出國報告（出國類別：國際研討會）

赴中國武漢咸寧大學參加 EEAE 2011 研討會論文發表及專題演講報告

服務機關：國立高雄應用科技大學土木系
姓名職稱：黃忠發 副教授
派赴國家：中國
出國期間：2011.04.15-4.20
報告日期：2012.06.11

摘 要

本次乃參加位於中國武漢之咸寧大學發表之研討會（4/15-4/18），該研討會為 IEEE 下屬之研討會，之後（4/18-4/20）並赴北京華北電力大學進行專題演講（文章及照片詳附件）。

此次研討會之主題乃為綠色科技，參加研討會得知目前各界在於營建材料及節能減碳方面之發展，對於研究視野之提升相當有助益。研討會後再赴北京華北電力大學主要與該校營建管理與經濟系趙振宇教授交流，進行一場學術交流並與該校系建立友好關係，演講之主題為營建企業倫理與企業社會責任，趙教授在企業倫理方面相當有興趣及研究，往後我們將有機會進行更進一步的研究合作。

目次

摘 要.....2

出國報告內文.....4

錄附一發表文章.....9

附錄二活動照片.....14

出 國 報 告 內 文

(一)目的

本次乃參加中國武漢之咸寧大學舉辦研討會（4/15-4/18），International Workshop on Energy, Environment and Architecture Engineering (EEAE 2011) IEEE 能源，環境與建築工程國際研討會，該研討會為 IEEE 下屬之研討會，屬於 EI 檢索，此次發表文章篇名為：The Current Practice and Promotion Strategy of Dry-mix Mortars in Taiwan-Taking Technology Acceptance Model as an Approach，之後（4/18-4/20）並赴北京華北電力大學進行專題演講（文章及照片詳附件）。

（二）過程

此次研討會之主題乃為綠色科技，參加研討會得知目前各界在於營建材料及節能減碳方面之發展，對於研究視野之提升相當有助益。研討會會前於 4/16-4/18 共三天於武漢之咸寧(*Xianning)* 大學舉辦，這次共有三百餘篇文章發表，故會場有點凌亂與擁擠，場地明顯不足，我的場次安排在 4/16 的上午 11:00～11:15，大部分參與者都是中國當地學者及少部分台灣學者，較少外籍人士，稍嫌可惜。

在本研究報告中發現，根據內政部建築研究所的資料顯示，台灣營建相關產業所產生之二氧化碳排放量約佔全國總排量的 28%，而在七大行

業的耗能統計中，水泥能源消耗佔全國的 11.79%，故不論是能源損耗或二氧化碳排放量，皆佔全國相當高的比重。在 1997 年京都議定書簽定後，各國無不致力於二氧化碳的減量。由於水泥之製造過程及施工時膠結產製的砂漿是產生二氧化碳的主因；而土砂或岩石相互碰撞，抑或搬運時落下之衝擊，均會產生大量的粉塵。因此如何在新材料或技術上改善此問題，乃相當重要之議題。傳統水泥砂漿是在現場使用散裝砂與袋裝水泥，憑著工地師父的經驗，將大量的水泥和砂加水拌和成砂漿，經常造成工地現場煙霧瀰漫，不僅造成工地環境污染，也常因過多之損耗造成建材資源浪費。在 60 年代，西歐開始發展相關的機械設備與製程發展乾粉式的水泥乾拌砂(Dry-mix Mortar)，以克服現場拌合砂漿的不足之處。由於水泥乾拌砂是一種預先在工廠拌合、調配的乾粉砂漿，使用者只需摻加定量的拌和水均勻攪拌，即可直接使用的砂漿建材，並以集中式生產，有更完善的清潔、過篩、烘乾、配比及攪拌，可以降低現場拌製的各種瑕疵問題，能夠比傳統水泥砂漿提供更好且穩定的品質。根據 2007 年的統計資料全世界年產量約 1 億噸到 1.5 億噸，對於東歐國家，包括俄羅斯、中東等地也發展快速，尤其是在西歐的德、法更為普及。因此，從先進國家的發展趨勢來看，水泥乾拌砂的運用將是未來建築發展的趨勢。然而，台灣引進水泥乾拌砂已有近 40 年的歷史，但使用上並不普及，且目前水泥乾拌砂相關研究不多，究竟原因何在、往後該如何推廣，相

當值得探討。故本文從技術管理之角度切入，藉由技術引進時常用之分析模式(Technology Acceptance Model,以下簡稱 TAM)，將以水泥乾拌砂的品質認知及援用 TAM 理論中的認知有用性、認知易用性等為主要考量，以瞭解營建產業人員使用水泥乾拌砂之現況，並分析不同背景之人員瞭解水泥乾拌砂的特性後，能否達到推廣之意向，以供業界採用參考。

從營建工程人員對於科技接受模式構面認知情形中，受測者在認知有用性及認知易用性的構面上，均顯示受測者在科技接受模式構面中都持偏向贊同的看法，也可見變數之間都有一定程度之關係。從路徑分析中發現，在 TAM 個構面中，認知有用性才是影響使用者是否協助推廣之主要原因。當認知實用性愈高時，使用滿意度愈高且推廣意願的程度也愈高。

研究發現，乾拌砂漿未廣泛的被使用，故建議廠商能利用廣告行銷方式有效的推廣此產品，以利提升使用情形，減少工程對環境的傷害，俾達良好工程品質之目的。台灣目前尚未有相關法規嚴格禁止在現地拌合材料，因此大部分施工人員仍多利用傳統水泥砂漿在現場自行拌合，不但對環境造成傷害，也對工程品質有所威脅。故建議政府機關可加強此方面之管控，有利於提升乾拌砂漿的使用。另，TAM 在本研究中証實是有用的，往後可推廣至評估其他新進材料或工法之使用。

研討會後我於 4/18 日搭機再赴北京華北電力大學主要與該校營建管理與經濟系趙振宇教授交流，並與該系之教授進行座談，進行一場學術交流並與該校系建立友好關係，共有三位教授及二十餘位研究生聽講，演講之主題為營建企業倫理與企業社會責任，這兩個研究主題為筆者近五年之研究重點，演講內容包括研究動機目的、研究設計與研究結果等，研究方法主要是以問卷調查法為主。在演講中我們亦充分討論目前這兩大主題於國際間之研究現況與未來趨勢，中國之學生對於我的研究主題及演講內容相當有興趣，故講授九十分鐘、發問大約三十分鐘。

中國學生對於演講這兩大主題相當好奇，原本我想要與他們進行問卷之交流及跨國研究，但因仍身處共產國家，意見表達可能會不是如此自由，問卷填達之真實度堪慮比較，故若要進行跨國研究，此方面仍需在研擬適當之策略。

（三）心得

營建倫理方面之議題對於中國相當重要，他們深感興趣，而趙教授在企業倫理方面相當有興趣及研究，在那次交流之後，我們進行充分之研究交流，往後我們期盼能有機會進行更進一步的研究合作。華北電力大學因為於北京，故屬於佔地規模較小之學校，但其學校之人數也有一兩萬人，在中國，尤其是電力界影響相力不小，該系位於管理學院下，

但所學亦與土木相關課程類近，惟其加入機電類課程，使其學生更有特色與競爭力，值得參酌。

（四）建議

此次活動也讓我更認知兩岸間之學術距離已經越來越近，值得我們警惕並多交流。另，建議參加研討會的學者要多注意研討會之主辦單位，IEEE 掛名之 EI 等級研討會已有氾濫之趨勢，後來發現類似研討會在中國一年就主辦多場，此研討會看似組織嚴謹，但至會場後發現諸多經驗不足之處，因第一次赴中國參加研討會，故經驗不足，下次參加會更慎重考量。此次接受補助部分主要用在機票部分，相當感謝此補助讓我能夠成行，此次活動獲益良多，有機會希望能夠再度前往類似活動。

附錄一

發表文章

The Current Practice and Promotion Strategy of Dry-mix Mortars in Taiwan

-Taking Technology Acceptance Model as an Approach

Chung-Fah Huang
Associate Professor, Dep. of Civil Eng.
National Kaohsiung Univ. of Applied Sciences
Kaohsiung City, Taiwan
Jeffrey@cc.kuas.edu.tw

Rong-Lu Chen and Jin-Ling Lin
Ph.D. Student and Graduate Student, Dep. of Civil Eng.
National Kaohsiung Univ. of Applied Sciences
Kaohsiung City, Taiwan
1096102102@ cc.kuas.edu.tw

Abstract: Compared with traditional cement processing methods, dry-mix mortars are more environmental friendly by reducing air pollution or waste production on construction sites. It can also reduce carbon dioxide emissions, helps to keep the construction site clean, and allow for more flexibility in storage space for materials while reducing cement redundancy after the cement finishing is completed. It can be said that this new and advanced construction material is environmental friendly and convenient to deploy and transport, delivers product of stable quality, helps to facilitate construction, and saves materials.

In this study, a questionnaire survey was conducted on people in the construction industry in Taiwan to explore their perceptions of the characteristics of dry mix mortars and their acceptance of this material. Totally 133 valid samples were returned. After the analysis of the questionnaire results, this research found the more the respondents find dry-mix mortars useful, the more satisfied they are with the material; the more they are satisfied, the more willing they are to promote it. Among all the factors, the perceived usefulness of this material has a particularly significant influence.

Keywords: dry-mix mortars; technology acceptance model; TAM; environmental protection

I. INTRODUCTION

When the traditional cement processing method is used, construction sites are always littered with bagged or bulk cement. The traditional method also requires more space on site and frequently causes smokes of flying cement powder. It causes not only pollution on construction site and waste of construction materials. Moreover, different construction workers have different ratio of water, sand and cement when mixing cement, which can lead to drastically varying construction quality. To prevent the above-mentioned problems, dry mix mortars were developed.

Compared with the other industries, the construction industry is relatively resource-consuming and polluting. Since the Kyoto Protocol in 1997, governments around the world have been paying more attention to reducing carbon emissions. Cement production and processing is one of the major sources of CO_2 and, therefore, the construction material industries around the world are all keenly moving toward the strategy of less water and cement powder. The dry-mix mortars were first developed in Europe and have been heavily invested to meet rapidly increasing demands. Nearly a half of the dry-mix mortar industries originate in Europe and they are the largest in size worldwide. Based on the development in advanced countries, the use of this material is a definite future trend in the construction industries around the globe. However, despite 30 more years of promotion, the material has not been widely used in Taiwan. There has been little research on why this material is still not popular and how it should be promoted in the future. Therefore, this study was conducted from the perspective of technology management by using the Technology Acceptance Model (TAM) to explore the current applications of and acceptance levels with dry mix mortars among people in Taiwan's construction industry and analyze their willingness to promote this material. Hopefully, the results of this research can provide helpful references for the construction industries in Taiwan and other countries.

II. LITERATURE REVIEW

A. Introduction to Dry-mix Mortars

Dry-mix mortars or dry mortars are factory-mixed dry mortars that can be directly used by adding a certain ratio of water and stirring the mixture evenly. Dry mortars are composed of at least three components: binder, aggregate, and chemical additives [1].The three component can be mixed based on different ratios to produce different types of dry mortars for different functionality demands and then delivered directly to construction sites in bags or special silos [2]. These mortars are very easy to transport and maneuver. Since they are factory mixed, they can produce cement of more consistent quality than the traditional method. They are easy-to-transport, user-friendly, and environmentally friendly advanced materials that help to save materials and facilitate construction process [11]. In addition, they also help to reduce construction wastes, save site cleaning fees and improve working conditions on construction sites [3].

B. TAM: Definition and Contents

TAM was developed by Davis in 1989 based on the theory of reasoned action (TRA) in the context of information system application. The purpose of TAM is to

explain what factors can decide users' acceptance of an information technology and explore how users use a technology. It discusses about how external factors affect three internal factors among users: beliefs, attitudes, and intentions and how these internal factors affect their use of technologies [4]. TAM is an effective model explaining users' willingness to use an information system. In addition, just like TRA, TAM also believes a user's beliefs can affect his attitudes, which then affects his intentions while intentions have a significant and positive influence on his actual use of a system [12].TAM is different from TRA in its introduction of two dimensions, perceived usefulness (PU) and perceived ease of use (PEOU), suggesting that a user's attitude toward using a system and PU are the two decisive factors of his behavioral intention to use this system [5]. The following is a short introduction to TAM's dimensions:

1) PU: According to Davis (1989), PU is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance."

2) PEOU: Davis (1989) defined it as "the degree to which a person believes that using a particular system would be free from effort."

3) Attitude toward using: It refers to "the strength of a person's positive or negative feeling of using a information technology. If his attitude toward a behavior is stronger, he is more likely to conduct the behavior. Therefore, one's attitude toward a behavior can be used to precisely predict his behaviors."

4) Behavioral intention: TAM hypothesizes that one's use of an information system is decided by his behavioral intention. This is similar to the hypotheses of TRA and theory of planned behavior (TPB). However, different from them, TAM believes one's behavioral intention can be affected by his perceived usefulness of and attitude toward using this system.

TAM allows researchers to explore the influences of external factors on a user's beliefs, attitudes, and intention and then predict his use of technologies [5]. External factors such as personal variances, system characteristics, environmental variances, can affect a user's beliefs by affecting his PU and PEOU of a technology or system[14]. However, TAM has been relatively seldom used in research on construction-related industries. Therefore, this study is an experimental attempt to use TAM's PU and PEOU as the core of its research model to explore the use of dry mortars in Taiwan's construction industry and the decisive factors of the use.

III. RESEARCH DESIGN

This section is mainly composed of four sub-sections with the first one explaining the research framework based on which the questionnaires are designed, the second one describing the subject and sampling method, the third one giving a short description of the questions, and the fourth one indicating the statistical methods used to analyze the questionnaire results.

A. Research Framework

Based on TAM's two major dimensions, PU and PEOU, the questionnaires are intended to explore how satisfied the respondents are with dry mortars and how willing they are to promote this new material.

B. Subjects and Sampling

The questionnaire was sent to on-job trainees who work in the construction industry and construction material suppliers in Taiwan. Totally 180 questionnaires were sent and they were filled out and sent back anomalously. Totally 157 were collected. After invalid questionnaires were excluded, there were totally 133 valid questionnaires (with a valid rate of 84.70%)

C. Question Design

The questions in the questionnaire were positive questions and most of them structural ones. There were four categories of questions. The first category asked about respondents' perception of dry mix mortars, the second category about the perceived quality of dry mix mortars, the third about their acceptance of dry mix mortars, and the fourth about basic information of the respondents.

D. Statistic Analysis Methods

The questionnaire used a 5-point Likert scale to measure the respondent's attitudes and perceptions in each dimension. The questionnaire results were then statistically analyzed using SPSS software to conduct descriptive statistic analysis, reliability analysis, correlation analysis, and path analysis.

IV. ANALYSIS RESULTS

A. Descriptive Analysis

1) Satisfaction Dimension

Table 1 lists the descriptive analysis results of the questionnaire survey. The average score of the satisfaction with dry-mix mortars' quality dimension was 3.66 (standard deviation =0.766), indicating the respondents' satisfaction with the quality of dry-mix mortars was somewhere between strong and fair. The average score of Question 3, "I think using dry-mix mortars helps to keep the construction site clean," was the highest (3.76 with a standard deviation of 0.760) while that of Question 6, "I think using dry-mix mortars helps to reduce surface cracking," was the lowest (3.48 with a standard deviation of 0.743). This indicates there is still room for improvement in dry-mix mortars' perceived quality in reducing surface cracking.

Table 1. Descriptive Analysis Results of Satisfaction Dimension

Dimension	Question	Average	Standard Deviation

Satisfaction	3. I think using dry-mix mortars helps to keep the construction site clean.	3.76	0.760
	16. I think dry-mix mortars are very suitable for plastering.	3.74	0.783
	8. I think using dry-mix mortars helps to reduce spillage of materials caused by transportation.	3.70	0.798
	2. I think using dry-mix mortars helps to reduce waste pollution.	3.66	0.787
	4. I think using dry-mix mortars is more environmentally friendly.	3.69	0.751
	20. I think using dry-mix mortars helps to shorten construction time.	3.65	0.740
	1. I think using dry-mix mortars helps to reduce carbon emissions.	3.61	0.767
	6. I think using dry-mix mortars helps to reduce surface cracking.	3.48	0.743
Dimension average＝3.66; standard deviation＝0.766			

2) TAM Dimension

Table 2 lists the descriptive analysis results of the TAM dimension. The average of this dimension was 3.52 (standard deviation =0.805). The average scores of the PU questions ranged from 3.42 to 3.66, indicating the respondents all agreed upon the perceived usefulness of dry-mix mortars. Among the questions, Question 4, "I think using dry-mix mortars is very helpful for plastering," had the highest average score. The average scores of the PEOU questions ranged from 3.56 to 3.89, indicating the respondents all agreed upon dry-mix mortars' perceived ease of use. The question, "Dry-mix mortars are easy to use in construction work," had the highest average score.

Table 2. Descriptive Analysis Results of TAM Dimension

Dimension	**Question**	**Average**	**Standard Deviation**
PU	4. I think using dry-mix mortars is helpful for plastering.	3.66	.799
	6. Using dry-mix mortars is very good for the constructions.	3.60	.728
	5. I think using dry-mix mortars makes my job easier.	3.53	.766
	1. Using dry-mix mortars allows me to complete my job more quickly.	3.45	.823
	3. I think using dry-mix mortars helps to improve my performance.	3.44	.839
	2. Using dry-mix mortars makes me perform better at construction work.	3.42	.874
Dimension average＝3.52; standard deviation＝0.805			
PEOU	11. Dry-mix mortars are very easy to use in construction work.	3.89	.661
	9. It is easy to understand how to use dry-mix mortars.	3.83	.642
	7. I think it's very easy to learn how to use dry-mix mortars.	3.73	.780
	10. The component ratio of dry-mix mortars can be flexible without damaging construction quality.	3.62	.736
	12. Using dry-mix mortars can easily make me feel I have mature skills.	3.56	.744
	8. Using dry-mix mortars helps to deliver expected results.	3.56	.668
Dimension average＝3.70; standard deviation＝0.705			

3) Question Reliability Analysis

In this research, Cronbach's α analysis was used to measure the reliability of each question. Questions with a corrected item-total correction of less than 0.3 would be excluded. In addition, if the overall α value could increase after the exclusion of a question, the question would then be excluded. The reliability analysis results showed all the questions and dimensions in the questionnaire had a reliability value of higher than 0.70, indicating the questions and scales in the questionnaire are highly consistent and stable in reliability.

B. Correlation Analysis and Path Analysis

1) Analysis of Correlation

This research used Pearson correlation analysis to test the correlations among the dimensions in its research model. As indicated in Table 3 that lists the analysis results, the dimensions are positively correlated with each other. PU and Satisfaction (S) (r=0.745**1), PEOU and satisfaction (r=0.627**), PU and promotion willingness (r=0.668**), PEOU and Promotion Willingness (PW) (r=0.592**) were significantly positively correlated with each other while satisfaction and promotion willingness (r=0.702**) were significantly positively correlated with each other. These results indicate the more satisfied the respondents are with the quality of dry-mix mortars, the more willing they will promote this material.

Table 3. Correlation Analysis Results

	(1)	(2)	(3)	(4)
(1) S	1	0.745**	0.627**	0.702**
(2) PU	0.745**	1	0.718**	0.668**
(3) PEOU	0.627**	0.718**	1	0.592**
(4) PW	0.702**	0.668**	.592**	1

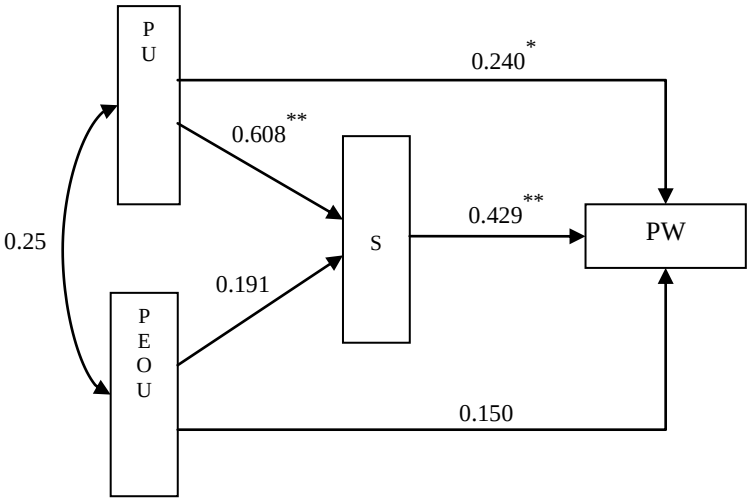
Note: *p<0.05 **p<0.01

2) Path analysis

Path analysis uses a linear causality model to establish a regression equation and explain relationships among multiple variables. It is used in this study to explore the relationships among the dimensions [8]. When satisfaction was used as the dependent variable and PU as the independent variable or PW as the dependent variable and PU as the independent variable, the results were not significant. Other than these two cases, the causality relationships among the other variables were significant. The R-square of satisfaction dimension was 0.573, indicating PU and PEOU can explain 57.3% of satisfaction

dimension variances while PU, PEOU and satisfaction dimension can explain 55.1% of PW variances.

As illustrated in Figure 1, PU and PW are significantly related with a path coefficient of .240 (p^{*} <0.05), indicating the more the respondents perceive dry-mix mortars useful, the more willing they are to promote the material. Moreover, PU was found to have an indirect influence on PW through satisfaction (PU→S→PW) with a path coefficient of .261(=0.608*0.429). This means even though PU has a direct influence on PW, it is easier to explore PU's influence on PW through satisfaction. In addition, satisfaction's influence on PW is stronger than that of PU on PW. The path model also indicates PEOU and satisfaction have no significant influence on PW. In other words, the respondents pay more attention to the usefulness of dry-mix mortars than its ease of use. Therefore, future promotion strategies of dry-mix mortars need to appeal more to the effectiveness and usefulness of this material to achieve better promotion results.



Note: *p<0.05 **p<0.01

Figure 1. Path Analysis

V. Conclusion and Suggestions

According to the analysis results of this study, the respondents generally agreed upon the perceived usefulness (PU) and perceived ease of use (PEOU) of dry-mix mortars. The results also indicate there are certain levels of connections between and among the variables. The path analysis results show only perceived usefulness is the major factor deciding the respondents' willingness to promote this material. The more useful they find this material is, the more satisfied they are with it and then more willing to promote it.

Based on these findings, this study suggests better promotion of dry-mix mortars through advertising and marketing so that people in the industry will know more about the usefulness of this material in environmental protection and construction quality improvement. In addition, it is also suggested the government promulgate stricter regulations regarding the use of traditional method of cement production and processing. This will be helpful for the promotion of dry-mix mortars. Last but not least, TAM is found as an effective research tool for the construction industry in this research. It can be used in future research on the use and promotion of new construction materials and technologies.

REFERENCES

[1] Bayer R, Lutz H (2003). Dry mortars, *Ullmann's Encyclopedia of Industrial Chemistry*, 6th edn., Vol. 974–94, Weinheim: Wiley–VCH.

[2] Bollen, K and J. Long, S.(1992), "Tests for Structural Equation Models: Introduction," *Sociological Methods and Research*, Vol. 21(November), pp. 123-131.

[3] Chiu H. S. (2008), *Use of Pre-mixed Mortars,* General Manager of RuenTex Cement Corp. *(In Chinese)*

[4] Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly,* 13(3), 319-340.

[5] Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science,* 35(8), 982-1003.

[6] Dishaw, M. T., & Strong, D. M. (1999). Extending the technology acceptance model with task-technology fit constructs. *Information & Management, 36*(1), 9-21.

[7] Hair et al. (1998). *Multivariate Data Analysis.* 5th edition. New Jersey: Prentice-Hall International.

[8] Huang C.F. and Hsueh, S.L (2007). "A study on the relationship between intellectual capital and business performance in the engineering consulting industry: A path analysis approach", *Journal of Civil Engineering and Management,* 13(4): 265-271.

[9] Johann, P.(2004). Applications of biopolymers and other biotechnological products in building materials. *Applied Microbiological Biotechnology*, 66: 1–9.

[10] Lewis-Beck, M. S. (1994). Factor Analysis and Related Techniques. Sage Publications, Inc.

[11] Lin Shi-tang (2010), "Introduction to Dry-mix Mortars," *Journal of Taiwan Concrete Institute*, Vol. IV, No. 2, pp 40-44. *(In Chinese)*

[12] Szajna, B. (1996). Empirical evaluation of the revised technology acceptance model. *Management Science*, 42(1), 85-92. *(In Chinese)*

[13] Tan, K.C., "A Structure Equation Model of New Product Design and Development," *Decision Science,* 2001, 32(2), pp. 195-226.

[14] Venkatesh, V., & Davis, F. D. (2007). A model of the antecedents of perceived ease of use: Development and test. *Decision Sciences, 27*(3), 451-481.

附錄二

活動照片

圖1 活動剪影

圖2 活動剪影