9. Some limitations of this research need to be addressed. First, the limited number of publications, company case studies, and accidental records does not represent the most updated statistics information on construction safety. Studies on construction safety regarding changes in technologies, individual differences in work systems and their cultures should be investigated. Future research should focus on how to help raise safety awareness and provide a better understanding on the ways to reduce construction accidents, injuries, and losses.

Based on macroergonomics and HFACS theories, more details on personnel and technological subsystems, internal and external environments, and organization/management are needed to explore. Impaired conditions of construction workers (i.e., adverse mental states, adverse physiological states, and physical/mental limitations) with poor personal factors (i.e., lack of crew resource management, and inadequate personal readiness) under inappropriate environmental factors (i.e., physical and technological environments) can easily lead to accidents. In addition, individuals with unsafe acts (i.e., always have skill-based/decision/perceptual errors and/or act in routine/exceptional violations) are more likely to cause or are involved in accidents. Changes in unsafe human behaviors and environmental and personnel factors are critical to make construction safe. As such, improvements for organizational safety in construction industry need to seek the better understandings of the origins of work system failures in the future work.

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Appendix

Table 1: Rates of work-related injuries in construction industry and in other industries during 1996 to 2011

Countries	Industries	Severity of injuries	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Thailand	Construction	Fatal injuries	200[7]	217[7]	161[7]	106[7]	98[7]	93[7]	98[7]	106[7]	109[7]	207[7]	115[7]	112[7]	83[7]	86[7]	79[7]	80[7]
		Disables	367[7]	554[7]	248[7]	127[7]	133[7]	129[7]	124[7]	127[7]	153[7]	157[7]	105[7]	134[7]	131[7]	130[7]	107[7]	47[7]
		Nonfatal injuries	37,308[7]	36,983[7]	23,210[7]	15,767[7]	11,995[7]	12,347[7]	12,052[7]	13,827[7]	16,788[7]	18,152[7]	17,888[7]	18,733[7]	14,993[7]	18,733[7]	12,733[7]	9,148[7]
		Total	37,875[7]	37,754[7]	23,619[7]	16,000[7]	12,226[7]	12,569[7]	12,274[7]	14,060[7]	17,050[7]	18,516[7]	18,108[7]	18,979[7]	15,207[7]	13,396[7]	11,295[7]	9,275[7]
		Workers	733,640[7]	532,300[7]	623,837**	712,335[7]	554,199[7]	523,828[7]	486,067[7]	310,148[7]	299,659[7]	331,838**	340,052[7]	332,290[7]	342,898[7]	377,721[7]	361,183[7]	355,186[7]
		Injury rate per 1,000 workers	51.6*	70.9*	37.9*	22.5*	22.1*	24.00*	25.3*	45.3*	56.9*	55.8*	53.3*	57.1*	44.4*	35.5*	31.3*	26.1*
	All Industry	Fatal injuries	962[7]	1,033[7]	790[7]	611[7]	620[7]	607[7]	650[7]	787[7]	861[7]	1,444[7]	808[7]	741[7]	613[7]	597[7]	619[7]	590[7]
		Disables	5,060[7]	5,301[7]	3,733[7]	3,408[7]	3,532[7]	3,530[7]	3,438[7]	3,838[7]	3,798[7]	3,444[7]	3,434[7]	3,275[7]	3,111[7]	2,391[7]	2,160[7]	1,634[7]
		Nonfatal injuries	239,594[7]	224,042[7]	181,975[7]	167,978[7]	175,414[7]	185,484[7]	186,891[7]	206,048[7]	210,875[7]	209,347[7]	200,015[7]	66,242[7]	172,778[7]	52,397[7]	143,732[7]	127,408[7]
		Total	245,616[7]	230,376[7]	186,498[7]	171,997[7]	179,566[7]	189,621[7]	190,979[7]	210,673[7]	215,534[7]	214,235[7]	204,257[7]	198,652[7]	176,502[7]	149,436[7]	146,511[7]	129,632[7]
Japan	Construction	Fatal injuries	1,001[11]	848[11]	725[11]	794[11]	731[11]	644[12]	607[12]	548[12]	594[12]	497[12]	508[12]	417*	430[7]	371[7]	365[7]	510[7]
		Nonfatal injuries	43,885*	40,840*	37,392*	34,596*	32,868*	31,964*	30,043*	28,715*	27,820*	26,696*	26,364*	27,413*	23,952*	21,114*	21,033*	16,473*
		Total	44,886[11]	41,688[11]	38,117[11]	35,310[11]	33,599[11]	32,608[12]	30,650[12]	29,263[12]	28,414[12]	27,193[12]	26,872[12]	27,830**	24,382	21,485**	21,398[14]	16,983[7]
		Workers	5,775,000[15]	5,630,000[10]	5,480,000[10]	5,440,000[10]	5,330,000[10]	5,260,000[10]	5,030,000[10]	4,880,000[10]	4,980,000[10]	4,688,449*	4,144,037[16]	5,520,000[17]	5,370,000[17]	5,170,000[17]	4,980,000[17]	4,730,000[45]
		Injury rate per 1,000 workers	7.8*	7.4*	7.0*	6.5[10]	6.3[10]	6.2[10]	6.1[10]	6.0[10]	5.7*	5.8[10]	6.5*	5.0*	4.5*	4.2*	4.3*	3.6*

Note: * calculating results, ** forecasting results

Table 1: Rates of work-related injuries in construction industry and in other industries during 1996 to 2011 (continue)

Countries	Industries	Severity of injuries	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Japan	All Industry	Fatal injuries	2,363[11]	2,078[11]	1,844[11]	1,992[11]	1,889[11]	1,790[12]	1,658[12]	1,628[12]	1,620[12]	1,514[5]	1,472[12]	1,357[15]	1,268[7]	1,075[7]	1,195[7]	1,024[7]
		Nonfatal injuries	160,499*	154,648*	146,404*	135,324*	132,059*	131,808*	124,260*	124,122*	121,184*	118,840*	119,906*	119,999*	18,023*	104,643*	106,564*	118,598*
		Total	162,862[11]	156,726[11]	148,248[11]	137,316[11]	133,948[11]	133,598[12]	125,918[12]	125,750[12]	122,804[12]	120,354[12]	121,378[12]	121,356[15]	119,291[15]	105,718[15]	107,759[14]	119,622[7]
Singapore	Construction	Fatal injuries	51[16]	72[16]	67[16]	48[16]	49[16]	27[16]	38[16]	31[16]	24[16]	22[16]	24[16]	24[16]	25[16]	31[16]	32[16]	22[16]
		Disables	33[16]	49[16]	51[16]	44[16]	37[16]	24[16]	26[16]	29[16]	19[16]	20[16]	27[16]	35[16]	35[16]	44[16]	38[16]	30[16]
		Nonfatal injuries	1,159[16]	1,417[16]	1,414[16]	1,412[16]	1309[16]	1,404[16]	1,273[16]	1,133[16]	1,173[16]	1,258[16]	2,364[16]	2,401[16]	2,804[16]	2,778[16]	2,336[16]	1,820[16]
		Total	1,243[16]	1,538[16]	1,532[16]	1,504[16]	1,395[16]	1,445[16]	1,337[16]	1,193[16]	1,216[16]	1,300[16]	2,415[16]	2,460[16]	2,864[16]	2,853[16]	2,406[16]	1,872[16]
		Workers	214,545**	213,612*	212,778*	197,895*	199,286*	184,178*	171,411*	156,974*	148,239*	183,099*	254,211*	295,900[14]	353,400[14]	377,300[14]	380,700[14]	402,700[14]
		Injury rate per 1,000 workers	5.8*	7.2[10]	7.2[10]	7.6[10]	7.0[10]	7.9[10]	7.8[10]	7.6[10]	8.2[10]	7.1[10]	9.5[10]	8.3*	8.1*	7.6*	6.3*	4.6*
	All Industry	Fatal injuries	73[16]	103[16]	91[16]	69[16]	74[16]	52[16]	64[16]	55[16]	51[16]	47[16]	62[16]	63[16]	67[16]	70[16]	55[16]	61[16]
		Disables	107[16]	124[16]	161[16]	143[16]	111[16]	83[16]	91[16]	87[16]	93[16]	94[16]	168[16]	163[16]	132[16]	126[16]	136[16]	121[16]
		Nonfatal injuries	4,126[16]	4,195[16]	3,995[16]	3,741[16]	3,334[16]	3,655[16]	3,233[16]	3,037[16]	3,139[16]	3,258[16]	9,031[16]	9,792[16]	10,873[16]	10,638[16]	10,128[16]	9,939[16]
		Total	4,306[16]	4,422[16]	4,247[16]	3,953[16]	3,519[16]	3,790[16]	3,388[16]	3,179[16]	3,283[16]	3,399[16]	8,604[16]	10,018[16]	11,072[16]	10,834[16]	10,319[16]	10,121[16]
USA	Construction	Fatal injuries	1,047[17]	1,107[17]	1,174[17]	1,191[17]	1,155[17]	1,226[17]	1,125[17]	1,171[17]	1,234[17]	1,243[17]	1,239[17]	1,204[17]	975[17]	834[17]	774[17]	721[17]
		Nonfatal injuries	182,300[17]	189,800[17]	178,300[17]	193,800[17]	194,400[17]	185,700[17]	163,600[17]	1,554,200[17]	153,200[17]	157,070[17]	153,180[17]	135,350[17]	120,240[17]	92,540[17]	74,950[17]	71,600[17]

Note: * calculating results, ** forecasting results

Table 1: Rates of work-related injuries in construction industry and in other industries during 1996 to 2011 (continue)

Countries	Industries	Severity of injuries	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
USA	Construction	Total	183,347[17]	190,907[17]	179,474[17]	194,991[17]	195,555[17]	186,926[17]	164,725[17]	156,591[17]	154,434[17]	158,313[17]	154,419[17]	136,554[17]	121,215[17]	93,374[17]	75,724[17]	72,321[17]
		Workers	5,460,000[19]	5,664,853[19]	5,798,942[19]	6,201,626[19]	6,572,800[19]	6,491,994[19]	6,307,370[19]	6,381,404[19]	6,647,641[19]	6,781,327[19]	7,339,100[19]	7,268,000[19]	7,044,000[19]	6,201,626[19]	5,498,000[19]	5,500,000[19]
		Injury rate per 1,000 workers	33.6*	33.7*	31.0*	31.4*	29.8*	28.8*	26.1*	24.5*	23.2*	23.3*	21.0*	18.8*	17.2*	15.1*	13.8*	13.2*
	All Industry	Fatal injuries	6,202[17]	6,238[17]	6,055[17]	6,054[17]	5,920[17]	5,915[17]	5,534[17]	5,575[17]	5,764[17]	5,734[17]	5,840[17]	5,657[17]	5,214[17]	4,551[17]	4,690[17]	4,693[17]
		Nonfatal injuries	1,880,500 [17]	1,833,40 [17]	1,730,500 [17]	1,702,500 [17]	1,664,000 [17]	1,537,600 [17]	1,436,200 [17]	1,315,920 [17]	1,259,320 [17]	1,234,680 [17]	1,183,500 [17]	1,158,870 [17]	1,078,140 [17]	964,990 [17]	933,200 [17]	908,310 [17]
		Total	1,886,702*	1,839,638*	1,736,555*	1,708,554*	1,669,920*	1,543,515*	1,441,734*	1,321,495*	1,265,084*	1,240,414*	1,189,340*	1,164,527*	1,083,354*	969,541*	937,890*	913,003*
South Korea	Construction	Fatal injuries	789[18]	798[18]	650[18]	583[18]	614[18]	659[18]	667[18]	762[18]	779[21]	609[21]	631[21]	630[21]	669[21]	606[19]	611[19]	621[19]
		Nonfatal injuries	18,973*	17,493*	12,522*	10,372*	12,745*	16,112*	19,258*	21,918*	18,117*	15,309*	17,324*	18,420*	19,804*	20,392*	21,893*	22,161*
		Total	19,762[18]	18,291[18]	13,172[18]	10,955[18]	13,359[18]	16,771[18]	19,925[18]	22,680[18]	18,896[21]	15,918[21]	17,955[21]	19,050[21]	20,473[21]	20,998[20]	22,504[20]	22,782[19]
		Workers	2,439,754*	2,540,417*	1,804,384*	1,825,834*	2,190,000*	2,430,580*	2,767,361*	2,637,210*	2,010,213*	2,122,400*	2,296,000[12]	2,304,000[12]	2,186,000[12]	1,720,000[11]	1,753,000[11]	1,751,000[11]
		Injury rate per 1,000 workers	8.1[10]	7.2[10]	7.3[10]	6.0[10]	6.1[10]	6.9[10]	7.2[10]	8.6[10]	9.4[10]	7.5[10]	7.8*	8.3*	9.4*	12.2*	12.8*	13.0*
	All Industry	Fatal injuries	2,670[19]	2,742[19]	2,212[19]	2,291[19]	2,528[19]	2,748[19]	2,605[19]	2,923[19]	2,825[19]	2,493[19]	2,453[19]	2,406[19]	2,422[19]	2,181[19]	2,200[19]	2,114[19]
		Nonfatal injuries	68,878*	64,028*	49,302*	53,114*	66,448*	78,686*	79,306*	92,001*	86,049*	82,918*	87,457*	87,741*	93,384*	95,640*	96,445*	91,178*

Note: * calculating results, ** forecasting results

Table 1: Rates of work-related injuries in construction industry and in other industries during 1996 to 2011 (continue)

Countries	Industries	Severity of injuries	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
		Total	71,548[19]	66,770[19]	51,514[19]	55,405[19]	68,976[19]	81,434[19]	81,911[19]	94,924[19]	88,874[19]	85,411[19]	89,910[19]	90,147[19]	95,806[19]	97,821[19]	98,645[19]	93,292[19]
Malaysia	Construction	Fatal injuries	116[29]	81[29]	124[29]	146[23]	159[23]	89[23]	88[23]	95[23]	81[28]	127[28]	64[28]	76[28]	64[28]	45[28]	88[37]	62**
		Disables	476[29]	459[29]	571[29]	610[27]	642[27]	618[27]	652[27]	566[28]	566[28]	566[28]	543[28]	589[28]	552[28]	691[28]	815[37]	635**
		Nonfatal injuries	4,710*	2,970*	2,848*	3,991*	4,072*	3,886*	4,275*	3,993*	3,798*	3,267*	3,079*	3,038*	3,122*	3,372*	4,813[37]	4,240*
		Total	5,302[29]	3,510[22]	3,543[29]	4,747[22]	4,873[22]	4,593[22]	5,015[22]	4,654[22]	4,445[22]	3,960[28]	3,686[28]	3,703[28]	3,738[28]	4,108[28]	5,716[37]	4,937**
		Workers	796,000[23]	876,100[23]	765,300[23]	748,800[23]	759,000[28]	829,800[22]	905,100[28]	942,500[28]	890,800[28]	904,400[28]	908,900[28]	922,500[28]	998,000[28]	1,015,900[28]	1,082,700[28]	1,133,600[28]
		Injury rate per 1,000 workers	6.7*	4.0*	4.6*	6.3*	6.4*	5.5*	5.5*	4.9*	5.0*	4.4*	4.1*	4.0*	3.8*	4.0*	5.3*	5.1*
	All Industry	Fatal injuries	1,020[25]	1,473[25]	1,273[25]	984[25]	911[25]	976[33]	989[33]	958[33]	1,034[33]	973[33]	926[33]	755[31]	981[31]	1,231[36]	1,194[36]	1,254[36]
		Disables	17,038[25]	19,374[25]	21,130[25]	17,264[25]	20,009[25]	10,423[30]	11,932[26]	9,589[30]	9,796[30]	9,796[30]	9,101[33]	9,555[24]	10,931[35]	13,228[35]	13,972[35]	11,439**
		Nonfatal injuries	88,450*	65,742*	62,935*	73,826*	74,086*	74,4467*	68,889*	63,306*	58,302*	51,131*	48,294*	46,029*	42,201*	40,727*	42,473*	47,204*
		Total	106,508[25]	86,589[25]	85,338[25]	92,074[22]	95,006[26]	85,866[22]	81,810[32]	73,858[22]	69,132[32]	61,882[32]	58,321[32]	56,339[34]	54,113[34]	55,186[34]	57,639[36]	59,897[36]
Hong Kong	Construction	Fatal injuries	51[17]	41[17]	56[40]	47[39]	29[39]	28[40]	24[40]	25[40]	17[40]	25[40]	16[40]	19[40]	20[42]	19[41]	9[41]	23[41]
		Nonfatal injuries	16,418*	18,518*	19,532*	14,031*	11,896*	9,178*	6,215*	4,342*	3,816*	3,523*	3,384*	3,023*	3,013*	2,736*	2,875*	3,089*
		Total	16,469[38]	18,559[38]	19,588[38]	14,078[38]	11,925[38]	9,206[38]	6,239[38]	4,367[38]	3,833[38]	3,548[38]	3,400[38]	3,042[38]	3,033[42]	2,755[41]	2,884[41]	3,112[41]
		Workers	74,907[20]	81,629[20]	79,007[20]	70,900[10]	79,600[10]	80,300[10]	73,200[10]	64,100[10]	63,500[10]	59,300[10]	52,900[10]	50,200[10]	49,422[21]	50,501[21]	55,341[21]	62,635[21]

Note: * calculating results, ** forecasting results

Table 1: Rates of work-related injuries in construction industry and in other industries during 1996 to 2011 (continue)

Countries	Industries	Severity of injuries	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
		Injury rate per 1,000 workers	219.9[20]	227.4[20]	247.9[20]	198.6[10]	149.8[10]	114.6[10]	85.2[10]	68.1[10]	60.4[10]	59.8[10]	64.3[10]	60.6[10]	61.4*	54.6*	52.1*	49.7*
	All Industry	Fatal injuries	66[42]	58[42]	68[42]	52[42]	43[42]	34[42]	25[42]	28[42]	24[42]	29[42]	26[42]	25[42]	24[42]	21[13]	18[13]	29[13]
		Nonfatal injuries	40,185*	43,247*	42,966*	35,934*	33,609*	28,484*	22,428*	17,221*	17,509*	16,888*	17,260*	16,092*	14,908*	13,579*	13,997*	13,571*
		Total	40,251[42]	43,305[42]	43,034[42]	35,986[42]	33,652[42]	28,518[42]	22,453[42]	17,249[42]	17,533[42]	16,917[42]	17,286[42]	16,117[42]	14,932[42]	13,600[13]	14,015[13]	13,658[13]
Taiwan	Construction	Fatal injuries	160[44]	188[44]	183[44]	146[44]	206[44]	185[43]	165[45]	171[46]	122[46]	165[46]	167[46]	124[46]	116[46]	118[46]	106[46]	121[46]
		Disables	990**	932**	877**	825**	836[44]	868[43]	827[46]	671[46]	658[46]	669[46]	654[46]	687[46]	594[46]	580[46]	553[46]	590[46]
		Nonfatal injuries	3,812*	4,411*	5,960*	7,286*	10,187*	10,062*	9,447[46]	9,462[46]	10,003[46]	9,694[46]	10,401[46]	10,516[46]	11,113[46]	10,890[46]	11,001[46]	11,0453[46]
		Total	4,962[44]	5,531[44]	6,750[44]	8,257[44]	11,229[44]	11,115[43]	10,439[46]	10,304[46]	10,783[46]	10,528[46]	11,222[46]	11,327[46]	11,823[46]	11,588[46]	11,660[46]	11,756[46]
		Workers	756,634*	724,712*	720,769*	710,830*	837,985*	745,000[18]	724,000[18]	701,000[18]	732,000[18]	791,000[18]	829,000[18]	846,000[18]	842,000[18]	788,000[18]	797,000[18]	831,000[18]
		Injury rate per 1,000 workers	6.6[10]	7.6[10]	9.4[10]	11.6[10]	13.4[10]	14.9*	14.4*	14.7*	14.7*	13.3*	13.5*	13.4*	14.0*	14.7*	14.6*	14.1*
	All Industry	Fatal injuries	728**	679**	634**	650[45]	602[45]	543[45]	507[43]	401[43]	366[43]	382[43]	325[43]	293[43]	320[43]	301[43]	281[43]	319[43]
		Disables	6,114**	5,762**	5,431**	4,815[45]	5,207[45]	4,839[45]	4,456[43]	3,974[43]	3,695[43]	3,361[43]	3,321[43]	3,113[43]	2,992[43]	2,588[43]	2,677[43]	2,840[43]
		Nonfatal injuries	23,848*	27,779*	32,545*	28,244*	33,053*	33,004*	31,363*	32,113*	34,094*	33,605*	35,338*	35,391*	37,346*	35,317*	37,110*	36,193*
		Total	30,690**	34,220**	38,610**	33,709[45]	38,862[45]	38,386[45]	36,326[43]	36,488[43]	38,155[43]	37,348[43]	38,984[43]	38,797[43]	40,658[43]	38,206[43]	37,110[43]	40,001[43]

Note: * calculating results, ** forecasting results