CHAPTER 4

RESEARCH METHODOLOGY

4.1 Study Design

This study is descriptive. The Human Capital Approach is applied to estimate economic loss based on secondary data of approved work injury claimants, in the year 2000. In addition, time-series data of the National Income (NI) and compensate of employees are applied to obtain the expected earning growth. According to different economic level of each region, indirect loss is estimated by region. To analyze the determinants of work injury rate, this study applies time-series data from 1981 to 2000 using multiple linear regression.

4.2 Operational Definitions

Work accident:	Unexpected and accidental event in workplace resulting person to be injured, disabled, die, or asset loss, including production delaying, halting or, time loss
Work injury:	An injury, whether physically or mentally, sustained by employees during work performance, resulting in temporary disability, organ loss, permanent disability, or death, including suffering from occupational diseases
Work injury rate:	The rate representing the work injury probability of workers under WCF coverage
Compensation payment:	Money paid to workers as employer's liability for work injury, illness, disability, or death
Economic loss:	Opportunity loss or benefit foregone if the resources have alternative use as input of other activities in economic system.
Death rate:	The rate of specific event occurring in a particular year per average population of that year, mid-year population

Mortality rate:	The rate representing the risks of death to population in a specific time period

4.3 Creating a Life Table and a Working Life Table

4.3.1 Life table

Prasatkul and Wapatanawong (2001) presented that life table is a statistical table, which is created to indicate population's survival condition based on the death rate, then calculate the probability of dying or probability of surviving, and an average remaining life-year or "Life Expectancy." At the same time, the life table concludes specific death rates for respective age groups. Therefore, the life table can also be called the "Mortality table." The advantage of the life table over other death indicators is the fact that the life table cannot be affected by population structure, and can be compared at inter-country level. Basic data for constructing a life table is age specific death rate, which is essential in calculation of the probability of dying or the probability of surviving and, person-year lived.

The authors also mentioned that the life table could be divided into 2 types according to the details provided. A complete life table provides details for every year of age starting from birth to the last possible year of living. An abridged life table provides details for certain age group, i.e., 5 or 10-year interval. Generally, the abridged life table provides sufficient details for general proposes. Abridged life tables normally use a 5-year interval with 1-year interval for age under 1, and open for the age over 80.

Keeping in mind a concept that people working age may not end up at 60, the abridged life table is constructed based on midyear population and number of deaths by age group. Secondary data of work injuries by age and by severity is available by region, not by gender. Therefore, this study creates only one abridged life table for Thai population subject to

the steps as described in Chapter 3 "Steps of creating a life table." (Prasatkul and Wapatanawong, 2001: 29-49)

Assumptions for creating an abridged life table in this study:

- Population is closed population, which may be changed only by death.
- Death in population follows death patterns by age group and constant over the time period.
- Number of deaths is uniform distribution in each age group.
- Pattern of death is gender unique.

The abridged life table of Thai population in 2000 is presented as follows:

Table 4.1: Abridged Life table of Thai population, 2000

Age group X	Population in age gr.	No. of Deaths	Death rate ${}_nM_x$	Prob. of dying in interval ${}_nq_x$	Life table survivors I_x	Deaths in interval ${}_nD_x$	Years lived in interval ${}_nL_x$	Cumulative years lived T_x	Life expectancy e_x
< 1	742,750	4822	0.00649	0.00647	100,000.0	647.1	99,676.4	7,465,264.7	74.65
1-4	3,619,648	4402	0.00122	0.00485	99,352.9	482.1	396,447.3	7,365,588.3	74.14
5-9	4,785,879	3246	0.00068	0.00339	98,870.8	334.7	493,517.0	6,969,141.0	70.49
10-14	4,563,973	2222	0.00049	0.00243	98,536.0	239.6	492,081.2	6,475,624.0	65.72
15-19	5,046,845	6289	0.00125	0.00621	98,296.5	610.5	489,955.9	5,983,542.8	60.87
20-24	5,416,372	11263	0.00208	0.01034	97,685.9	1,010.4	485,903.5	5,493,586.8	56.24
25-29	5,586,662	21355	0.00382	0.01893	96,675.5	1,830.2	478,802.0	5,007,683.3	51.80
30-34	5,623,738	24299	0.00432	0.02137	94,845.3	2,027.1	469,158.6	4,528,881.3	47.75
35-39	5,250,822	21298	0.00406	0.02008	92,818.1	1,863.5	459,432.0	4,059,722.7	43.74
40-44	4,496,700	19564	0.00435	0.02152	90,954.6	1,957.3	449,879.9	3,600,290.8	39.58
45-49	3,578,623	19352	0.00541	0.02668	88,997.3	2,374.2	439,051.0	3,150,410.9	35.40
50-54	2,718,420	19862	0.00731	0.03588	86,623.1	3,107.8	425,346.0	2,711,359.9	31.30
55-59	2,023,519	21479	0.01061	0.05170	83,515.3	4,317.9	406,781.9	2,286,013.9	27.37
60-64	1,802,902	27324	0.01516	0.07301	79,197.5	5,782.3	381,531.5	1,879,232.0	23.73
65-69	1,418,505	31929	0.02251	0.10655	73,415.1	7,822.3	347,519.9	1,497,700.5	20.40
70+	2,200,592	125496	0.05703	1.00000	65,592.8	67,688.0	1,150,180.6	1,150,180.6	17.54

Note: Computed from data in Appendix 2, Table 2.1 and Table 2.2, following the steps for creating a life table (Prasatkul and Wapatanawong, 2001: 29-49)

4.3.2 Working Life Table

Working life table is a method applying the life table to calculate an average remaining working life-year for individuals in working period or as labour force. Working life table can be called "Labour force status life table" or "Table of economically active life." In continuation from life table, working life table requires age-specific labour force participation rate. There are two types of working life tables, based on creation methods, namely, conventional working life table and increment-decrement working life table. (Prasatkul and Wapatanawong, 2001)

This study applies the age specific labour force participation rate in the life table to create a working life table in accordance with the steps as described in Prasatkul and Wapatanawong, 2001: pp. 125-135.

Assumptions for creating a working life table in this study:

- There is a unimodal curve of labour force participation. This means that the labour force participation rate is low at young age group, and gradually increases to the highest rate in a specific age group. After that, the labour force participation rate decreases.
- No change or departure of labour force participation before the age of the highest participation rate.
- No return of labour force after the age of the highest participation rate.

This study applies the labour force participation rate from Labour Force Participation Surveys, round 2/2000 – 4/2000, conducted by NSO. The survey was conducted in population aged 13 or over, the labour force participation rate for age ranging 13-14 is adjusted to be the rate applicable to the age group ranging 10-14 on the basis of even distribution. This study also assumes that the labour force participation rate of the age group 60 and over is the rate of the age ranging 60-64. The working life table of Thai population is presented in Table 4.2

Table 4.2: Working life table for Thai Population 2000

Age	Work part. rate		Life table Survivors		Years lived in interval		Cumulative years lived		Life Expectancy	
	${}_nLPR_x$	LPR_x	I_x	Iw_x	${}_nL_x$	${}_nLw_x$	T_x	Tw_x	e_x	ew_x
	(1)	(2)	(3)	(4)=(3)*(2)/100	(5)	(6)=(1)/100*(5)	(7)	(8)	(9)=(7)/(3)	(10)=(8)/(3)
<1	0	0	100,000	0	99,676	0	7,465,265	3,341,503	74.7	33.42
1-4	0	0	99,353	0	396,447	0	7,365,588	3,341,503	74.1	33.63
5-9	0	0	98,871	0	493,517	0	6,969,141	3,341,503	70.5	33.80
10-14	3.308	0	98,536	0	492,081	16,278	6,475,624	3,341,503	65.7	33.91
15-19	34.7	19.0	98,296	18,680	489,956	170,015	5,983,543	3,325,225	60.9	33.83
20-24	71.43	53.1	97,686	51,837	485,904	347,081	5,493,587	3,155,211	56.2	32.30
25-29	86.33	78.9	96,676	76,258	478,802	413,350	5,007,683	2,808,130	51.8	29.05
30-34	88.73	87.5	94,845	83,018	469,159	416,284	4,528,881	2,394,780	47.8	25.25
35-39	89.87	89.3	92,818	82,887	459,432	412,892	4,059,723	1,978,496	43.7	21.32
40-44	88.33	89.1	90,955	81,041	449,880	397,379	3,600,291	1,565,604	39.6	17.21
45-49	88.33	88.3	88,997	78,611	439,051	387,814	3,150,411	1,168,225	35.4	13.13
50-54	78.87	83.6	86,623	72,417	425,346	335,470	2,711,360	780,411	31.3	9.01
55-59	78.87	78.9	83,515	65,869	406,782	320,829	2,286,014	444,941	27.4	5.33
60-64	32.53	55.7	79,197	44,113	381,531	124,112	1,879,232	124,112	23.7	1.57
65-69	0	16.3	73,415	11,941	347,520	0	1,497,701	0	20.4	0.00
70+	0	0	65,593	0	1,150,181	0	1,150,181	0	17.5	0.00

Note: Computed from data in Appendix 2, Table 2.1, Table 2.2, and Table 2.3 following the steps creating a working life table (Prasatkul and Wapatanawong, 2001: 125-135)

4.4 Estimating the Economic Loss from Work Accidents

4.4.1 Earning loss due to premature death (IDL1) and permanent total disability (IDL2)

Indirect loss from work accident resulting in fatality or total disability is a productivity loss in the future, which can be estimated from expected earning if workers have not died or suffered from work accidents. This estimation is based on a major assumption that if workers have not died, they would have been able to work and earn money until the end of their working age. Therefore, future earning losses from premature death and total permanent disability are estimated by applying an average earning and remaining working year. The discount rate is applied to convert the earning loss into the present value.

Working year loss of each age group refers to the remaining working year of that specific age group. Working year loss is used in estimating the earning loss from premature death (IDL1) and permanent total disability (IDL2) at each age group as follows:

$$L_k = N_k * \sum_{i=1}^{e} \frac{Y_d(1+g)^i}{(1+r)^i}$$

L_k = present value of earning loss from premature death/permanent total disability at age group k by region

N_k = number of fatality/permanent total disability in age group k by region

Y_d = average yearly earning of private employees by region

e = remaining working year

i = time of year (i=o in the year of death/total disability)

g = expected income growth rate

r = discount rate

Earning loss from premature death (IDL1) and permanent total disability (IDL2) is the summation of earning losses of each age group from all regions at each level of severity.

4.4.2 Earning loss from permanent partial disability or organ loss (IDL3)

According to Boonsothorsathit (1991), the partial permanent disabilities had an average of 40 workdays lost for treatment and rehabilitation, and estimated the earning loss by multiplying 40 days to the average daily earning and the number of permanent partial disabilities.

For the expected earning loss, this study estimated the opportunity loss from permanent partial disability (IDL3) according to the number of cases by age based on a concept that the opportunity loss should not equal at different ages of becoming partially disabled.

$$L_o = N_o * p * \sum_{i=1}^{e} \frac{Y_d * (1+g)^i}{(1+r)^i}$$

L_o = present value of earning loss from organ loss at age group k by region

N_o = number of organ loss in age group k by region

p = average proportion of organ loss compared with death

Y_d = average yearly earning by region

e = remaining working year

i = time of year (i=o in the year of organ loss)

g = expected earning growth rate

r = discount rate

The total earning loss (IDL3) is the summation of loss from all regions.

4.4.3 Earning loss from temporary disability from work (IDL4, IDL5)

$$L_A = N_A * Y_m * (D_A/M)$$

L_A = value of earning loss by region

N_A = number of temporary disabilities by severity ($\leq$ 3days, > 3 days) by region

Y_m = average yearly earning by region

D_A = average workday loss for temporary absence (1.5, 15.58)

M = number of average working days per year

The total earning losses (IDL4, IDL5) are the summation of losses at all levels of severity from all regions.

Explanation and Measurement of Variables

Number of work injuries (N)

Work injury is legally defined as worker's injury or disease, which is stemmed from his or her employment. Work injury is classified into four types according to severity as follows:

a) Fatality: injury resulting in death
b) Permanent total disability: injury resulting in total physical or mental limitation or impairment
c) Permanent partial disability: injury resulting in partial physical or mental limitation or impairment
d) Temporary disability: injury resulting in temporary incapacitation for work.

These variables are obtained from WCF. The number of injury cases are analyzed by regions, namely Bangkok; Bangkok's surrounding vicinity; Central; Northern; Northeastern; Southern, and by age group for work fatality and permanent total disability.

Average yearly earning (Y_d)

This variable is the average of annual earning of private employees in 2000. The measurement is 12 times of monthly earning of private employees, obtained from the Department of Welfare and Labour Protection, MOLSW.

Remaining working year (e)

This variable is the expected remaining working year if workers have not died or suffered from permanent total disability. This variable is calculated from the age of death or disability and person-years lived with labour force participation, based on the life table and age specific labour force participation rate.

Earning loss from fatality/total permanent disability by age group (L_k)

This variable is the earning loss caused by premature death or permanent total disability. This variable is calculated from the remaining working year (if workers have not died or become disabled) and the expected future earning.

Earning loss from permanent partial disability in each age group (L_o)

This variable is the earning loss caused by permanent partial disability. This variable is calculated from the expected remaining working year, the expected future income and the proportion of loss.

Proportion of loss from permanent partial disability (P)

This variable is the average proportion of loss caused by permanent partial disability or organ loss. This study applies the average of workdays charged of 385.75 days from Boonsothornsathit (1991). However, this study analyzes the earning loss based on the ages of becoming partial disabled. According to the American Medical Association's standards that estimate that the number of workdays charged of death or total disability is 6,000 days. Therefore, the partial disability is 6.43% of death or total disability.

Workdays lost for temporary disability (D_A)

This variable is the average of workdays lost by workers for temporary incapacitation, which is 1.5 days for temporary absence for less than 3 days, and 15.58 days for temporary absence for more than 3 days based on previous study. (Boonsothornsathit, 1991)

Number of average working day per year (M)

This variable is the average workdays per year of private employees. According to the Labour Protection Act (1998), workers are entitled to at least one holiday per week, and not less than 13 national and religious holidays per year. Therefore, the number of workdays per year is 299 days.

Expected income growth rate (g)

This variable is the expected salary growth rates of private employees. This study applies different rates of 6% 8% 10% and 12%. The figures of 6% and 8% are computed from the NESDB expected economic growth of 4% - 5% plus 2% - 3% inflation. The figure of 10% is the average growth rate of National Income (NI), while 12% is the average growth rate of compensation of employees during 1980-2000.

Discount rate (r)

This variable is the social opportunity cost that represents the rate of returns on society's best alternative use of resources. This study applies 5% as the discount rate.

4.4.4 Opportunity loss for family members (IDL5)

The opportunity loss is considered an additional economic loss due to family care of injured workers

$$L_F = N_C * Y_c * (D_s/M)$$

L_F = Value of opportunity loss for family members by region

N_C = Number of cases by severity ($\leq$ 3days, > 3 days, organ loss, total disability) by region

Y_c = Average per capita income

D_s = Average actual workday loss by severity

N = number of average working day per month

The total opportunity loss (IDL5) is the summation of loss of all regions from all levels of severity.

Explanation and Measurement of variables

Opportunity loss for family members (L_F)

This variable is proxy for family members' opportunity loss due to taking care of injured workers.

Average family member income (Y_c)

This variable is proxy for family members' earning. This study applies the data of per capita monthly income by region in 2000 from the report of the Household Socio-Economic Survey, conducted by the NSO.

Average workday loss by severity (D_s)

This variable is proxy for time spent by family members in taking care of the injured workers during disability (medical treatment and rehabilitation). This study applies the ratio of 1.1 to estimate the loss from Sumiratana (1996) that an average length of stay for injured patients from road accidents is 16.2 days and an average of days spent by family members in taking care injured patients is 17.1 days.

Number of average working day per month (M)

This variable is the average of working days per month of family members. As family members are general population, working days per month is 30 days on average.

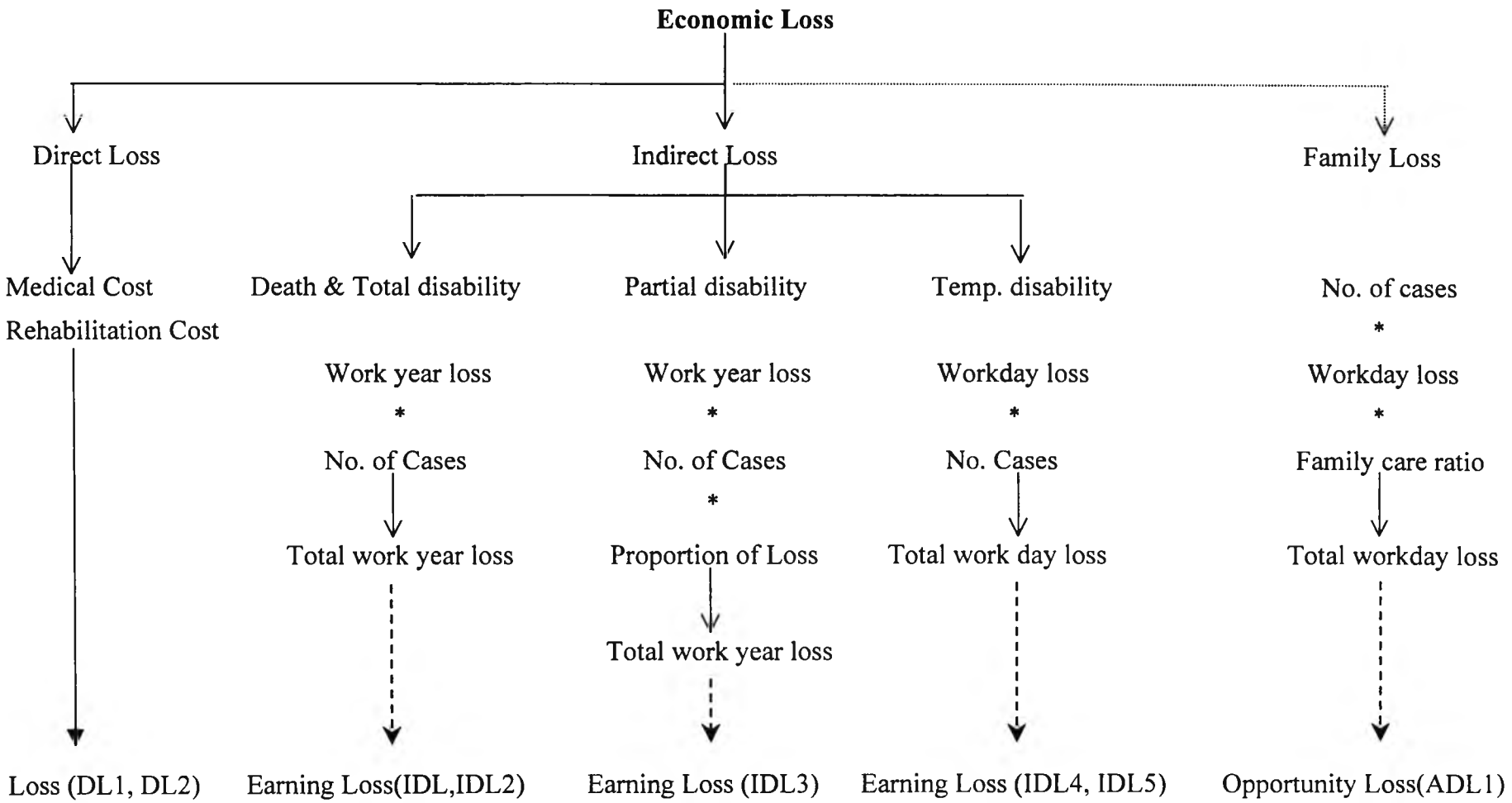
4.5 General Assumptions for Estimating the Earning Loss

This study estimates the economic loss based on secondary data of approved work injury claimants of WCF, comprising the number of work injuries by age and by severity as presented in Chapter 2. Secondary data of work injury rate by age and by severity are available but, data by age and by gender or industry are not available. Furthermore, no data of earning of private employees by age is made available. Therefore, the followings are general assumptions of this study.

1. Workdays charged for permanent partial disability are subject to the same pattern in all regions
2. Average worker earning in year 2000 is equal for all injured workers in every region regardless of gender, age, and industry
3. Expected earning growth of private employees is equal for all regions and remains constant for the time period of calculation
4. Discount rate remains constant for the time period of calculation

However, given that there is no universal acceptable rate of discount (Sorkin, 1992) and it is social value of judgement and social time preference (Drummond, et al., 1998), this study conducts a sensitivity analysis by applying different discount rates of 5%, 10%, and 15%.

Figure 4.1: Conceptual Framework for Calculating the Economic Loss



4.6 Model Determinants of Thailand's Work Injury Rate

4.6.1 Model formulation

Based on the basic concept relating to work accidents and national development, and the concept that work accidents are caused by workers' unsafe acts, private sector management and public sector administration, the model for work injury at national level is thus formulated. This model specifies that work injury rate is the function of economic growth, economic structure, WCF coverage, budget allocated to safety promotion, safety policy, law enforcement in terms of safety inspection and notifications which are aimed at safety in all workplaces.

The proposed model of work injury rate is written as:

$$Injury_t = \alpha_0 + \alpha_1 GDPgt_t + \alpha_2 Nonagri_t + \alpha_3 MCon_t + \alpha_4 WCF_t + \alpha_5 Budget_t + \alpha_6 Ins_t + \alpha_7 D1 + \alpha_8 D2 + \alpha_9 D3 + \varepsilon_t$$

where

$Injury_t$	=	Work injury rate at year t
$GDPgt_t$	=	Real GDP growth rate at year t
$Nonagri_t$	=	Proportion of non-agricultural GDP at year t
$MCon_t$	=	Percentage of workers in manufacture & construction at year t
WCF_t	=	Percentage of workers covered by WCF at year t
$Budget_t$	=	Operational budgets for occupational health & safety
Ins_t	=	Safety inspection coverage at year t
D1	=	Dummy of notification on employees' work safety (1985)
D2	=	Dummy of notifications on safety committee (1995)
D3	=	Dummy of economic crisis

4.6.2 Variables and Hypothesis

Work injury rate (Injury)

Work injury rate refers to the total number of approved claimants of WCF. Work injury rate is defined at the rate per 1,000 workers, covered by WCF.

$$Injury_t = \frac{\text{Number of work injuries in year t} * 1{,}000}{\text{Total number of workers covered by WCF in year t}}$$

Actual GDP growth rate (GDPgt)

This variable refers to the level of national economic development. This study applies the growth rate of Real Gross Domestic Product (GDP), based on the constant 1988 price, originated from all sectors. The statistics are obtained from NESDB.

Hypothesis: There is a positive relationship between work injury rate and economic development, meaning that work injury would cause the GDP growth rate to increase accordingly due to the fact that economic expansion would require more workers or longer hours of work. New workers and longer period of work lead to higher risk of work accidents.

Proportion of non-agricultural GDP (Nonagri)

This variable refers to the proportion of industrial and service sectors in national economic development. It is measured as the proportion of non-agricultural GDP, at the constant 1988 price.

$$Nonagri = \frac{\text{Non–agricultural GDP} * 100}{\text{GDP}}$$

Hypothesis: There is a positive relationship between work injury rate and the economic structure, meaning that the greater the proportion of non-agricultural GDP is, the higher rate the work injury would be accordingly. The reason is that the expansion of industrial and service sectors lead to a large number of labour force migration from agricultural sector, and this group of workers are likely unskilled workers who are susceptible to work accidents.

Proportion of workers in manufacture and construction (MCon)

This variable is defined as the proportion of workers in manufacturing and construction relative to total workers.

$$MCon = \frac{\text{Workers in Manufacturing \& Construction} * 100}{\text{Total workers}}$$

Hypothesis: There is a positive relationship between work injury rate and the proportion of workers in manufacture and construction sectors, meaning that higher proportion of workers in these establishments leads to higher work injury rate. The reason is that workers in these establishments expose to high accident risks.

WCF coverage (WCF)

In the past, WCF did not cover all provinces, and did not cover all types of workplaces. The number of workers under WCF coverage is less than the total number of workers employed, even in formal sectors. This study determines WCF coverage in percentage of workers covered by WCF.

$$WCF = \frac{\text{Worker under WCF} * 100}{\text{Total workers}}$$

Hypothesis: There is a positive relationship between work injury rate and WCF coverage, meaning that the greater number of workers covered by WCF results in the higher rate of injury reported. This is because the higher coverage also gives the impression that more workplaces and workers are aware of workers' entitlements.

Operational budgets allocated to Occupational Health & Safety (Budget)

This variable refers to the amount of operational budget, allocated to occupational health and safety promotion. Occupational health and safety are under the responsibility of the Department of Labour, subsequently changed to the Department of Welfare and Labour Protection (MOLSW), the Occupational Division, the Department of Health (MOPH), and WCF. The measurement is based on the total

amount of budget allocated to occupational health and safety activities including all categories, excluding capital expenditure.

Hypothesis: There is a negative relationship between work injury rate and budget allocated to safety promotion, because more budgets would lead to more activities on safety training and promotion.

Safety inspection coverage (Ins)

This variable refers to the coverage of public sector implementation to monitor private management and legislation compliance regarding work safety. This variable is proxy for law enforcement for safety work environment. It is measured based on the number of workplaces inspected by the Department of Safety Inspection.

$$\text{Ins} = \frac{\text{Number of workplaces inspected} * 100}{\text{Total number of workplaces}}$$

Hypothesis: There is a negative relationship between work injury rate and the percentage of workplaces subject to safety inspection. The safety inspection reflects the intensity of law enforcement and would lead to the management's awareness of improvement of safe work environment.

Dummy variables of safety policy (D1,D2)

These variables are defined as proxy for safety policy, relevant to all types of workplaces. The applicable laws include the notification on employees' work safety (1985) and, the notification on safety committee (1995). These variables are qualitative variables, the measurement are based on artificial variables that assign 0 as a value indicating absence, and 1 as a value indicating presence.

Hypothesis: There are negative relationships between work injury rate and dummy variables of the presence of notifications on safety, because the presence of laws should require workplaces to comply with work environment safety requirements.

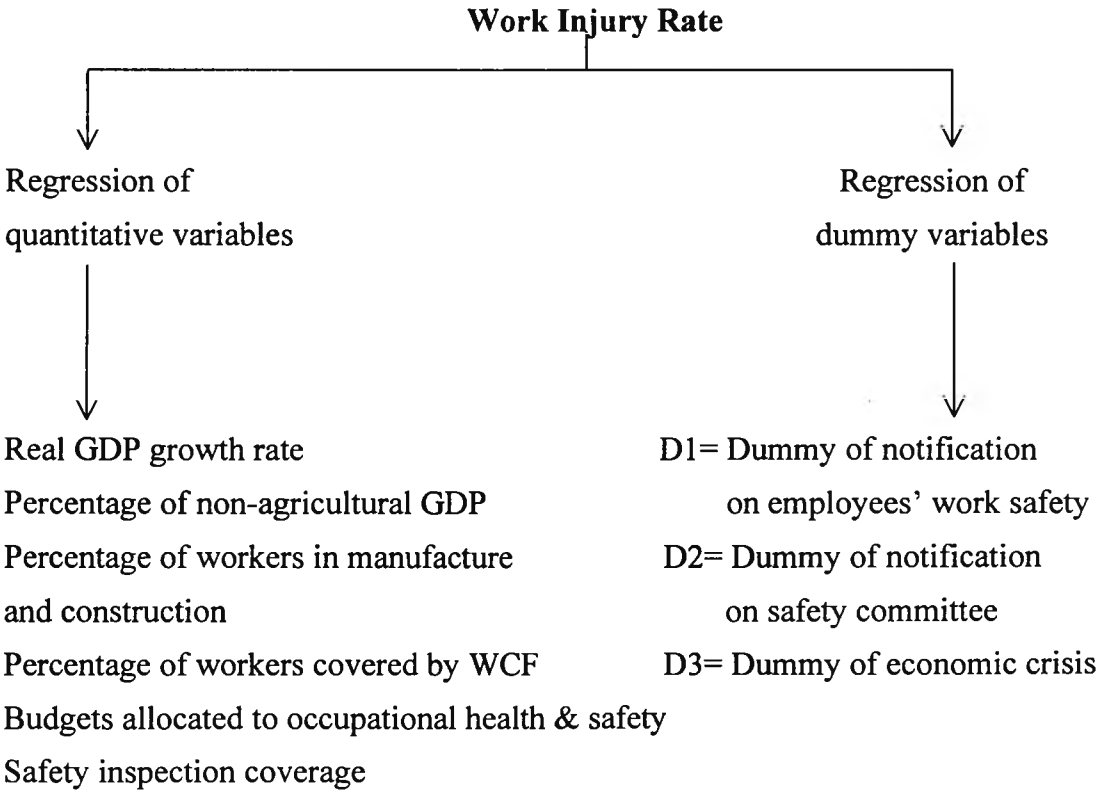
Dummy variable of economic crisis (D3)

This variable is defined as proxy for economic status, which leads to lower production output and excess production capacity. During the economic crisis, many workplaces layoff their workers, or reduced production output. This may results lower hours of work, or less man-hour of working.

Hypothesis: There is a negative relationship between work injury rate and this dummy variable, because less man-hour of work results in lower risk of accidents.

4.7 Determinants Estimation Method

Figure 4.2: Conceptual Framework for Analyzing the Determinants of Work Injury Rate



Multiple linear regression using ordinary least square method (OLS) is applied to obtain determinants of Thailand's work injury rate by using Eview

program. The results would be in terms of coefficients, which indicate the direction and the magnitude of effects of each variable upon the work injury rate, t-statistics, adjusted R-square, and F-statistics.

4.8 Data and Sources of Data

This study collects data from several related organizations as follows:

- The work injury statistics in Thailand in 2000 by severity and by age and by region, compensation payment, and time-series data of workers covered by WCF are obtained from WCF.
- The earning of private employees in 2000 by region is obtained from the Labour Studies and Planning Division, the Department of Labour Protection and Welfare, MOLSW.
- The average of monthly income per capita by region is obtained from NSO.
- Labour Force Participation Rate is obtained from NSO.
- Population statistics by age and the number of deaths by age in 2000 are obtained from the Department of Local Administration, MOI.
- Time-series data of workplaces and workers are obtained from the Department of Labour Protection and Welfare, MOLSW.
- Time-series data of Gross Domestic Product (GDP), National Income (NI), and compensation of employees are obtained from NSO, and NESDB.
- Time-series data of occupational health and safety inspection are obtained from the Department of Labour Protection and Welfare MOLSW, and Occupational Health Division, the Department of Health, MOPH.
- Time-series data of budget for safety promotion are obtained from WCF, Occupational Health Division, the Department of Health MOPH, and The Bureau of The Budget.