Available online at www.sciencedirect.com
ScienceDirect
International Journal of Project Management 27 (2009) 544–551
International Journal of Project Management
www.elsevier.com/locate/ijproman

Design professionals' legal risks increased under nature's attack: Chichi Earthquake experience

Yu-Lin Huang [1], Shih-Hung Chang *

Civil Engineering Department, National Chiaotung University, 3F-5 No. 20 Minquan W. Road, Taipei City 104, Taiwan, ROC

Received 7 August 2008; received in revised form 11 October 2008; accepted 21 October 2008

Abstract

This paper aims to examine increases in professional liability for architectural and engineering (A/E) professionals following quantitative changes in litigation risks after the Chichi Earthquake. The methodology uses *t*-tests and ANOVA to analyse the impact of the earthquake with regard to (1) the number of A/E litigations, (2) the type of plaintiff, (3) court decisions, and (4) the scope of A/E activities or practices challenged by litigation. Our results showed the risk of liability lawsuits increased significantly, and lawsuits were more persistent after the earthquake. The professional liability risk seemed to intensify in higher courts. The risks of both professional liability and criminal indictment by public prosecutors were increased.

Keywords: Legal; Risk; Claims

1. Introduction

Large earthquakes typically cause massive destruction in built environments and result in injuries and fatalities. This not only incurs enormous costs to society in general, but also has profound legal implications for the architectural and engineering (A/E) community. The 1999 Chichi Earthquake in Taiwan is a case in point. The magnitude of the earthquake was 7.3 on the Richter scale. It destroyed 53,661 buildings, damaged 53,024 others, and led to 2405 fatalities and numerous injuries [1]. After the earthquake, the Building Construction Bureau promptly strengthened building codes, and the public expressed a firm belief that the damage, injuries, and fatalities were caused not by the earthquake alone, but also by the negligence and wrongdoing of the A/E community. As a result, the legislature imposed stricter controls on A/E professional responsibilities and liabilities, and many lawsuits were filed against A/E firms.

Legal remedies for professional irresponsibility and misconduct are not the most efficient way to mitigate exposure to earthquake risk. Indeed, Europe has promoted the use of science and technology to mitigate this exposure [2]. Another survey in the US indicated that most people would elect to strengthen building codes and existing buildings [3]. Others believe that the integration of disaster management and community planning is the key to sustainable mitigation of natural disasters [4]. These differences not only reflect the variety of expert opinions, but also mirror the depressed social mood after natural disasters and probably influence the politics of risk management [5].

Notwithstanding these diverse views and measures, A/E professionals are in a poor position in the face of legal remedies. They have a duty not only to their clients, but also to contractors, third parties, and society in general. Apart from the independent professional roles of designer, administrator, supervisor, and certifier of works, an A/E professional usually acts as a client's agent and adjudicator or quasi-arbitrator, unless the contract states otherwise [6]. Despite these complicated roles and responsibilities,

* Corresponding author. Tel.: +886 933163632; fax: +886 225367645.
E-mail addresses: huangyulin2000@yahoo.com (Y.-L. Huang), ericsh.cv90g@nctu.edu.tw (S.-H. Chang).
[1] Present address: No. 1001 Daxue Road, Hsinchu City 300, Taiwan, ROC.

0263-7863/$34.00 © 2008 Elsevier Ltd and IPMA. All rights reserved.
doi:10.1016/j.ijproman.2008.10.008

the A/E professional has no contract with the general contractor or other project participants [7]. Once disputes arise, A/E professionals' duties and liabilities are ambiguous, and they must rely on the law of tort under applicable contract law [8].

In particular, changes in the modern engineering environment have made A/E professional duties and liabilities more intensive [9,10] and legally complex [11]. Modern professional liability (PL) theory has tended to expand A/E responsibilities [12]. The range of potential claimants of PL lawsuits against A/E professionals has also become broader, in particular including third parties other than contractors [13,14]. The expansion of the claimant cycle is not a trivial issue. According to economic theory, litigation occurs when the plaintiffs' expected returns exceed their expected losses [15]. Under certain restrictive assumptions, the plaintiffs have a 50% chance of winning [16]. Although the "50% rule" is correct only if the distribution of a court's decision-making standards is symmetric [17], the plaintiffs are persistent and tend to appeal when they fail in the lower courts [18].

The claimants' aggressive behaviour is not attributable only to their expectation of winning, nor is it simply to raise the stakes of trials to induce settlements [19]. It is also because the courts are independent, and the views of courts at different levels often differ [20]. When the lower courts oppose the views of the higher courts, they may attempt to avoid or even impede [21,22]. The lower courts may even defy the higher courts' previous decisions [23].

Nevertheless, the applicable law places most of the risk of loss on the design professionals in the absence of a contractual reallocation [24]. Wang et al. [25] surveyed 91 supervisory firms to identify the obstacles to the implementation of professional liability insurance in the Chinese construction industry. One obstacle is the lack of a clear definition of the professional liability of a supervisory engineer. This will increase the number of future disputes regarding the supervisor's liability. In the face of aggressive claimants, the A/E professionals, as rational decision makers whose objective is to maximize self-interest (see, for example [26,27]), use their best efforts to defend themselves and reduce their potential liability [28]. Indeed, if the A/E professionals value their contested legal entitlements highly, they are willing to spend considerable sums on litigation to defend themselves [29].

However, the success of an A/E professional's defence depends on the court recognizing a reasonable distribution of professional responsibilities and liabilities. The court may have to request expert testimony before deciding if the plaintiff has followed the appropriate standards of care in professional practices [30]. The A/E professional can spend more on litigation to collect information and improve the quality of defence. The facts in legal proceedings are intrinsically vague and uncertain; legal institutions are designed to manage uncertainty [31], and the court should attempt to reduce this [32]. However, the lengthy legal proceedings mean the A/E professional's resulting litigation costs are very high.

Accordingly, this paper investigates what quantitative changes were caused by the Chichi Earthquake, who the claimants were, what the claimants' motives were, how the courts judged the cases, and what kinds of A/E professional responsibilities and liabilities were affected and in what manner. The remainder of the paper is organized as follows. Section 2 describes the data and the research methodology. Section 3 provides the statistical analyses and results. Section 4 summarizes and discusses the results. Section 5 concludes with some future research directions.

2. Data and research methodology

There are several channels available to resolve construction disputes, such as amicable dispute resolution under the Government Procurement Law, arbitration, and litigation. This paper only investigates cases of litigation, for three main reasons. First, privacy considerations prevent the collection of other data. Second, because the decisions of other dispute resolution channels often create further disputes, and thus lead to litigation for final resolutions, litigation tend to be more complete. Third, courts set precedents, their decisions are more objective, and their public records are more reliable.

The period of investigation is between January 1996 and May 2004, during which time 483 A/E litigation cases were conducted and 348 of these cases, about 72%, listed A/E professionals as defendants. There are three levels of court in Taiwan, namely the district, high, and supreme courts. Since the law imposes time limits for court decisions, there are time gaps among these litigation cases. Taking this into account, this paper uses the time of the Chichi Earthquake as a benchmark, and classifies the cases into two groups—one with the earthquake treatment and the other without—for statistical analyses. Table 1 provides some descriptive statistics of the cases where the court has made a definite liable/non-liable decision.

In the following, a *t*-test and ANOVA were used to investigate the impacts of the Chichi Earthquake on four areas of concern: (1) the number of A/E litigations, (2) the types of plaintiff, (3) the court decisions, and (4) the scope of A/E activities or practices challenged by litigation.

3. Results

3.1. Impact on the number of A/E litigations

The number of litigations is a good indication of how A/E professionals' legal risks may have been influenced by the Chichi Earthquake. For preliminary assessment, define θ_{CL} as the rate of change of A/E related litigations at a given court level, which is given by: $\theta_{CL} = \frac{\Delta y}{\Delta x}$, $\Delta x = \frac{A_{ante}}{D_{ante}}$, $\Delta y = \frac{A_{post}}{D_{post}}$. Here, Δx is the ex-ante annual occurrence rate,

Table 1
Descriptive statistics of the lawsuits against A/Es.

Year	Panel 1 (before EQ)						Panel 2 (after EQ)					
	D		H		S		D		H		S	
	L	NL	L	NL	L	NL	L	NL	L	NL	L	NL
1996	3	2	3	4	1	2						
1997	8	8	3	8	1	2						
1998	5	5	4	9	0	0						
1999			3	11	0	0	7	8				
2000					1	1	16	23	6	9		
2001							12	29	7	14	1	2
2002							10	16	11	15	0	1
2003							1	9	6	17	0	1
2004							0	4	4	6	0	3
Mean	5.33	5.00	3.25	8	0.6	1	7.67	14.83	5.67	12.2	0.25	1.75
S.D.	2.52	3.00	0.5	2.94	0.55	1	6.28	9.66	3.61	4.55	0.5	0.96

L: guilty or liable cases; NL: not guilty or non-liable cases; D: district courts; H: high courts; S: Supreme Court.

A_{ante} is the number of litigations before the earthquake, and D_{ante} is the corresponding duration (years) of observation. Likewise, Δy is the ex-post annual occurrence rate, A_{post} is the number of litigations after the earthquake, and D_{post} is the corresponding duration of observation.

The θ_{CL} value is 2.18 in the district courts, 1.69 in the high courts, and 2.03 in the Supreme Court. Accordingly, substantial changes occurred after the earthquake. A t-test was used to confirm these changes further. The annual average number of litigations was 1.08 before the earthquake and 2.09 thereafter. The difference is significant at the .05 level ($t = 2.108$, $p = .047$).

Removing the earthquake-related cases from the sample pool, the θ_{CL} value is 1.06 in the district courts, .96 in the high courts, and 1.56 in the Supreme Court. The t-test shows that the difference is not significant ($t = .48$, $p = .64$).

To sum up, the Chichi Earthquake had a significant impact on the number of lawsuits brought against A/E professionals.

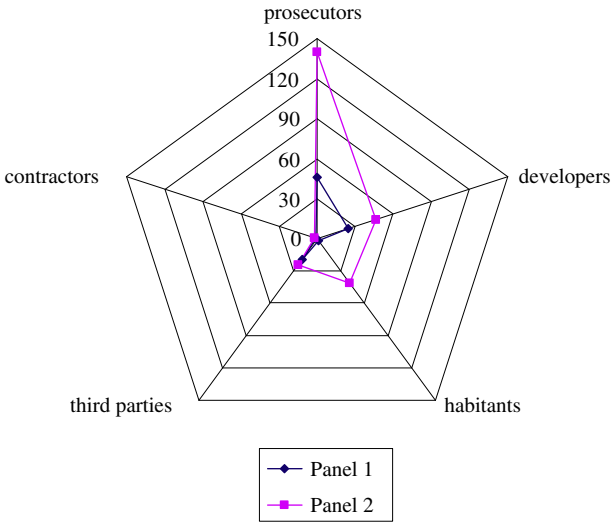

Fig. 1. Distribution of plaintiff type.

3.2. Impact on the plaintiff types

As mentioned above, when A/E responsibilities expand, the number of parties involved in PL lawsuits also expands. The problem thus arises of whether the Chichi Earthquake had an impact on the types of plaintiff in litigation cases.

Plaintiff types are classified into five groups, namely the clients of design contracts, general contractors, public prosecutors, the residents of damaged buildings, and other third parties. Fig. 1 shows the distribution of plaintiff types. The θ value for each plaintiff type is 1.54 for clients, 1.1 for general contractors, 2.1 for public prosecutors, 12.6 for residents, and .82 for third parties. Therefore, except for third parties, the number of lawsuits filed by the various plaintiff types substantially increased.

The t-test further confirms the differences. For residents, the annual average number of litigations was .11 before the earthquake and 1.48 thereafter; this difference is significant at the .05 level ($t = 2.29$, $p = .03$). Likewise, for prosecutors, the average was 1.70 before the earthquake and 5.19 thereafter, and this difference is significant at the .05 level ($t = 2.11$, $p = .045$). However, the differences for clients ($t = 1.41$, $p = .17$), general contractors ($t = .57$, $p = .57$), and third parties ($t = .27$, $p = .79$) are not significant.

The significant increase in the number of residents as plaintiffs is understandable, because residents were the primary victims of the earthquake. The increase in the number of prosecutors as plaintiffs is a phenomenon that is worth further examination.

To begin with, the change in the mean value of prosecutor-initiated litigations is 1.06 in district courts, 1.13 in high courts, and 2.05 in the Supreme Court. It seems that the prosecutors' efforts were persistent. The following hypothesis is thus proposed:

H1: Both the Chichi Earthquake and the court level had significant impacts on the number of prosecutor-initiated litigations.

Table 2
Two-way ANOVA of the prosecutor-initiated litigations.

Source	*F*	*p*-Value
Corrected model	5.127	.000
Intercept	36.239	.000
CL[a]	9.026	.000*
EI[b]	6.273	.013*
CL * EI	1.628	.199

[a] Court level (all courts).
[b] Earthquake incidence.
* Significant at the .05 level.

Table 2 shows the results of the two-way ANOVA. The effect of the interaction between the court level and the earthquake is not significant ($F = 1.63$, $p = .199$). The main effect of the earthquake is significant at the .05 level ($F = 6.27$, $p = .013$). The marginal mean value of the litigations was .894 before the earthquake and 2.169 thereafter. In addition, the main effect of the court level is also significant at the same level ($F = 9.03$, $p = .00$). The post hoc test shows that the average annual number of litigations was 1.82 in the high courts and .54 in the district courts. The 1.28 mean difference is significant at the .05 level.

These results show that court level also had a significant impact on the incidence of litigations, and the high courts' average number of cases is significantly higher than that of the district courts. This indicates that the prosecutors were persistent. They tended to appeal when their cases were rejected by the district courts. The Chichi Earthquake thus increased the risk of criminal charges being brought against A/E professionals.

3.3. Impact on court decisions

As mentioned above, court decisions have significant implications for A/E duties and liabilities, and the views of courts at different levels may differ. The problem then arises whether decisions at the various court levels were different after the earthquake.

First, we classify the decisions into two groups: liable/guilty and non-liable/not guilty. Supreme Court cases were excluded from this analysis, as most were dismissed for further consideration and are thus inconclusive. Fig. 2 shows the distribution of liable/non-liable decisions with the mean value.

A *t*-test was then used to analyse the differences caused by the earthquake. For the number of liable/guilty cases, the difference between the periods before and after the earthquake is not significant ($t = 1.416$, $p = .179$). For non-liable/not guilty cases, however, the difference is significant at the .1 level ($t = 1.91$, $p = .07$). The change of mean value of these cases is 1.36 in the district courts and .91 in the high courts. To examine whether the court level had a significant impact, the following hypothesis is proposed:

H2: Both the Chichi Earthquake and the court level had significant impacts on the number of non-liable or not guilty decisions.

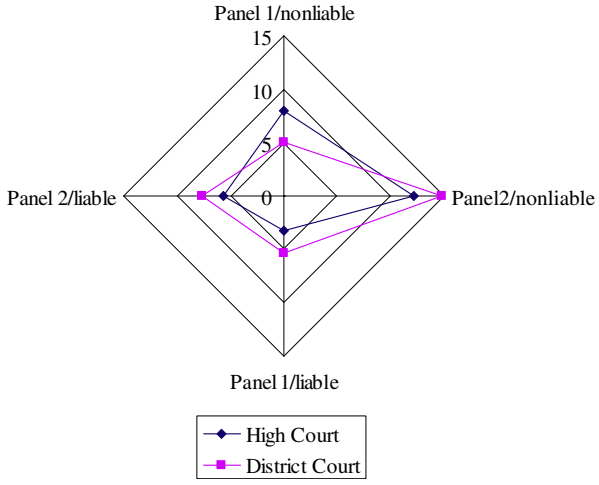

Fig. 2. Distribution of liable/non-liable decisions.

Table 3
Two-way ANOVA of the non-liable cases.

Source	*F*	*p*-Value
Corrected model	7.179	.000
Intercept	57.528	.000
CL[a]	17.152	.000*
EI[b]	4.355	.038*
CL * EIY	.123	.726

[a] Court level (district courts and high courts).
[b] Earthquake incidence.
* Significant at the .05 level.

Table 3 shows the results of two-way ANOVA. The effect of the interaction between court level and the earthquake is not significant ($F = .12$, $p = .73$). Both earthquake occurrence ($F = 4.36$, $p = .038$) and court level ($F = 17.15$, $p = .00$) have significant effects. The marginal mean of these cases is .95 for the period before the earthquake and 1.67 thereafter. Likewise, the marginal mean is 2.02 in the high courts and .59 in the district courts.

Thus, court level had a significant impact on the non-liable/not guilty decisions. In addition, the high courts' average of these cases was significantly higher than the district courts'. In other words, while the conviction rate in the district courts was very high, the risk of conviction decreased significantly after appeals.

3.4. Impact on the scope of A/E activities or practices challenged by litigation

The scope of A/E services varies, depending the specific terms and conditions of contracts. For the purpose of this subsection, the scope of A/E professionals' involvement in construction projects is divided into four activities or practices, namely contract tendering/signing, design, cost estimation/specification preparation, and site supervision. The litigations are then classified in accordance with the types of charges concerning these activities or practices.

Table 4
Descriptive statistics of the litigations against A/E services.

A/E activity/practice	Panel 1						Panel 2					
	D		H		S		D		H		S	
	Cr	Ci	Cr	Ci	Cr	Ci	Cr	Ci	Cr	Ci	Cr	Ci
Tendering	1	0	4	2	0	0	0	0	1	0	0	0
Design	11	4	15	8	2	8	40	37	30	18	3	11
Estimate	4	1	2	1	0	0	1	0	2	0	0	0
Supervision	13	9	23	16	6	11	111	54	82	26	9	19
Mean	7.25	3.50	11.00	6.75	2.00	4.75	38.00	22.75	28.75	11.00	3.00	7.50
S.D.	5.68	4.04	9.83	6.90	2.83	5.62	52.11	27.17	37.96	13.11	4.24	9.26

Cr: criminal cases; Ci: civil cases.

Note that each litigious action may involve more than one issue, in terms of either the type of charges or the A/E practices. The types of charges are broadly divided into two groups, namely civil (Ci) and criminal (Cr), as shown in Table 4. It appears that litigations concerning A/E design and supervision are the most frequent ones.

Although litigations against A/E tendering and cost estimation were less common, they are worth a brief mention. The cases related to tendering involved mainly criminal charges such as fraud, corruption, and bribery. These decreased greatly after the earthquake. For litigations related to cost estimation, there were also more criminal than civil cases, but the number of criminal cases decreased after the earthquake. The criminal charges involved mainly forgery, corruption, and bribery.

In the following, litigations related to both design and supervision will be further analysed. For preliminary screening, define δ as the rate of change of the number of litigations, which is given by: $\delta = \frac{\Delta j}{\Delta i}$, $\Delta i = \frac{L_{Type}}{L_{Tptal}}$, $\Delta j = \frac{L'_{Type}}{L'_{Total}}$. Here, L_{Total} is the total number of litigations brought against the construction service (four activities) before the earthquake, and L_{Type} is the total number of criminal or civil cases brought against the design or supervision service before the earthquake. Likewise, L'_{Total} is the total number of litigations brought against the construction service after the earthquake, and L'_{Type} is the total number of criminal or civil cases brought against the design or supervision service after the earthquake.

3.4.1. Litigations concerning A/E design practices

The rate of change concerning design practices is $\delta = .75$ for the criminal cases and $\delta = 1.28$ for the civil cases. Accordingly, although the number of criminal cases is larger, the rate of change is smaller. Fig. 3 shows the rate of change concerning design practices.

The t-test further confirms this trend. The average number of criminal lawsuits increased from .38 to .63, but the difference is not significant ($t = 1.61$, $p = .12$). On the other hand, that of the civil lawsuits increased from .16 to .44, and the difference is significant at the .05 level ($t = 4.48$, $p = .00$).

Civil litigations are important because they involve A/E professional liability. As shown in Table 4, the number of

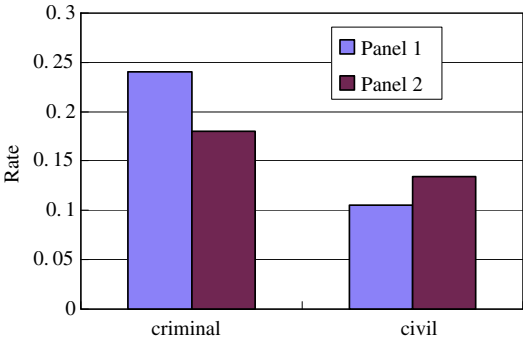

Fig. 3. Rate of change concerns design practices.

these litigations varies with the level of courts. The question then arises whether the level of court, along with the occurrence of the earthquake, played an important role in the incidence of these cases. The following hypothesis is proposed:

> H3: Both the Chichi Earthquake and the court level had significant impacts on the incidence of civil litigations concerning A/E design practices.

Table 5 shows the results of the two-way ANOVA. The effect of the interaction between court level and earthquake occurrence is not significant ($F = .06$, $p = .939$). The main effect of earthquake occurrence is significant at the .10 level ($F = 3.33$, $p = .07$). The marginal mean value of these civil cases increased from .33 before the earthquake to .68 thereafter.

Table 5
Two-way ANOVA of civil litigations against the design practice.

Source	F	p-Value
Corrected model	3.594	.004
Intercept	27.661	.000
CL	5.645	.004*
EI	3.327	.070**
CL * EI	.063	.939

* Significant at the .05 level.
** Significant at the .10 level.

Likewise, the main effect of the court level is significant at the .5 level ($F = 5.65$, $p = .004$). The post hoc test shows that the mean value of litigations is .72 in the high courts and .29 in the district courts. The .43 mean difference is significant at the .05 level. In addition, the .39 mean value in the Supreme Court is also higher than that of the district courts, but the difference is not significant.

As a result, both the Chichi Earthquake and the court level had significant impacts on the incidence of civil litigations concerning A/E design practices. This indicates that the earthquake had increased A/E professionals' PL risks in their design practices. In addition, the average number of cases in the high courts is significantly higher than that in the district courts. This indicates that the plaintiffs were more likely to appeal after the earthquake, causing the PL risks to intensify in higher courts.

3.4.2. Litigations concerning A/E supervision practice

The supervision service is legally the most complicated A/E practice. In particular, Taiwanese law defines A/E professionals as "supervisors", rather than as taking the less intensive role of performing "site checks", for example, under the standard AIA form of contract. The legal definition of "supervisor" is not clear, however, which makes it more difficult to clarify the related A/E responsibilities and liabilities once disputes arise.

As shown in Table 4, criminal cases concerning supervision practices increased rapidly after the earthquake. The rate of change (the δ value) reached 1.52, although the t-test does not show the increase to be significant at the .10 level ($t = 1.68$, $p = .106$). Fig. 4 shows the rate of change concerning supervision practices. In contrast, the rate of change of the civil cases is only .88, but the t-test shows that the increase of civil cases is significant at the .10 level ($t = 1.89$, $p = .07$).

The civil cases also vary with the court level (Table 4). To ascertain whether court level had an important role in the incidence of these cases, the following hypothesis is proposed:

H4: Both the Chichi Earthquake and the court level had significant impacts on the incidence of civil litigations concerning A/E supervision practices.

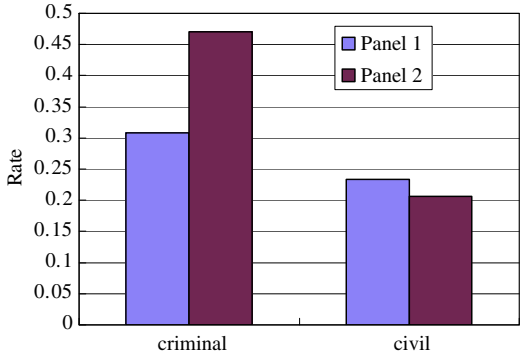

Fig. 4. Rate of change concerns supervision practices.

Table 6
Two-way ANOVA of civil litigation cases against the supervision practice.

Source	F	p-Value
Corrected model	3.200	.008
Intercept	36.203	.000
CL	6.777	.001*
EI	2.718	.101
CL * EI	.350	.705

* Significant at the .05 level.

Table 6 shows the results of the two-way ANOVA. The effect of the interaction between court level and earthquake incidence is not significant ($F = .35$, $p = .71$). The main effect of earthquake occurrence is marginally significant at the .10 level ($F = 2.72$, $p = .101$). The marginal mean value of these cases is .73 before the earthquake and 1.27 thereafter. In addition, the main effect of court level is significant at the .05 level ($F = 6.78$, $t = .001$). The post hoc test shows an average of .93 cases in the high courts and .41 in the district courts. The .52 mean difference is not significant at the .05 level. However, the average of 1.67 cases in the Supreme Court is significantly higher than that of the district courts at the same confidence level.

As a result, both the Chichi Earthquake and the court level had significant impacts on the incidence of civil litigations concerning A/E supervision practices. In addition, the average number of cases in the high courts was not significantly higher than that in the district courts. Accordingly, the PL risk of the supervision practices was not as high as that of the design services after the earthquake.

4. Summary and discussion

The findings of the foregoing analyses can be summarized as follows:

- The Chichi Earthquake had a significant impact on the number of lawsuits against A/E professionals.
- Residents and prosecutors were the primary types of plaintiff in these lawsuits.
- The prosecutors were persistent, lodging appeals when they failed in actions in lower courts. The Chichi Earthquake thus increased the risk of criminal charges against A/E professionals.
- The court level had a significant impact on decisions over the litigations. Although the conviction rate in the district courts was very high, the risk of conviction decreased significantly after appeal.
- After the earthquake, litigation focused on charges against the A/E professionals' design and supervision practices. Although the numbers of criminal cases concerning these practices were higher, the increase in the civil cases was more significant. As a result, the earthquake increased the risk of A/E professional liability.
- The court level also had a significant impact on civil lawsuits concerning A/E professionals' design and

supervision practices. The average number of civil cases in both the high courts and the Supreme Court was higher than that in the district courts. The plaintiffs in the design cases were more likely to appeal to the high courts. Likewise, the plaintiffs in the supervision cases were more likely to appeal to the Supreme Court. As a result, the PL risk seemed to be greater in higher courts.

These findings are further discussed below:

- It is understandable that residents, as the principal victims, became the primary plaintiff type after the earthquake. Although some residents failed in their lawsuits, it is predictable that the trend will continue in the future because of increasingly influential consumer movements and ideology.
- Design professional liability for the criminal acts of third parties is a rapidly developing area [33]. The increased persistence of prosecutors may be explained, at least in part, by the depressed social mood after the earthquake. Prosecutors' involvement benefited the victims as follows:
  - The prosecutors transferred some of the litigation costs of the victims to the government.
  - The prosecutors' official investigations on behalf of the victims produced more complete facts and information, which could have been used to file civil lawsuits against A/E professionals and to obtain compensation.
  - When the prosecutors succeeded in pressing criminal charges, it became much easier for the victims to succeed in their civil lawsuits.

- Civil lawsuits also persisted at the different levels of courts. This may be explained, in part, by the complexity and uncertainty of A/E professional liability associated with design and supervision. More legal proceedings were required to clarify the PLs, and the A/E professionals' litigation costs thus increased substantially.
- Both the number and the conviction rate of civil lawsuits were lower in the high courts. It is conceivable that, as the stakes in trials were increased after appeals, some cases were settled; see, for example [18]. This issue is worth further investigation.
- The key risks related to designers' liability in Australia have been compared.
- Zou et al. [34,35] conducted a survey to explore Australian practitioners' perceptions of risks associated with construction projects. Results show the following risks:
  - *Design variations:* The comparison presents equivalent risk in both countries. We learn also that, after the earthquake, the litigations focused on charges against the A/E professionals' design practices. This risk arises from issues such as "variations by the client" and defective design.
  - *Inadequate program scheduling:* The comparison presents equivalent risk in the two countries. We also find that, after the earthquake, the litigations focused on charges against the A/E professionals' design and supervision practices. This risk arises from tight schedule issues, because the clients always request shorter project schedules to reap investment returns promptly. Nonetheless, design professionals find it difficult to set accurate schedules when uncertainty surrounds a project.
  - *Inadequate site information:* This risk arises from issues such as soil tests and survey reports. It leads to defective designs and affects the progress of excavation or foundation construction. Our study cannot accurately assess the importance of this risk.
  - *Incomplete or inaccurate cost estimates:* Although the comparison presents equivalent risks in both countries, litigations concerning cost estimates against A/E professionals are less common in Taiwan. This risk arises from issues such as fluctuation of market prices, estimation methods, designer professional experience, and attitude toward work.

5. Conclusions

Although the distressing aftermath of the Chichi Earthquake has become history, the subsequent litigations against the A/E community have provided fertile ground for the study of A/E professionals' legal risks after a major natural disaster. It was shown that the earthquake substantially increased the number of lawsuits against A/E professionals. The risks of both professional liability and criminal indictment by public prosecutors were increased. The presence and persistence of prosecutors in these litigations was a notable phenomenon, which is attributable, at least in part, to the social mood after the shock. The involvement of prosecutors put A/E professionals at a greater disadvantage.

Not only did the prosecutors persist, but civil lawsuits against A/E professionals also tended to be more persistent after the earthquake and thus generated more litigation costs for the professionals. The lawsuits centred on the A/E professionals' design and supervision practices, and would have been reduced if the A/E professionals' contractual obligations had been more clearly defined. A/E professionals will have to pay more attention to these areas of service.

Although these findings are preliminary in nature, they are useful in that they provide precise evidence to A/E practitioners, and to engineering managers, to help them understand the legal implications of natural disasters on A/E liability. Some improvements for A/E professionals' role are as follows: (1) the results show that civil liabilities incur high legal costs and risks, and that A/E professionals should pay attention to contract clauses before signing

them. (2) A/E professionals who are risk averse should have clear legal guidance to mitigate future litigation risks. (3) Regulatory bodies should understand the practical implications of modifying regulatory schemes for A/E liability, which may pose risks to public safety and the integrity of the design profession.

This paper suggests that not only the continuing education of the A/E community but also university programs should focus on these liability trends increased by earthquakes. Ultimately, the A/E community will promote service quality to pursue public welfare. Naturally, the good impression of the A/E professionals' role must be maintained. More investigations are required to tackle some critical issues, such as the conviction and appeal rates at the various court levels, the detailed contexts of professional liability challenges, and plaintiffs' and defendants' litigation strategies.

References

[1] Chen LC, Hong HJ, Chen SY, Lai MR. Impact on social economy of 921 earthquake and reconstruction: examples of Taichung and Nantou County. Civil Hydraul Eng 2002;29(2):8–20.

[2] Spence R. Earthquake risk mitigation in Europe: progress towards upgrading the existing building stock. In: Proceedings of the fifth national conference on earthquake engineering; 2003. p. 1–9.

[3] Flynn J, Slovic P, Mertz CK, Carlisle C. Public support for earthquake risk mitigation in Portland, Oregon. Risk Anal 1999;19(2):205–16.

[4] Pearce L. Disaster management and community planning, and public participation: how to achieve sustainable hazard mitigation. Nat Hazard 2003;28:211–28.

[5] Alesch DJ, Petak WJ. The politics and economics of earthquake hazard mitigation: unreinforced masonry buildings in southern California. Institute of Behavioral Science, Colorado: University of Colorado; 1986.

[6] Demkin JA. The architect's handbook of professional practice. 13th ed. New York: John Wiley & Sons; 2001.

[7] Anon. Architectural malpractice: a contract-based approach. Harvard Law Rev 1979:1075–102.

[8] Bunni NG. The FIDIC form of contract: the fourth edition of the red book. 2nd ed. Oxford: Blackwell; 1997.

[9] Cruz JR. Architectural malpractice: toward an equitable rule for determining when the statute of limitations begins to run. Fordham Urban Law J 1988:509–33.

[10] Partridge PH, Noletto VA. Construction management: evolving roles and exposure of construction managers and architects/engineers. Am J Trial Advocacy 1988:55–86.

[11] Bruner PL. The historical emergence of construction law. William Mitchell Law Rev 2007;34:1–24.

[12] Flatt WD. The expanding liability of design professionals. Memphis State University Law Rev 1990:611–27.

[13] Nischwitz JL. The crumbling tower of architectural immunity: evolution and expansion of the liability to third parties. Ohio State Law J 1984:217–63.

[14] Schneider J. The expanding liability of environmental consultants to third parties. Villanova Environmental Law J 2002;13:235–62.

[15] Posner RA. An economic approach to legal procedure and judicial administration. J Legal Stud 1973;2(2):399–458.

[16] Priest GL, Klein B. The selection of disputes for litigation. J Legal Stud 1984;3(1):1–55.

[17] Thomas RE. The trial selection hypothesis without the 50 percent rule: some experimental evidence. J Legal Stud 1995;24:209–28.

[18] Peppet SR. Contract formation in imperfect markets: should we use mediators in deals? Ohio State J Dispute Resolut 2004:283–367.

[19] Fournier GM, Zuehlke TW. Litigation and settlement: an empirical approach. Rev Econ Stat 1989;71(2):189–95.

[20] Johnson CA. Lower court reactions to Supreme Court decisions: a quantitative examination. Am J Polit Sci 1979;23(4):792–804.

[21] Benesh SC, Reddick M. Overruled: an event history analysis of lower court reaction to Supreme Court alteration of precedent. J Polit 2002;64(2):534–50.

[22] Songer DR, Segal JA, Cameron CM. The hierarchy of justice: testing a principal-agent model of Supreme Court–circuit court interactions. Am J Polit Sci 1994;38(3):673–96.

[23] Cross FB, Tiller EH. Judicial partisanship and obedience to legal doctrine: whistleblowing on the federal courts of appeal. Yale Law J 1998;107(7):2155–76.

[24] Morgan GK, Phillips AE. Design professional contract risk allocation: the impact of waivers of consequential damages and other limitations of liabilities on traditional owner. J Coll Univ Law 2006;33:1–31.

[25] Wang J, Liu J, Huang L. Study on the professional liability insurance system of the supervision engineer in China. Construct Manage Econ 2007;25(7):801–10.

[26] Cooter R, Ulen T. Law and economics. 4th ed. Boston: Pearson; 2004.

[27] Harrison JL. Law and economics in a nutshell. 3rd ed. St. Paul, MN: West; 2003.

[28] Day RW. Written document and civil litigation. J Prof Iss Eng Educat Pract 1995;121(1):21–4.

[29] Cooter RD, Rubinfeld DL. Economic analysis of legal disputes and their resolution. J Econ Lit 1989;27(3):1067–97.

[30] Farrug EJ. The necessity of expert testimony in establishing the standard of care for design professionals. DePual Law Rev 1989:874–96.

[31] Mashaw JL. Law and engineering: in search of the law-science problem. Law Contemp Probl 2003;66(4):135–53.

[32] Wright MH, Boelzner DE. Quantifying liability under the architect's standard of care. Univ Richmond Law Rev 1995:1471–97.

[33] Hanks GC. Gazing into the murky crystal ball: the rise of design professional liability for the criminal acts of third parties. Houston Business Tax Law J 2004;4:339–56.

[34] Zou PXW, Zhang G, Wang JY. Identifying key risks in construction projects: life cycle and stakeholder perspectives. In: Proceedings of the 12th Pacific rim real estate society conference; 2006.

[35] Zou PXW, Zhang G, Wang J. Understanding the key risks in construction projects in China. Int J Project Manage 2007;25:601–14.