

Construction Accident Tort Cases: Mathematical and Economic Modelling Approach

Rita Yi Man Li, Frankie Fanjie Zeng
Hong Kong Shue Yan University,

Kwong Wing Chau, Sun Wah Poon, Wilson Weisheng Lu, Darren Tat Ki Fung
The University of Hong Kong

Daniel Chi Wing Ho,
Technical and Higher Education Institute of Hong Kong

Tat Ho Leung
University of Manchester

Construction industry has always been considered as a risky industry, many accidents happen on sites every year in Hong Kong. Millions of dollars are spent annually as compensation. Among the various different concerns in compensation, liability is one of the most important issues. Nevertheless, few or no research attempts to study the accident compensation cases through mathematical and economic models. In view of this, this paper aims to fill this academic gap to study the liability of accident compensation between employers and victims under tort cases. It firstly shows the process to achieve Nash Equilibrium under the negligence rule. After that, the paper adopts the risk compensation theory to analyse risk taking behaviours among the workers on sites. Based on risk thermostat theory, we attempt to review why workers take risk. Moreover, it attempts to demonstrate mathematical interpretation on risk construction accident compensation. The results of this study show that 1) negligence rule forces worker to keep high level of due care and minimize the total social cost and 2) many of these models show that risk taking behaviour is an optimal solution to worker. It is unlikely that taking zero risk is the best to them. As many places around the globe adopt common law as their formal institutions which govern construction compensation, the paper shall provide practical implication to legal and construction industry in similar jurisdictions.

Keywords: construction safety, economic analysis, mathematical model, tort

Introduction

Construction accidents on sites lead to an insurmountable social costs. One possible way to reduce the likelihood of accidents on sites is to increase the costs of accidents. Hence, judges' decisions on the costs of accidents pay an important role in encouraging the employer to provide a safe working environment. Likewise, worker is encouraged to work safely when he can be liable for accident due to his own reckless behaviour. Whilst previous research conducted by Li (2015), Li and Poon (2013) studied construction accident compensation from law and economics' perspective, research on liability and negligence in tort and the risk of construction compensation from mathematical perspective is scarce.

In view of these, an analysis of liability and compensation between employers, contractors and victims has important academic and practical implications. In economics, the relationship between various stakeholders in accident compensation can be studied under game theory framework. It is believed that Nash Equilibrium can be achieved under negligence rule.

Similar to many occupation accident court cases, construction accident court cases fall under the umbrella of tort. According to Oxford (2017), tort mainly concerns with the compensation for personal injury and property damage due to negligence. It also protects interests such as reputation which include defamation, personal freedom, title to property, enjoyment of property, and commercial interests. It must be shown that the wrong was done intentionally or negligently. Most torts are actionable if they have caused damage. The person liable is the one who committed the tort, i.e. the tortfeasor. Nevertheless, under the principal of vicarious liability, one may be liable for tort which is committed by another person. Examples include negligent taxi driver which causes injury to his passenger. The passenger may sue either in tort.

Optimal solution for tort mainly shed light on negligence liability, strict liability, contributory negligence. It also studies the feasible legal innovation such as compensation for future damage and compensation criteria (Diamond, 1974a). Liability studies the optimal level of care among different stakeholders in construction project (Posner and William 1980). Economic literature on tort pointed out that there is a close relationship between tort and economic analysis. Rational assumption assumes that stakeholders minimize risk and maximize their benefits. In this paper, we analyse tort based on mathematical models. It studies the application of economics theory in tort and investigates the issue based on mathematical models to evaluate safety risk and accident compensation in construction industry. In risk compensation theory, risk thermostat model provides some useful insight on the issue. As individuals may have propensity to take risk by the time they consider the possible benefits may exceed the costs, the actual mechanism in dynamic risk decision-making involves the so-called risk homeostasis theory (Wilde 1976, Adams 1995, Sweeting 2011).

Economics analysis of the tort

Tort provides a useful means to redistribute the negative impact of accidents and incentives to lower safety risks on sites. Stakeholders minimize risk and maximize gain in compensation process e.g. Hylton (2001) and Mau (2010). According to Dongen & Verdam (2016), development of contributory negligence theory is slow under strict liability rule and the share of liability among different stakeholders was not discussed prior1945. Besides, De Mot et. al. (2015) evidence that courts with more cases are more likely to adopt contributory negligence approach whereas courts with less cases adopt both contributory and comparative negligence when the judges make decisions for construction accidents compensation. Hylton & Lin (2013) show a new model to study the relationship between negligence and causation. Their model suggest that information possessed by court plays an important role in negligence test.

Thomas (2004) develops an economic model of liability in accident tort cases and show that only when stakeholders engage in risky activities, they have the right bargain with the other stakeholders correctly with regards to compensation. As such, the compensation shall reflect the appropriate liability assignment, irrespective to the liability rule. Gruning (2006) investigates economics loss due to various stakeholders' negligence. The study finds that there might be conflicts between policies and the economic loss. The study concedes that American tort has an agreement that liabilities caused by economic losses, should be set, but there is no agreement on precise amount. However, Bayern (2009) challenge the role of economics in tort, he believes that economic theories fail to explain negligence. Similarly, Anderson (2006) argue that economic models cannot provide some clues for different parties' liabilities outside the regime of contract, i.e. tort. Thus, liability analysis varies case by case. Faure & Weber (2015) argue that if there is dispersed loss, it leads to market failure due to negative externality, because of potential enforcement failure. There is a small harm suffered by individual as a result. And s/he may not be willing to take legal action against. And it leads to the problems of economics failures.

Risk management and compensation in construction

Occupational Safety and Health Potential Risk Model (OSH-PRM) is proposed by Sousa, Almeida, & Dias (2015). They estimate the cost-benefit relationship in occupational safety and health risk management. Pinto (2014) develops a new fuzzy QRAM model which the aims to lower safety risks at work. Instead of studying risk management on construction sites, Feng & Wu (2013) explore construction workers' compensation via case study and collect data through direct observations, questionnaires and interviews. The results show that existing risk compensation behaviours varies from experiences and whether they are injured or not previously, in the construction sites. The more experience workers display lower safety awareness.

By soliciting 574 occupational fatality cases from 1999 to 2011 from the Northern Region Inspection Office of the Council of Labor Affairs of Taiwan. Pearson correlation and analysis of variance (ANOVA), Liao & Chiang (2015) find that construction accident compensation have correlation with contractor size and daily salary. In short, previous literatures mainly utilise qualitative analysis to reveal the economic issues and the liability in tort. Studies on negligence and mathematical models on risk compensation research is relative scarce. We aim to fill the academic gap between risk theory and application in mathematical model.

No liability, Strict Liability and negligence rule in Tort

Apart from strict and no liability, some incidents fall between them (Jain 2015). In no-liability rule, employer does not need to pay for accident compensation when that happens purely due to employees' negligence. The notion of self-interest maximization suggests that employer does not wish to pay for safety precaution. He considers he does not have any duty of care and hence $\varphi = 0$. Nevertheless, construction workers wish to prevent accidents (Posner and William 1980). Even when employer cares about his employees and pay for accident precaution, $y > 0$, level of care among workers is higher than the employer $\beta^1 > \gamma^1$ (Posner and William 1980).

In strict-liability rule, employee who comes across accidents is liable for his acts. Hence, he has to take his own safety precaution where $B_\gamma = -p_\gamma D$ with the level of care to potential injurer equals zero, $\beta^* = 0$ (Posner and William 1980). Posner and William (1980) are of the view that the transaction costs in case of strict-liability exceed no-liability. Under the lens of negligence rule, no one needs to bear the compensation burden when accident happens. In negligence rule, employer takes proper due care but worker does not, i.e., $\gamma = \gamma^* \; and \; \beta = 0$. Accident social is minimized since only employer has to bear the cost of caring. Such that no compensation is needed and worker does not have cost of caring but positive cost of damage (Posner and William 1980):

$$L(0,\gamma^*) = p(0,\gamma^*)D + B(\gamma^*) \quad \text{(i)}$$

Here, the major concern is whether employer can shoulder off the accident compensation for his employee (Posner and William 1980):

The total cost of accident victim is the sum of the caring cost paid by the employer if the employer fails to meet his own due care, $\gamma_0 < \gamma^*$:

$$\mathrm{p}(0,\gamma_0)\mathrm{D} + \mathrm{B}(\gamma_0) \quad \text{(ii)}$$

The cost of taking due care without any legal compensation burden will be:

$$\mathrm{B}(\gamma^*) \quad \text{(iii)}$$

Accident victim has to consider the decision based on costs and benefits and opt for an optimal solution:

$$\mathrm{p}(0,\gamma_0)\mathrm{D} + \mathrm{B}(\gamma_0) \gtreqless \mathrm{B}(\gamma^*) \quad \text{(iv)}$$

If the cost of taking due care exceeds the cost of not taking due care plus accident compensation, worker will be negligent (Posner and William 1980) such that:

$$L(0,\gamma^*) = p(0,\gamma^*)D + B(\gamma^*) < L(0,\gamma_1) = p(0,\gamma_1)D + B(\gamma_1) \quad \text{(v)}$$

Where $\gamma_1 < \gamma^*$

The negligence rule forces the worker to attain due care to minimize total social cost so as to minimized the total private cost. Posner and William (1980) ignore contributory negligence in this model.

Nash analysis on contributory negligence

According to Lai, Hou, & Wen (2015), Nash equilibrium is a useful tool to model the problem when there is limited number of solutions. Nash equilibrium helps us identify all the possible choices employers and employees, who wish to maximize their benefits and minimize costs. Posner and William (1980) suggest that equilibrium is possible to attain according to the following Table.

Table 1 Expected lose of worker in case of accidents.

	Worker's level of due care	
Employer's level of due care	$\beta_0 < \beta^*$	β^*
$\gamma_0 < \gamma^*$	$p(\beta_0,\gamma_0)D + A(\beta_0)$	$A(\beta^*)$
γ^*	$p(\beta_0,\gamma^*)D + A(\beta_0)$	$p(\beta^*,\gamma^*)D + A(\beta^*)$

Table 2 Expected losses of defendant when accident happens.

	Employer's level of due care	
Worker's level of due care	$\gamma_0 < \gamma^*$	γ^*
$\beta_0 < \beta^*$	$B(\gamma_0)$	$B(\gamma^*)$
β^*	$p(\beta^*, \gamma_0)D + B(\gamma_0)$	$B(\gamma^*)$

Tables 1 and 2 show that worker takes due care level $\beta^*$to minimize economic and non-economic lose due to accidents at work when he holds the view that his employer is negligent. According to Posner and William (1980), an accident's social cost is:

$$L(\beta, \gamma) = p(\beta, \gamma)D + A(\beta) + B(\beta) \text{ ... (vi)}$$

Social cost of accident is minimised when worker and employer take due care:

$$(\beta^*, \gamma^*) = p(\beta^*, \gamma^*)D + A(\beta^*) + B(\gamma^*) \text{ (vii)}$$

If worker and employer take less due care, $\gamma_0 < \gamma^*$ and $\beta_0 < \beta^*$, the worker's expected lose will be:

$$p(\beta_0, \gamma_0)D + A(\beta_0) = L(\beta_0, \gamma_0) - B(\gamma_0) \text{ ... (viii)}$$

The expected loss of worker if he is negligent but contractor takes appropriate due care will be:

$$p(\beta_0, \gamma^*)D + A(\beta_0) = L(\beta_0, \gamma^*) - B(\gamma^*) \text{ ... (ix)}$$

Accordingly, if both parties take due care, expected loss to worker would be:

$$p(\beta^*, \gamma^*)D + A(\beta^*) = L(\beta^*, \gamma^*) - B(\gamma^*) \text{ ... (x)}$$

If worker takes all his possible due care but the contractor takes a lower due care level, the expected loss to the worker will be:

$$A(\beta^*) = L(\beta^*, \gamma_0) - p(\beta^*, \gamma_0)D - B(\gamma_0) \text{ ... (xi)}$$

Workers with certain level of contributory negligence are optimal under the negligence rule. The same analytical deduction is applicable to the expected loss to employer. The most satisfied outcome to employer would be negligent with employee. Hence, the expected loss can be minimized as $B(\gamma_0)$.

Due level of care in tort

Posner's risk-neutral assumption suggested that workers and contractors have linear utility function, which is $U_0 = \beta_0, +\alpha$ where $\beta > 0$ and $\alpha \geq 0$ (Posner and William 1980). To investigate the level of due care, it is assumed that A is a victim of the accident and B is an employer. When an accident occurs and the level of care provided by A is β where the level of care taken by B is φ, likelihood of accident depends on the level of care β and φ (Posner and William 1980):

$$p = p(\beta, \gamma) \quad \text{(xii)}$$

Posner and William (1980) suggest that marginal product of care is negative and decrease in nature, such that the level of care is negatively related to the likelihood of an accident at a diminishing rate. When we take the second-order condition, it will become:

$$\frac{\partial(\frac{\partial \mathrm{p}}{\partial p_\beta})}{\partial p_\beta} = p_{\theta\theta} > 0 \quad \text{(xiii)}$$

$$\frac{\partial\left(\frac{\partial \mathrm{p}}{\partial p_\gamma}\right)}{\partial p_\gamma} = p_{\gamma\gamma} > 0 \quad \text{(xiv)}$$

The model studies the expected utility of worker and employer. Assume D is worker's monetary losses in accident. (Posner and William 1980). Expected utility of A will then become:

$$\overline{U^A} = p\big(I^A - D - A(\beta)\big) + (1-p)\big(I^A - A(\beta)\big) \;\; = I^A - pD - A(\theta) \quad \text{(xv)}$$

And the expected utility of B will be:

$$\overline{U^B} = p\big(I^B - A(\gamma)\big) + (1-p)\big(I^A - A(\gamma)\big) = I^B - B(\gamma) \qquad \text{(xvi)}$$

Hence, the utility of victim and employer when accident happens:

$$\overline{U^A} + \overline{U^B} = [\![I^A - pD - A(\beta)] + [I^B - B(\gamma)] = I^A + \mathrm{I}^B - pD - A(\beta) - B(\gamma) \quad \text{(xvii)}$$

If utility is maximized, social welfare is maximized. Accident's social cost, i.e. the expected lose due to accident and costs of due care ($pD + A(\beta) + B(\gamma)$) are minimized (Posner and William 1980). An accident's social costs will become (Posner and William 1980):

$$L(\beta,\gamma) = p(\beta,\gamma)D + A(\beta) + B(\gamma) \ldots \text{(xviii)}$$

Social cost of accident depends on the level and the marginal cost of care, A_β *and* B_γ are positive and do not have tendency to drop (Posner and William 1980). If worker and employer select the optimal level of due care, β^* *and* γ^*, accident's social cost is minimized. The due care level of victim and employer in the first order condition will become:

$$\frac{\partial \mathrm{L}}{\partial \beta} = 0 \ldots \text{(xix)}$$

$$\frac{\partial \mathrm{L}}{\partial \varphi} = 0 \ldots \text{(xx)}$$

Eventually, due care level reaches an equilibrium level with marginal cost of care equals to the reduction in expected damage on construction worker and employee when the former one need to pay for the victim's accident compensation (Posner and William 1980),

$$A_\beta = -p_\beta D \ldots \text{(xxi)}$$

$$B_\gamma = -p_\gamma D \ldots \text{(xxii)}$$

Contributory negligence tort model

If a worker fails to take his due care ($\theta_1 < \theta^*$) to prevent accident, he has contributory negligence. Victims at work have to bear the accident costs and share the costs of damage with his employer no matter under the strict-liability rule or negligence. Thus, employer pays less than the calculated accident compensation even when he is liable for the accident. Posner and William (1980) conjecture that there are four possible results of liability in negligence rule when the worker has contributory negligence, where s^A *and* s^B represents the victim and employer's contribution negligence:

Table 3:Four different cases of liability in contributory negligence model

Level of due care	Liability for construction accident
β^*, γ^*	$s^A = 1;\ s^B = 0$
$\beta_1 < \beta^*, \gamma^*$	$s^A = 1;\ s^B = 0$
$\beta_1 < \beta^*, \gamma_1 < \gamma^*$	$s^A = 1;\ s^B = 0$
$\beta^*,\ \gamma_1 < \gamma^*$	$s^A = 0;\ s^B = 1$

According to Table 3, employer does not have any responsibility for damage if 1) workers and employers take due care (x*, y*) or 2) worker is negligent but employer takes due care or 3) both of them are negligent (case 1 to case 2). Only the last case with the due care performed by workers and with negligent employer, the cost of damage is shifted to defendant (Posner and William 1980). It opens up multiple-party analysis which implies that an accident could involve more than two parties. For multiple-party, it can separate into two situations which are one victim to many injuries and one injury to many victims (Jain 2015)

Risk thermostat theory (also known as risk compensation theory)

An increase in safety awareness can alleviate the safety risk at work. The risk thermostat model shows workers' choice between risk and safety behaviour. It hypothesizes that we all have a target risk level and measure risk according to our own risk thermostat. The consequence between external environment interventions on different individuals could be different (Adams 1995).

Individuals have different level of perceived risk and risk assessment is essential in decision-making process. Each of us has specific target level of risk taking propensity and all of them are intended to retain such target level. If there is disparity between perceived risk and target level of risk, they will spontaneously adjust the level of risk to target level by actions. Thus, this internal assessment is known as risk homeostasis in dynamic decision-making process. In fact, participants do not only modify their behaviour in response to external changes but seek to counteract these changes completely and return to our desired risk level. Therefore, risk compensation is needed as people are not machines. Besides, safety measures that change the external condition and environment, risk behaviour changes with the external variation. (Hedlund 2000). For example, if there is an accident occurred last year, contractors will take higher due care on construction site, leading to lower accident compensation. At the same, the site workers will also evaluate the risk on site during operation and take higher due care after implementing the relevant safety enhancement policy.

The risk thermostat model was firstly proposed by Wilde and revised by Adams (Wilde 1976, Adams 1985, Adams 1988). Nevertheless, the risk thermostat model is an impressionistic, conceptual but not an operational one (Adams 1995). On the other hand, although heaps of research has been conducted on risk compensation and risk thermostat theory, there is no research on generalized mathematical interpretation based on risk compensation theory. Therefore, we attempt to demonstrate risk compensation theory in construction safety from mathematical perspective.

Risk compensation is adopted to study the relationship of human behaviour under legal regulations. For example, acts of drivers to after seat belt laws are implemented in Europe and the US (Crandall and Graham 1984, Blomquist 1988, Adams 1994); HIV/STD Transmission (Pinkerton 2001); behaviours of beer drinkers (Rogers and Greenfield 1999). Under risk compensation theory, workers on sites may have propensity to take risk and accident still occur. Bernoullian model can be used to evaluate the net effect of changes in risk taking behaviours on site by estimating the overall probability of accident (Pinkerton 2001).

Therefore, the risk of an accident is:

$$R = 1 - \left\{(1-\pi) + \pi\left(1 - (1 - f_0\varepsilon)\right)^n\right\} \quad \text{(xxiii)}$$

Where n refers to the number risky actions; π is the probability of accident occurs; f is the proportion of being protected by safety apparatus and policy; and, ε is the effectiveness of the safety apparatus and policy.

The theory simplifies the risk taking action as there is only little mutual impact among workers on construction site. It assumes that there is no innocent suffer if accident occurs. To examine the consequence under risk homeostasis condition, it supposes an increase in construction site safety apparatus and policy. Therefore, the proportion of being protected will shift from f_0 to f_1. The Homeostatic Threshold, T_{f_0,f_1}, is the inherent factor which balances workers' behaviours. It further implies that workers would have higher incentive in taking risk after receiving construction site safety improvement. From equation (xxiii),

$$T_{f_0,f_1} = \frac{\ln[1-(1-f_0\varepsilon)]}{\ln[1-(1-f_1\varepsilon)]} \quad \text{(xxiv)}$$

Where the natural logarithm function represents the offset of risk reduction from construction site safety improvement from f_0 to f_1. Thus, actual risk taking activities increases from n to nT_{f_0,f_1}. Individual propensity of risk taking can be influenced by plural rationalities. It implies a reasonable situation that it is necessary for worker to cooperate in order to accomplish a task. The collective perceptions of risk in construction site are actually mutual affected. From equation (xxiii),

$$R = 1 - \left\{(1-\pi) + \pi\left(1 - (1 - f_0\varepsilon)\right)^n\right\}^m \quad \text{(xxv)}$$

$$R' = 1 - \left\{(1-\pi) + \pi\left(1 - (1 - f_1\varepsilon)\right)^n\right\}^m \quad \text{(xxvi)}$$

Where m shows the level of mutual risk taking .

Site safety improvement enhances collective awareness of risk. Assume workers' work is fixed, workers may increase or decrease the level of cooperation due to the nature of the task. Despite the final outcome varies, we can generalize the level of cooperation under risk compensation situation τ as follows:

$$\tau = m\frac{\ln(1-\pi) + \pi[1-(1-f_0\varepsilon)]^n}{\ln(1-\pi) + \pi[1-(1-f_1\varepsilon)]^n} \quad \text{(xxvii)}$$

By evaluating the risk compensation, it provides an effective, scientific and significant estimation for contractors. Before safety improvement programs implemented, contractors can use this model to estimate the risk compensation effect among workers. It helps us to derive optimal resource allocation on site safety.

Conclusions

Construction accident compensation is one of the good means that deter the negligence behaviour of worker and motivate employer to provide a safe working environment. One of the important roles of the judge in tort cases is to determine the level of liability between worker and employer. Many of the previous studies on construction accidents torts cases restrict on economic and legal aspect. This paper sheds light on construction accident compensation based on mathematical and economical perspective. It fills the academic gap in risk theory and mathematical model analysis on construction accident compensation.

The mathematical model shows that negligence rule suggests that employee has to take due care so as to minimize the total social cost arises in accident. Having said that however, if the cost of taking due care is more than the cost of not taking sufficient due care, worker will be negligent. The Nash analysis on contributory negligence equilibrium illustrate that worker with certain level of contributory negligence attains optimal solution. Finally, risk thermostat model shows that the decision made between risk and safety behaviour. It suggests that worker has his own target risk level and measures risk according to his own risk thermostat. Thus, even though these theories are proposed by different scholars, they share common ground that certain level contributory negligence is the optimal solution. Besides, it also illustrates that judges in courts with more cases tend to adopt contributory negligence approach while courts with less cases adopt contributory and comparative negligence rule when they make decisions for construction accidents compensation.

Acknowledgement

This paper is supported by University Grant Committee, Faculty Development Scheme, Construction safety index for skyscrapers in Hong Kong: A Multi-criteria decision-making approach (Project Reference No.: UGC/FDS15/E01/15).

References

Adams, J. (1985). Risk and Freedom: the Record of Road Safety Regulation. London, Transport Publishing Projects.

Adams, J. (1988). Evaluating the Effectiveness of Road Safety Measures. Traffic Engineering and Control: 344-352.

Adams, J. (1994). Seat Belt Legislation: The Evidence Revisited. Safety Science 18: 135-152.

Adams, J. (1995). Risk. London, UCL Press.

Anderson, J. M. (2006). The missing theory of variable selection in the economic analysis of tort law. SSRN Electronic Journal. doi:10.2139/ssrn.987957

Bayern, S. (2009, February 26). The limits of formal economics in tort law: The puzzle of negligence by Shawn Bayern. Brooklyn Law Review, Vol. 75, p. 707, 2010.

Blomquist, G. (1988). The Regulation of Motor Vehicle and Traffic Safety. Boston, Kluwer.

Crandall, R. W. and J. D. Graham (1984). Automobile Safety Regulation and Offsetting Behavior: Some New Empirical Estimates. American Economics Review 74: 328.

De Mot, J., Faure, M., & Klick, J. (2015). Appellate caseload and the switch to comparative negligence. International Review of Law and Economics, 42, 147–156. doi:10.1016/j.irle.2015.01.003

Dongen, E. G. D. van, & Verdam, H. P. (2016). The development of the concept of contributory negligence in English common law. Utrecht Law Review, 12(1), 61. doi:10.18352/ulr.326

Faure, M., & Weber, F. (2015). Dispersed losses in tort law – an economic analysis. Journal of European Tort Law, 6(2), 163-196. doi:10.1515/jetl-2015-0012

Feng, Y., & Wu, P. (2013). Risk compensation behaviours in construction workers' activities. International Journal of Injury Control and Safety Promotion, 22(1), 40–47. doi:10.1080/17457300.2013.844714

Gruning, D. (2006). Pure economic loss in American tort law: An unstable consensus. The American Journal of Comparative Law, 54, 187–208. doi:10.2307/20454536

Hedlund, J. (2000). Risky Business: Safety Regulations, Risk Compensation, and Individual Behavior. Injury Prevention 6: 82-89.
Hylton, K. N. (2001). The theory of tort doctrine and the restatement of torts. Boston University School of Law Research Paper 07: 1-21.
Hylton, K. N., & Lin, H. (2013). Negligence, causation, and incentives for care. International Review of Law and Economics, 35, 80–89. doi:10.1016/j.irle.2013.04.004
Jain, S. K. (2015). Economic Analysis of Liability Rules. India, Springer.
Lai, J.-F., Hou, J., & Wen, Z.C. (2015). A smoothing method for a class of generalized Nash equilibrium problems. Journal of Inequalities and Applications, 90, 1-16. doi:10.1186/s13660-015-0607-6
Li, R.Y.M. & Poon, S.W. (2013) Construction Safety, Germany, Springer
Li, R.Y.M. (2015) Construction Safety and Waste Management: An Economic Analysis, Germany, Springer
Liao, C.W., & Chiang, T.L. (2015). The examination of workers' compensation for occupational fatalities in the construction industry. Safety Science, 72, 363–370. doi:10.1016/j.ssci.2014.10.009
Oxford (2017) Oxford Reference http://www.oxfordreference.com/view/10.1093/oi/authority.20110803105014458
Pinkerton, S. D. (2001). Sexual Risk Compensation and HIV/STD Transmission: Empirical Evidence and Theoretical Consideration. Risk Analysis 21(4): 727-736.
Pinto, A. (2014). QRAM a qualitative occupational safety risk assessment model for the construction industry that incorporate uncertainties by the use of fuzzy sets. Safety Science, 63, 57–76. doi:10.1016/j.ssci.2013.10.019
Posner, R. A. and M. L. William (1980). The Positive Economic Theory of Tort Law. Georgia Law Review 15: 851-924.
Rogers, J. D. and T. K. Greenfield (1999). Beer Drinking Accounts for most of the Hazardous Alcohol Consumption Reported in the United States. Journal of Studies on Alcohol 60: 732-739.
Sousa, V., Almeida, N. M., & Dias, L. A. (2015). Risk-based management of occupational safety and health in the construction industry – part 2: Quantitative model. Safety Science, 74, 184–194. doi:10.1016/j.ssci.2015.01.003
Mau, S.D. (2010). Tort of Negligence. In Tort law in Hong Kong: An introductory guide. Hong Kong University Press.
Thomas, J. M. (2004). An Economic Model of Tort Law. In The economic approach to law. Stanford University Press.
Wilde, G. J. (1976). The Risk Compensation Theory of Accident Causation and its Practical Consequences for Accident Prevention. Annual meeting of the Osterreichische Gesellschaft Fur Unfallchirurgies. Salzburg.