Economic Evaluation of Transport Companies Which Operates in Accordance with the ISO39001 Road Safety Standard System

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(Received: March 16, 2022; Revised: May 22, 2022; Accepted: June 1, 2022)

Abstract

This study aimed to evaluate the value of investment in road safety operation system for transportation companies. The target population was a group of companies that had established a safety system according to ISO 39001 road traffic safety standard. This research used cost-benefit approach to analyze worthiness of transport companies in Thailand in accordance with the ISO39001 road safety standard system. Data were collected from 3 companies who were willing to participate in this project. Cost and benefits analysis were performed using marginal cost and marginal benefit from having a road traffic safety management policy according to ISO 39001 guidelines. The analysis was undergone from both society perspective and company perspective in conjunction with insurance under the Compensation Fund Act. The study results found that Net Present Value (NPV), from the perspective of society, was 121,153 baht, Benefit-Cost Ratio (BCR) was 1.14, and the Internal Rate of Return (IRR) was 23%, It also found its worth in the aspect of transport companies in conjunction with insurance with the NPV of 74,906, BCR of 1.01 and IRR of 15%. In conclusion, the assessment was worth the investment. To provide incentive for managing road safety and pursuing the ISO 39001 certification for more transport companies, the government may help provide information, tax benefits, and sharing information to private sectors such as information on travel routes and risky points.

Keywords: 1) ISO 39001 2) Road safety 3) Economic evaluation 4) Road accidents 5) Cost-benefit analysis

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This research is supported by Road Safety Policy Foundation under the Academic Center for Road Safety project plan with the Office of the Health Promotion Fund.

Introduction

Road accidents are the leading cause of premature death and disabilities. (The International Health Policy Program Thailand, 2019, pp. 15-19; Vos, et al., 2020, pp. 1204-1222) Information from the social and quality of life database system and the number of accidents in the past five years report found that there has been an increase in the number of accident reports. The death toll per reported number of all accidents was 13 percent. If the severity of the severe injury was included, it was 24% of the total number of incidents reported (Social and Quality of Life Database System, 2018). In addition, data from the Social Security Office found that the rate of occupational harm or illness per 1,000 employees dropped from 15.76 in 2011 to 7.67 in 2020. However, considering the severity of the accidents in 2020, there were as many as 588 deaths, 14 disabilities, 1,005 partial dismemberments, 25,682 cases for more than three days off work, and 58,6244 cases for no more than three days off work. (Social Security Office, 2020a, pp. 19-20) The cause of death mostly came from 254 vehicle accidents or 43% of total loss. The subsequent loss was 97 deaths from falling from heights, and it is 16 percent of all deaths. (Social Security Office, 2020b, p. 93) When considering work-related deaths by the size of the establishment, it was found that small establishments were more likely to have a more significant number of deaths than large establishments (Social Security Office, 2020c, p. 98).

As the problem of road accidents from work is essential, the companies have taken measures to prevent and reduce the severity of accidents both management at an individual level and the corporate level (Newnam, Lewis and Watson, 2012, pp. 29-38) by starting from the senior management to place importance on this issue and implement clear regulations among drivers. According to the research studied from other countries, establishing security standards and rewarding compensation to drivers who meet safety standards can also positively affect the organization. It can also be evaluated as in the case of British Telecommunication (BT) which, assessed the outcomes of a road traffic safety management program and found that establishing safety measures in the workplace can dramatically reduce the number of claims for compensation for damages under insurance contracts and compensation (Wallington, et al., 2014a, pp. 194-202). The study of Work-related road safety: a case study of Roche Australia which is a study of the management, monitoring, and improvement of road safety performance under the program Company Motor Vehicle Safety Program by Roche Australia (a company in the pharmaceutical industry), found that the number of cars involved in accidents and the demand for insurance compensation tended to decline continuously after the start of the project. Overall, the number of claims for compensation for damages decreased by 56%. Also, the insurance claim rate or amount of claim for vehicle damage compensation decreased by 24%. In this case, it allowed the company to save a lot of insurance premiums (Murray, White, and Ison, 2012, pp. 129-137)

In the case of Thailand, many organizations or companies placed importance on road safety by implementing under the standards of the International Organization for

Standardization Systems of ISO 39001:2012 Road Traffic Safety (RTS) Management Systems. It runs by the organization (International Organization for Standardization or ISO), the standard for building road safety to reduce or prevent deaths and severe injuries from road traffic accidents. It is a management standard system that focuses on solving the problems caused by road accidents that cause damage to both life and property. The purpose is to improve road traffic safety performance including creating a system to prepare for accidents that may occur, which will help to reduce impacts losses and to show social responsibility (Suthammasa, 2013).

Road accidents are an important problem in Thailand, especially in the working-age population, which is the country's significant production capacity. As a result, the implementation of road safety for companies is essential to push forward. However, there is no academic evidence in Thailand that indicates whether it is worth implementing road safety standards in the workplace. Therefore, this research was conducted to analyze the value of the investment in road safety among companies. The target population of the project is the group of firms that have established a safety system according to ISO 39001:2012 (or ISO 39001), which is directly related to establishing road safety standards to provide information to companies and lead further to consideration of national policy.

Objective

To evaluate cost and benefit of transport companies in Thailand which operates in accordance with the ISO39001 road safety standard system.

Benefits

1. Know the cost and benefits that can be assessed in financial terms from implementing road traffic safety management according to ISO 39001 standards in companies.

2. Use the data as comparative information in deciding on the worthiness of the investment for companies that wish to operate the road traffic safety management systems under ISO 39001.

3. Provide some information for policy recommendations to create safety at the corporate level.

Conceptual Framework and Theoretical Literacy

1. Cost-Benefit Analysis (CBA)

CBA is the evaluation criteria for investment decisions on whether the project's return is greater or less than the project's total costs. This is used as a criterion to decide whether it is worth investing in that project by using direct and indirect cost estimation (Cost) and direct and indirect returns or benefits evaluation (Benefit). After that, the data based on time-adjusted investment decision-making criteria was calculated in terms of Net Present Value (NPV), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR) as explained below (Pattamapongsa, 2008, pp. 38-55; Federal Motor Carrier Safety Administration, 2013, pp. 37-39; Sukhothai Thammathirat Open University, 2015).

1) Net Present Value (NPV) shows the difference between the present value of the return (project benefit) and the present value of the project cost to determine whether the project should be invested or not. The equation (1) shows the formular of NPV.

$$NPV = \sum_{t=1}^{n} \frac{(B_t - C_t)}{(1 + r)^t} \text{ --- (1)}$$

Whereas B_t is the value of benefit, C_t is the cost value, r is the discount rate, and t is the investment period. Criteria for making investment decisions show that the decisions can be made when the net present value is positive, and this also means the project is economically worth the investment.

2) Benefit-Cost Ratio (BCR) shows the ratio between the present value of the project benefit and the present value of the project cost shown as equation (2). When the benefit-cost ratio is greater than or equal to one, it indicates a positive pointer for investment.

$$B / C = \sum_{t=1}^{n} \frac{\frac{B_t}{(1+r)^t}}{\frac{C_t}{(1+r)^t}} \text{ --- (2)}$$

The criteria used for decision making is the benefit-cost ratio. If a project has a benefit-cost ratio greater than or equal to one, the project is expected to deliver a positive net present value, therefore a good decision to invest in the project.

3) Internal Rate of Return (IRR) is the rate of return received from the investment, which is the discount rate that makes the present value of the benefit equal to the present value of the cost shown as equation (3).

$$\sum_{t=1}^{n} \frac{(B_t - C_t)}{(1 + r)^t} = 0 \text{ --- (3)}$$

If the internal rate of return is greater than the opportunity cost of capital, it shows that the project is suitable for investing. The opportunity cost of capital may use the loan interest rate (Klahan, 2013, p. 24; Passprasert, 2016, p. 70). For example, the interest rate for the loan as announced by the Bank of Thailand or government bond interest rates. This opportunity cost of capital was used as a criterion to compare the value with the IRR whether the project is suitable or worthwhile to invest in.

The NPV BCR and IRR are vital criteria the have been used when assessing the worthiness of an investment. Those criteria are also used when it comes to arrange an investment in various projects. In general, the study results from all three criteria provide a corresponding value whether it is worth investing in or not (European Road Safety Observatory, 2018a, p. 17). As an Analysis Guidebook of Costs and Benefits published by the Department of Transport and Main Roads, in Queensland, Australia (Queensland government, 2021a, pp. 2.11-1.12), explained that BCR is most used to analyze transportation projects on both large and small scale and it is a unique cost-benefit analysis. NPV can be used to assess any situation, and it should always be included in the assessment report. Project feasibility analysis tool document by Sukhothai Thammathirat University (Sukhothai Thammathirat open University, 2015) explained that, in the case of multiple-choice projects, each project has different investment capital, the BCR value alone may not indicate a project priority. Therefore, BCR values should also be considered in conjunction with NPV values. In the past research, BCR, NPV, and IRR criteria were considered together (Tangvitoontham and Chaiwat, 2012, pp. 301-314) or consider both NPV and BCR together (Daniels, et al., 2019a, pp. 2-3)

2. The Concept of Indirect Assessment from Health Problems

Health indirect cost assessment analyzed by morbidity that causes a decrease in working efficiency, including the costs of absences and mortality. There are currently three main concepts (Jo, 2014, pp. 327-337) which are

1) The Human Capital Approach (HCA) estimates the costs assessed based on human work performance capability. The value of humans as labor is taken from the efficiency of their work throughout the labor period. The opportunity cost of labor will persist until retirement.

2) The Friction Cost Approach (FCA) is an assessment based on the actual cost of health problems affecting private sector businesses. According to this approach, workers missing due to health problems can be replaced because there will always be unemployed. The costs incurred only during the friction period. From the worker's point of view (Johannesson and Karlsson, 1997, pp. 249-255), this estimate underestimates the value of a health program because it does not consider the health costs burdened by workers.

3) The Willingness to Pay Approach (WPA) is an assessment from the perspective of people with health problems directly. The cost is assessed based on the value that people of working age are willing to pay for their better health

3. The Concept of Economic Benefit

The concept of benefit consists of, (Pongwanich-Anan, 2009, p. 27)

1) The direct benefit can be measured in precise numbers. It is the value of goods and services produced directly from the investment.

2) The indirect benefit may refer to social benefits returned on road accident prevention projects, such as reduction in mortality, decreasing the rate of injury, damage reduction and a reduction in the cost incurred from accidents.

3) Intangible returns such as building a positive image for the organization, boosting morale and motivation for employees, giving back benefits to society, etc.

If focusing in particularly on transportation and accident, guide to cost and benefit analysis of transportation projects and systematic literature review studies, most of the benefits are assessed in the context of the reduced loss value from accidents according to different severity. It may consider changes in travel time, reducing vehicle repair costs, reducing vehicle-related expenses such as the decreasing in fuel and maintenance costs, the expenses associated with the relevant agencies (police or courts), increased security developments, reduced emissions, reduced parking fees, increased production efficiency, and a reduction in medical expenses and compensation, etc. (Gibson and Wallace, 2016, pp. 12-17; European Road Safety Observatory, 2018b, pp. 11-18; Daniels, et al., 2019b, pp. 1-13; Queensland government, 2021b, pp. 2.16-2.19)

4. The Conceptual Framework for Estimating the Cost of Road Accidents

The economic cost analysis is different from the accounting cost analysis or general cost analysis. Based on the literature review, most studies estimated the cost of an accident according to the analytical frameworks for the cost of illness. In addition, indirect costs are mostly estimated from the human capital

concept and the willingness to pay using the perspective of society as the dimension of the estimate. Kanthiya Pradabboon (Pradabboon, Phanthunane, and Pratoomsoot, 2015, pp. 108-123) have estimated the cost of accidents among insurers from the societal perspective. It includes the direct costs from the accident, which were all the monetary costs incurred in that accident, such as vehicle repair costs and medical expenses. Accident costs also included the indirect costs of an accident, such as the lost productivity of the accident victims, absenteeism at work, or loss of ability to work due to an accident resulting in layoffs.

Pipat Thongchim (Thongchim, et al., 2007a, pp. 2891-2903) also used the human capital and the willingness to pay concept to analyze the cost of road accidents in Thailand. The provinces represented in the study were Khon Kaen, Lampang, Nakhon Sawan, Songkhla, and Bangkok. The costs were categorized into three groups as follows: 1) the human cost group, which was related to production cost loss, emergency medical services, and long-term care costs 2) the cost of property damage group, which included vehicle repair costs and non-vehicle damage 3) general cost of a accident, including insurance fees, police fees, judicial expenses, emergency rescue and delayed travel time. A study by Maen Ghadi (Ghadi, Torok, and Tanczos, 2018, pp. 129-134) also applied the human capital conceptual framework and the concept of willingness to pay. The concept of human capital could be classified into three groups which were human cost, property damage cost, and general cost of vehicle crashes. For human costs, it covered the cost of death, disability, loss of work, medical expenses, pain and suffering, and the loss of family and community. The willingness to pay concept was used to survey how much respondents are willing to pay per year to reduce the risk of death from an accident.

5. ISO39001 Road Traffic Safety Management System

The ISO 39001 system is a road traffic safety management system operated by ISO (International Organization for Standardization). The benefits obtained from implementing the ISO 39001 system are: 1) help the organizations have a safer traffic management system, reduce risks, and reduce road traffic accidents. which results in severe injury and death to employees and related persons 2) reduce costs and losses from road accidents 3) reduce and control the risk of hazards from using the road 4) prepare to handle accidents that may occur which will help to reduce the impact and the loss, it also represents social responsibility (Professional Evaluation and Certificate Board, 2015; Suthammasa, 2013)

Methods

In the research, data came from both primary and secondary sources. The primary data were collected from an interview with transportation companies in Thailand certified by the ISO 39001. In 2020, while conducting research, Road safety research center suggested that there were fourteen ISO 39001 certified companies. Therefore, it can be considered as a small population size. We selected the sample in this study based on the willingness to participate the project and availability of information on process relating to ISO 39001 as well as its cost and benefits. Regarding those criteria, there were three

companies participated the project, including a transportation company with hazardous goods, a freight transportation company, and a personal transportation company.

The semi-structured interview was adopted to explore information on cost and benefits of building safety in the workplace. Apart from the data that were provided by the companies, we also collected data from secondary sources, in order to verify the data gained from the companies as well as to gather other data associated with the cost and benefits of implementing workplace safety standard, for example the compensation for legal disability and the average number of natural deaths and disabilities. These secondary data were derived from both statistical data and literature reviews.

This study used the cost-benefit analysis (CBA) approach as a conceptual framework for economic assessment of the value of the investment for road safety in firms that have an ISO 39001 road traffic safety management system. Both primary and secondary data were used to identify and value the variables used in the cost-benefit model as explained below.

1. Project Evaluation

1) Estimating the economic cost of a project

From the interview, and literature review, costs were classified into pre-operation costs, post-processing costs, and costs during operation. They were classified according to the framework of ISO 39001 and Haddon Matrix, which included people, vehicles, roads, and cover management costs and other expenses (Geller, et al., 1987, pp. 1-17; Newnam, Lewis and Watson, 2012, pp. 29-38). The cost data was obtained from the representative of three ISO certified companies and was reviewed by the ISO auditing company. Calculating costs based on marginal cost concepts between the road safety operation cost of an ISO 39001 certified facility and the road safety operation cost of establishments of the same size that have not yet entered the ISO3 901 certification process, according to the study of Panakorn Tonglim (Tonglim, 2012, pp. 329-346), the equation can be written as follows:

$$Cost = (C_1 + C_2 + C_3 + C_4 + C_5) - (C_6 + C_7 + C_8 + C_9 + C_{10})$$

Whereas:

C_1 = Pre-operation costs of ISO 39001 certified companies

C_2 = Personnel-related costs of ISO 39001 certified companies

C_3 = Vehicle-related operating costs of ISO 39001 certified companies

C_4 = Road-Related Costs of ISO 39001 certified companies

C_5 = Post-operation costs of ISO 39001 certified companies

C_6 = Pre-operation costs of companies of the same size that have not yet entered the ISO 39001 certification

C_7 = Personnel-related costs of companies of the same size that have not yet entered the ISO 39001 certification

C_8 = Vehicle-related operating costs of companies of the same size that has not yet entered the ISO 39001 certification

C_9 = Road-Related Costs of companies of the same size that have not yet entered the ISO 39001 certification

C_{10} = Post-operation costs of companies of the same size that have not yet entered the ISO 39001 certification

2) Project benefits evaluation

This benefit assessment consisted of the value of the change in road accident losses from the cause of death, injury, and various compensation. It also included expenses incurred from road accidents, etc. This study used a societal perspective and the view of entrepreneurs in conjunction with the view of insurance under the compensation fund act as a framework of analysis. In identifying the measurable benefits of the project, it is based on inquiries from various enterprises and national-level data on the severity of accidents. The collected data consisted of the number of deaths and the number of disabilities, including partial dismemberment from work-related causes. In this study, it refers to the average number of natural deaths and the average number of natural disabilities, respectively. Those data were provided by the Social Security Office Ministry of Labor. Note that, this study is not able to directly compare the characteristics of the data used before and after assessment due to data limitation of participating firms.

As per the societal perspective, this research was based on human capital or the concept of willingness to pay, which depended on the analytical framework of the past research that analyzed the cost of death and the cost of dismemberment and disability from accidents. Then took the obtained values to find the mean and adjust the inflation according to the information data provided from the Bank of Thailand. This study set the discount rate for future income and costs at 3% according to the Global Burden of Disease Study by the World Health Organization (Murray and Lopez, 1996, pp. 9-10)

Guidelines for the analysis of benefits from a societal perspective and the perspective of the companies in conjunction with insurance as shown in Table No. 1

Table No. 1 Guidelines for the Analysis of Benefits in Perspective of Society and Companies in Conjunction with Insurance

Analysis of Benefits in a Societal Perspective	Analysis of Benefits from the Perspective of Companies in Conjunction with Insurance
The benefits including reduced loss of mortality changes, disability changes, and cost change related to vehicle repairs. The study focused on the change of number of deaths and disabilities by difference natural death and disability with number of deaths of personnel in the companies participating in this research, as the following equation: Benefit = [(B1 – B2) x B3] + [(B4 – B5) x B6] + B7	The study focused on reducing loss from both mortality and disability, cost of the statutory insurance system, and reducing vehicle repair costs, as the following equation: Benefit = [(B1 – B2) x (B8 + B9 + B10 + B11)] + [(B4 – B5) x (B12 + B13 + B11)] + B7]

Whereas:

B1 = The average number of natural deaths

B2 = The number of personnel deaths from vehicle accidents per company (Average from three companies participating in the research project)

B3 = Cost per person killed in a road accident

B4 = The average number of natural disabilities

B5 = Number of Personnel Disabilities from Vehicle Accidents per company (Average from three companies participating in the research project)

B6 = Cost per person with disabilities from road accidents

B7 = Changes in the costs of the company car repairing

B8 = Compensation for legal death (70% of wages for a period of 10 years)

B9 = Medical expenses in the event of death from a road accident

B10 = Funeral expenses

B11 = Business opportunity cost from reduced production efficiency during the recruitment period and the training period for new workers to meet with the same working efficiency.

B12 = Compensation for legal disability (70% of wages for a period of 15 years)

B13 = Medical expenses in case of road accident disability

2. Cost-Benefit Analysis

This research used economic project analysis methods, including net present value (NPV), benefit-cost ratio (BCR), and internal rate of return (IRR), to further evaluate the value of worthiness. For the net present value (NPV) valuation, it is worth the investment if the value is greater than 0. For the benefit cost ratio (BCR) valuation, the project is expected to deliver a positive net present value to a firm and the investors if the BCR value is greater than 1. The internal rate of return (IRR) will be compared to the market interest rate. For this research, Microsoft Excel was used as a calculating program to get the value of cost-benefit analysis, NPV, BCR, and IRR. This study analyzed NPV, BCR and IRR during two assessment cycles (6 years). CBA model demonstrated in this article can be requested from the corresponding author.

3. Project Sensitivity Analysis

It was a one-way sensitivity analysis of the study results caused by changes in the cost-benefit calculation parameters. This research changed the parameters used in the benefits analysis from the natural average mortality and disability rates to a hypothetical reduction in the number of deaths and disabilities. The number of death and disabilities reduced were assumed to be 1 or less than one to show that even if the company can save less than one person per year it is still worth to invest. The discount rate used is increased from 3% to 12%, which is the discount rate recommended by the 2012 revised guidelines and criteria for public investment projects (Office of National Economics and Social Development Board, 2012, p. 13)

Results

It was found that the ISO 39001 certified companies have a similar approach to road safety and every company had a road safety

policy in place for many years before the assessment was carried out. However, having an assessment process to certify ISO 39001 safety standards provide a better-standardized work process to every business establishment. With some adjustments and additions to the process under the Haddon Matrix principle, it leads to road safety that will benefit both firms and society.

1. Cost Analysis

This cost analysis included pre-operating costs, operating cost, and post-operating costs. As the details in table 2, it was found that road safety operations were carried out with not much cost difference for companies of the same size as the sample companies in this research if excluding costs related to the assessment, such as appraisal costs, reassessment, or renewal costs and cost of assessment planning meetings. The only exception is the cost of the transport routes survey, which is 36,500 baht. Note that, the first year required good preparation to be certified. Due to the reaccredit, the cost in the fourth year was different from other years (Table No. 2).

Table No. 2 Cost Analysis of Road Safety Management

Types of Costs	ISO Certified (Baht)	Not Participate in ISO Certification Process (Baht)
Cost Before Operation		
1. Training to create understanding with the organization, needs, and expectations. It is also to determine the scope of the management system and implement action for road traffic safety (RTS)	25,000	0
2. Executive meetings to demonstrate policy making	16,000	0
3. Planning meetings to develop a road traffic safety management system (RTSMS), target action plan, defining risk management, and setting risk management objectives	50,000	0
4. A manpower planning meeting to carry out road safety operations such as the safety committee and safety department	16,000	0
5. Establishing a driving control center for employees by using the modern Global Positioning System (GPS)	580,000	580,000
6. GPS installation	450,000	450,000
7. The assessment team visits the establishment for the first time.	44,000	0

Table No. 2 (Continued)

Types of Costs	ISO Certified (Baht)	Not Participate in ISO Certification Process (Baht)
Operation Cost (person)		
1. Alcohol testing	50,000	50,000
2. Drug testing	16,050	16,050
3. Defensive Driving Course (DDC), both are sending people to training and internal training and other training.	240,000	240,000
4. Prior meeting before the start of work for safety	16,500	16,500
Operating Cost (vehicle)		
1. Maintaining the preventive maintenance system of transport vehicles to be always in perfect condition.	3,000,000	3,000,000
2. Sending data to the host server	30,000	30,000
3. Daily vehicle checks by the driver	16,500	16,500
4. Car toolbox (Toolbox)	30,000	30,000
Cost of Operation (Road)		
1. Pre-travel route checks including dangerous spots	36,500	0
Post-Operation Costs		
1. Auditing to monitor system maintenance ISO (Surveillance audit)	50,000	0
2. ISO 39001 Assessment	100,000	0
3. Other costs associated with the ISO 39001 assessment	90,000	0
4. Reassessment or renewal of certification (Reaccredit), which is done every 3 years	160,000	0

2. Benefit Analysis

As mentioned before, benefits analysis considered the reduction in value of death and disabilities after the companies certified ISO3900. The following details will explain data used to calculate benefits in terms of general information for estimating project benefits used for both societal and company perspectives, data used for estimating benefits based on perspective of society and data use for benefit estimation from the perspective of companies in conjunction with insurances.

1) General information

According to the Social Security Office information, it shows the average number of natural deaths or the number of deaths from

vehicle accidents from the past five years (from 2014-2018) of a company size 51-100 employees is 0.00236 people per company. The average number of natural disabilities or the number of injuries that resulted in dismemberment and disability due to vehicle accidents of a company size 51-100 employees from the past five years (from 2014-2018) is 0.00027 people per company. From the interviews with companies participating in the research project, it was found that after being certified, there were no deaths and no injuries that resulted in disability or loss of organs. It was also found that the amount of repair cost that can be saved was 165,000 baht.

2) Societal Perspective

The cost data for each accident was from a literature review (Faculty of engineer, Prince of Songkla University, 2007, p. 15; Thongchim, et.al, 2007b, pp. 2891-2906; McMahon and Dahdah, 2008, p. 6; Seehawon, 2010, pp. 48-81; Pradabboon, Phanthunane, and Pratoomsoot, 2015, pp. 108-123).

The value is then adjusted according to the inflation value published by the bank of Thailand. The cost of disability from accidents is between 1,735,494 and 7,465,854 baht per person, and the average is 4,189,399 baht per person.

3) Perspective of companies in conjunction with insurance

For medical expenses related to death and disability after adjusted with the inflation rate, it was found that the value for death was 11,726 baht per person. For disabilities, the value was 571,720 baht per person (Seehawong, 2010, p. 76). As for the opportunity cost of replacing an employee, from the information obtained from the interview, the assumption could be made that it took one month to find a replacement with a salary of 22,000 baht. It took three months to practice and to train. During practice and training session, it was assumed that the productivity was 50%. Therefore, the opportunity cost of the employee replacement was equal to 55,000 baht. According to the Workmen's Compensation Act (No.2) AD 2018 (the Workmen's Compensation Act (No.2) AD, 2018, pp. 3-4), the company pays a funeral fee of 40,000 baht and compensation of 70% of wages for ten years (1,848,000 baht) in the event of work-related death. For the case of disability, the company pays 70% of wages for not less than 15 years (2,772,000 baht). The payments would be made by the Social Security Office's Compensation Fund to the companies as the companies had insured with the Social Security Office under the law. The salary compensation in case of death used in this research is also 22,000 baht per month.

3. The Results of the Cost-Benefit Analysis

This research was a comparison between marginal costs (cost of the ISO 39001 certified companies and the companies of the same size that had not been assessed) and the incremental benefit of being able to reduce mortality, dismemberment, and disability and saving on vehicle repair costs. As for the research assignment, costs and benefits were assumed to occur at the end of the year, and there are no initial costs. The study results found that when analyzed during two assessment cycles (6 years) from a social perspective, the net present value, or NPV, was 121,153 baht, which was positive. It corresponded to the benefit-cost ratio (BCR)

greater than one and the IRR value more significant than the loan interest rate. It can conclude that an ISO 39001 assessment and certification was worth the investment. From the point of view of the companies in conjunction with insurance, it also found that a worthwhile investment even though the NPV value was lower than the societal perspective, and the BCR value was only 1.1 (Table No. 3)

Table No. 3 Cost-benefit analysis in societal perspective and the perspective of the companies in conjunction with the insurance

Description	1st year	2nd year	3rd year	4th year	5th year	6th year
Societal Perspective (3% discount rate)						
Total cost	377,500	86,500	86,500	196,500	86,500	86,500
Benefit (Death)	12,933	12,933	12,933	12,933	12,933	12,933
Benefits (Disabled)	1,126	1,126	1,126	1,126	1,126	1,126
Repair cost changing	165,000	165,000	165,000	165,000	165,000	165,000
Present value of costs	366,505	81,535	79,160	174,588	74,616	72,442
Present value of benefits	173,844	168,780	163,864	159,092	154,458	149,959
NPV	121,153					
BCR	1.14					
IRR	23%					
Company and Insurance Perspectives (3% discount rate)						
Total cost	377,500	86,500	86,500	196,500	86,500	86,500
Benefit (Death)	4,608	4,608	4,608	4,608	4,608	4,608
Benefits (Disabled)	914	914	914	914	914	914
Repair cost changing	165,000	165,000	165,000	165,000	165,000	165,000
Present value of costs	366,505	81,535	79,160	174,599	74,616	72,442
Present value of the benefit	165,556	160,734	156,052	151,507	147,094	142,810
NPV	74,906					
BCR	1.088					
IRR	15%					

When we performed one-way sensitivity analysis by changing the benefit value from natural death and disability to different assumptions as shown in Table 4. It was found that the NPV value was as high as 30 million baht from a societal perspective for reducing one death per year. For the company's perspective in conjunction with insurance, the number was

nearly 11 million baht. If it can reduce 0.25 disability per year (1 person in 4 years) and 0.25 death per year, NPV still as high as 13 million in societal perspective, and 7.3 million baht in the view of company in conjunction with insurance. Even with a reduction of 0.1 deaths 0.1 disability, the NPV value was still greater than 0, as well as the BCR value that was still greater than 1, from both a social and entrepreneurial perspective in conjunction with insurance.

When changing the discount rate from 3% to 12%, it was found that the NPV value in the societal perspective was 50,820 baht and the company's perspective with insurance was 15,721. The BCR value was still 1.07 and 1.02, respectively.

Table No. 4 Cost-benefit analysis in case of conversion of natural rates of benefit to the hypothesis

Decrease in Death or Disability	Societal Perspective		Perspective of Entrepreneurs in Conjunction with insurance	
	NPV	BCR	NPV	BCR
1 person fewer deaths, 0 fewer disabilities	29,764,510	36.06	10,634,118	13.53
0 deaths and 1 person fewer disability	22,723,516	27.77	18,456,507	22.74
0.5 person fewer deaths and 0.5 person fewer disability	26,244,013	31.92	14,545,312	18.14
0.25 person fewer deaths and 0.25 person fewer disability	13,144,502	16.49	7,295,152	9.59
0.1 person fewer deaths and 0.1 person fewer disability	5,284,796	7.23	2,945,056	4.47

Conclusion and Discussion

From the information obtained from the interview and secondary data analysis, this research had classified the cost into pre-operation costs, operating costs, and post-operation costs. Pre-operation costs included expenses to prepare for the ISO 39001 certification assessment. This cost mainly comprised the cost of meetings, planning, and training to create an understanding of the organization. It also included the cost of establishing an employee driving center with a GPS which is a one-time investment cost. The operating costs were costs associated to people, vehicles, and roads. These were the main incurred cost annually to maintain road safety standards. From interviews with all three companies, the highest cost was the cost for the vehicle for protection and maintenance system so that the cars were always available in good conditions. The last one is the post-operation costs. This included the cost of

reaccrediting, the cost of inspection by the ISO team, then took value to analyze the incremental cost. It was found that the cost associated with the certification was relatively high. It was about 340,000 baht, excluding the need to pay the inspection fee every year, and it must also be renewed (reaccredit) every three years. Another essential additional cost was the pre-trip road inspections cost. The companies were not willing to be certified did not have to pay in this part of 36,500 baht.

For the benefit analysis, we found that among the ISO 39001 certified companies that participated in the research, none of them shown numbers of death, disability, or dismemberment resulting from road accidents after being certified. The key data in the benefits analysis was the natural average number of deaths and disabilities from the Social Security Office, which may not straightforwardly reflect the change in the occurrence of the companies. It was different from other empirical research, such as the case of British Telecommunication Company (Wallington, et al., 2014a, pp. 194-202; Wallington et al., 2014b, pp. 1-13), with more than ten years of data collection. This made it possible to properly compare the results or benefits before and after the operation. The limitation of the data, especially the benefit assessment data, was one of the major limitations of this study. From these limitations, the study carried out a one-way sensitivity analysis by changing benefit values and hypothesized death and disability from road accidents as before and after the company's information. Although the death and disability were reduced to only one person in 4 years, it was still very worth the investment.

According to the available information, this research is the first to show investment value analysis results from putting importance on road traffic safety management systems at the workplace level, according to international standard. The study results should be considered in conjunction with the research limitations, consisting of six significant constraints. Firstly, the samples of this research were classified as large enterprises, according to Panakorn Thonglim (Tonglim, 2012, pp. 329-346). Therefore, the value of an incremental cost was not very high. The incremental cost tended to increase compared to a small company that did not have a systematic road safety process. For example, small companies did not have alcohol testing, and GPS was installed on every vehicle (Tonglim, 2012, pp. 329-346). In addition, the benefits from small companies might differ from the results of this research. Secondly, in the case of the passenger transportation company, the loss value was likely to be higher than other types of transport establishments. The future study will probably focus specifically on passenger transportation. Third, the social security information might result in severe injuries and deaths that were less than reality because it did not include the results with the parties and accidents caused by employee behavior such as drinking alcohol and substance abuse, etc. For the policies at some companies, there may not be any compensation for loss in case of an employee's impaired behavior or misbehaving. Therefore, when analyzing the marginal benefits, it would result in lower values than reality and then the study results would be underestimated. Fourth, the decreased repair cost was an essential factor of the analysis. The

limited period for data collecting of the sample groups could make the data less likely or more likely to be true. In addition, the cost of transporting dangerous goods, general goods, and passengers was different. Therefore, for future study, the results will be representative of each type if analyzed by type of transport. Fifth, the loss value of this research was not classified by age group. Therefore, it makes the opportunity worth the investment more feasible if the loss occurs at a young age. For example, the information from the Department of Highways showed that among the fatalities from trucks larger than ten wheels, about 5 percent of the total mortality number was children. Lastly, this study did not calculate the benefits in relation to the reduced rate of contributions to the reduced accident benefit fund, which is based on the loss rate calculated by the Social Security Office. This measure is an incentive for entrepreneurs to create safety in the workplace. It will start to change the contribution rate in the 5th year to a lower rate if there are no accidents or in the case of small numbers (Khaosod, 2020). Therefore, with the lower contribution rate, it will increase the benefits for entrepreneurs, which tends to bring more worth to investment.

The results showed that, from the perspective of society, the analysis during the two assessment cycles (6 years) provided the NPV value of 121,153 baht which was positive. It also explained that the benefit outweighs the cost of 121,153 baht, which corresponds to a BCR value greater than 1 (Or it can be explained that once the investment has been made, the benefits will be greater than the cost). Moreover, the IRR value was higher than the market interest rate, approximately 6 - 10%. This can be concluded that the assessment was worth the investment, even if the BCR is not very high. As per company and insurance perspective, which here means payment paid by social security or by the company in the event of death and disability, we found that investment was also worthwhile even though the NPV value was lower than the social perspective. The BCR value was still about 1.1. At least, it did not cause any loss to the entrepreneurs. When taken into consideration with the results of a one-way sensitivity analysis, under the assumptions of reducing death or injury from disability and adjusting the discount rate value to a higher value for sensitivity analysis, the results indicated worth the investment in sense of economics. The research results highlighted the importance of building road safety under ISO39001 safety standards. The investor, the owner of the transportation company, will benefit from both the societal perspective and company perspective more than the lost cost. From past literature reviews, there were no-cost and benefit studies that have been done on this subject in Thailand. Academic work published on the effectiveness of creating safety in working abroad showed that creating a safety system at work reduces accidents (Grayson and Helman, 2011, pp. 1-29). It also reduced the number of claims for compensation for damages (insurance claims). As in the case of British Telecommunications Company, the number decreased from 59 per 1,000 vehicles to 27 per 1,000 vehicles over approximately ten years (Wallington, et al., 2014a, pp. 194-202). For the case of Roche Australia, the compensation claim rate dropped from 24% between 2004 and 2009 (Murray,

White, and Ison, 2012, pp. 129-137). The importance of road safety in the workplace receives more attention, especially in developed countries like Australia, the EU countries and England. (Grayson and Helman, 2011, pp. 1-29; Small, Bailey and Lydon, 2014, pp. 1-22; European Road Safety Observatory, 2018c, pp. 1-24). However, the information for valuation was still very limited. This study not only aims to encourage companies to pay more attention to investments in road safety but also reflects the importance of data collection at the company level to enable companies to assess the value of the investment. This also will affect the development of efficiency in the workplace, educational benefits, and further push forward to the industrial or policy level, for example in terms of tax reduction and implementing the enforcement standard for companies,

Considering the value in terms of quality of life and psychological impact of the victims and their families, preventing incidents, no matter how many cases or in whichever case is a worthwhile investment. An interview from a company participating in the research gives an interesting perspective, namely "the managers always say, not to mention the cost of safety as the value of people's lives are always worth more than anything else." For future studies, qualitative research may be added to show the impact that cannot be assessed in monetary terms for both the victims and their families. This will lead to valuable recommendations for both the establishment and Thai policy levels.

Research Suggestions

1. Building road safety measures at the company level is an important issue. Especially for a company related to transportation, this issue should be prioritized for the benefit of the company itself, drivers and their families, and society. As the cost of evaluating ISO 39001 certification is relatively high, a company may start with a security policy by appointing a team to work in this area seriously to reduce the number of accidents and the severity of the accident. The companies may an internal assessment process before considering an external assessment process as is the case with ISO 39001 later. From onsite interviews, it found that certified companies will not only benefit from the traffic system or road safety, but they also benefit from the image and the credibility perspective. As for the perspective of business partners, being certified according to standards ensures business partners trust and makes them want to do business with continually.

2. The findings indicate the process of building critical road safety consists of several steps and it's in accordance with the recommendations or results of the studies from abroad. However, organizations in Thailand have not yet created a manual that is applicable to the companies. The relevant organizations involved in public health, land transport and labor, such as Thai Health Promotion Foundation, Road safety academic center, Department of Disease Control, Department of Land Transport, and the Social Security Office, may consider the preparation and dissemination of the road traffic safety management manual for transport companies. There also should be public relations to communicate with companies to use the manual as a guideline. The preparation and dissemination of the manual may be made

in digital media formats, such as images, infographics, or animations to provide effective communication, fast and easy to understand. As a result of this research, the Academic Center for Road Safety has raised awareness and encouraged more actions among establishments and published the process of building safety in the workplace through several media and social media such as YouTube Channel. Recently, social media has a potential for both formal and informal learning in workplace (Shepherd, 2011, pp. 3-4).

3. The research results indicated the value of the investment in road traffic safety management and accreditation of the ISO 39001 road traffic safety management system. Government should provide more incentives for establishments to take part in this assessment. An implementation can be done in the following ways.

1) Providing knowledge or training on road traffic safety management under ISO 39001 guidelines which may be conducted through Management System Certification Institute (MASCI), an institute established by the Ministry of Industry. This institute focuses on quality management system services, environmental management systems, and occupational health and safety management systems. The institute also creates a network organization to provide a process of advice or coaching between the state and the private sectors or private together

2) Providing tax incentives to encourage more entrepreneurs to take part in ISO 39001 certification such as deducting more expenses for the establishment.

3) Providing the processes to enable transport operators to share information with the state which includes collecting road data and conducting route surveys to define resting points, risk points and things to be aware of while traveling. Technology can also enhance support to distribute information to transport establishments. The information should constantly be updated to allow companies to use the information to create security for their organization without investment or operating all procedures by themselves.

Acknowledgments

This research is completed with the support of research funding by Road Safety Policy Foundation under the Academic Center for Road Safety project plan with the Office of the Health Promotion Fund. I would like to express my special thanks of gratitude to Dr. Thanapong Jinwong and Ms. Thanaphon Chai Suriyasak, who provide significant assistance in conducting research. I would also like to express my gratitude to Associate Professor Sarawut Suthamasa, President of the Occupational Health and Safety Association, and Dr. Thanat Ngern Prasertsri, Managing Director of Thanatwit Travel Group Co., Ltd., who gave helpful suggestions to make this research more complete. Also, special thanks to the three companies and their representatives for providing information and suggestions that are useful for the research for building road safety together. Finally, I would like to mention the support from two other companies to meet up with the research team, and this helps to provide a more comprehensive understanding of the process for building road safety.

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