行政院國家科學委員會專題研究計畫 成果報告

營建企業智能為基礎之專業服務平台技術研究—以工程顧問緊急問題解決為例(II)
研究成果報告(精簡版)

計 畫 類 別 ： 個別型
計 畫 編 號 ： NSC 98-2221-E-216-044-
執 行 期 間 ： 98 年 08 月 01 日至 99 年 07 月 31 日
執 行 單 位 ： 中華大學營建管理學系

計 畫 主 持 人 ： 余文德

報 告 附 件 ： 出席國際會議研究心得報告及發表論文

處 理 方 式 ： 本計畫涉及專利或其他智慧財產權，2 年後可公開查詢

中 華 民 國 99 年 10 月 20 日

行政院國家科學委員會補助專題研究計畫 **■ 成 果 報 告**
□期中進度報告

營建企業智能為基礎之專業服務平台技術研究
—以工程顧問緊急問題解決為例(第二年)

Construction Business Intelligence Based Professional Service Platform
—a Case Study of A/E Consultant Emergent Problem Solving (Year Two)

計畫類別：■ 個別型計畫 □ 整合型計畫

計畫編號：NSC 98-2221-E-216 -044 -

執行期間： 98 年 8 月 1 日至 99 年 7 月 31 日

計畫主持人：余文德

計畫參與人員： 吳誌銘、羅浩榕

成果報告類型(依經費核定清單規定繳交)：■精簡報告 □完整報告

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執行單位：中華大學建設與專案管理學系

中　華　民　國　99 年　10 月　18 日

目　錄

一、摘要

(一) 計畫中文摘要。(五百字以內)

營建業是以知識與經驗為基礎之專業服務產業，「營建企業智能(CBI)」可定義為：「企業組織過去所累積之知識，可以做為未來營運之決策依據，甚至提供問題之解決方案，經過應用及驗證確認後成為組織之知識資產者。」善用台灣過去所累積的營建企業智能，不但可以提升國內營建產業之技術能力，更可以輸出至其他工程環境且發展歷程與台灣類似的地區，具有創造營建產業產值之重大潛力。有鑑於此，本研究以營建產業中之工程顧問業為對象，發展以「營建企業智能為基礎之工程問題解決技術平台(CBI-PSP)」。本研究之目標在為工程顧問業提出一個企業智能加值之通用模式，此一模式關鍵在於將各工程專業所累積之知識轉換成為可專業服務商業化應用之企業資產，該模式可適用於其他營建產業。

本研究所定義之營建境外專業服務，主要標的雖為工程顧問業於海外進行工程之設計、營建顧問諮詢及專案管理等技術服務時所遭遇之專業上的緊急問題，然而所建立之技術將可應用於所有國內外之其他類型專業技術服務專案。另外，營建企業智能之主要建構方法包括智慧系統、知識發掘及知識管理等技術，在考量實務上之應用可行性，本研究擬以知識管理為主，知識發掘與智慧系統為輔，作為建立營建企業智能之技術。所採用之工具包括知識地圖、文字探勘、知識發掘及經驗學習等方法。營建知識之來源，包括過去所完成之專案結案報告、服務建議書以及知識管理系統所記錄之問題解決案例等。本研究所完成之系統將提供一個可擴充之「營建企業智能專業服務平台」，並可依據行業特性修改應用於其他營建產業(亦如營造業、統包業等)。研究目的在發展台灣營建業執行海外專業服務時所需之知識支援系統，而其長遠目標則在發展台灣營建知識經濟、建立營建業服務出口所需之相關技術能力。

為達成上述之研究目的，本研究擬以三年為期完成相關技術之研究，分年工作計畫如下：(1) 第一年—營建專業服務知識需求分析與系統規劃；(2) 第二年—營建專業服務系統平台技術之開發。本研究計畫已於第一年完成營建專業服務知識需求分析與系統之規劃，並完成初步之驗證。今年度為本計畫之第二年，主要重點在依據第一年之研究成果進行 CBI-PSP 系統之開發，並以專業服務問題解決為主要應用領域，進行驗證。

關鍵字：專業服務、知識管理、企業智能、平台技術

（二）計畫英文摘要。（五百字以內）

Construction is a knowledge- and experience-based professional service industry. Construction business intelligence (CBI) is the retained knowledge that supports the operation and competitiveness of the firm, which is accumulated and verified through application in real world projects and becomes the intellectual property of firm. By utilization of the knowledge accumulated before, the Taiwan construction industry can not only improve their technological capabilities but also export professional services to other tropical and subtropical countries to generate great revenue. The proposed research aims at developing a "CBI-based engineering professional service platform," which mimics the concept of Technology-based Professional Service raised by "Foresight Taiwan". The objective of this research is to propose a generic value-adding model of construction business intelligence for engineering consulting firm. The key function of such a model is to transform the engineering knowledge accumulated from various disciplines into enterprise intellectual assets so that they can be utilized in commercial professional services.

The scope of this research focuses on the emergent problem solving of A/E consultant professional service outside of Taiwan, which targets the engineering design, consultancy, and project management services of A/E firms in foreign countries. Even though, the technology developed in this research can be applied to both domestic and oversea construction service projects. The commonly adopted techniques for CBI development consist of intelligent systems, knowledge discovery in databases (KDD), and knowledge management (KM), the proposed research will develop CBI mainly based on KM approach. The required tools include knowledge mapping, text mining, data mining (DM), and lesson learning. The sources of construction knowledge are comprised of previous project final reports, proposals, and problem-solving cases recorded in the knowledge management system (KMS). The expected outcome is an extendable "Construction Business Intelligence based Professional Service Platform (CBI-PSP)". The short-term objective is to develop the knowledge support system to assist construction firms that

perform professional services overseas, while the long-term goal of the proposed research is to develop the technologies required for construction knowledge-based economy and exporting construction professional services.

In order to achieve the abovementioned objective, the research is proposed for three years to finish all required works as described in the following: (1) Year One—Analysis of construction professional services and their related knowledge, and system planning; (2) Year Two—Development of CBIPSP system. The outcome of the first year has identified the knowledge requirement and service mode of the CBI-based professional services. This is the second year of the proposed project. The focus of this year is to develop a prototype system for CBI-PSP. The prototype system is tested online to verify the feasibility and functionality of the proposed CBI-PSP.

Keywords: Professional service, knowledge management, business intelligence, platform technology.

二、動機與目的 (Research Motivation and Objective)

Construction management activities are centered with problem-solving [1,2], where the construction managers and engineers are faced with emergent problems and crises in their daily business operations, e.g., the bidding decision, design modification, material selection, construction method determination, site condition variation, change order, dispute resolution, etc. Some of the problems are due to the essential nature of the industry, such as the contracting system and the fragmented organization that creates inevitable interfaces and communication barriers. The others are caused by the external factors, such as the uncertainty in construction works or environment (e.g., site or weather conditions). No matter which reason causes the emergent problems, the basis for problem solving is usually the knowledge and experience accumulated from previous works.

Recently, the knowledge management approaches were widely adopted by construction organizations, including design & engineering consulting and construction firms, as a useful means to facilitate exploitation and utilization of their knowledge assets [3,4,5,6,7]. However, the managers of construction organizations are faced with an essential question: "Does a KMS really worth for the money spent? If so, how beneficial it is?" Such a question is hard to answer unless a convincing quantitative analysis result is determined. According to a thorough literature survey by the authors, very few reports were found on quantitative benefit analysis of KMS implementation. Several reasons may be attributed to the lack of such a quantitative analysis including: (1) difficulty to formulate the measure of benefits; (2) difficulty to differentiate the KM activities from non-KM activities; and (3) difficulty to evaluate the values resulted from KM activities; and (4) unwillingness of the organizations to reveal their insights in order to prevent peeps by their competitors. Among the four causes mentioned above, the unwillingness of organizations to reveal their data is probably the most important reason for the rare report on KMS performance. Although there were some attempts to establish quantitative performance models for KM implementations [8,9,10,11]. Most of the existing models were (indicator-based) indirect measures instead of the direct benefits that are most concerned by the managers, such as time saving, cost effectiveness, and man-hour reductions. Without convincing direct measures of the benefits resulted from a KMS, it is hard to explore the insights of the KM implementation. It is also difficult to determine how much money should be invested and how much return can be expected. Such causes have resulted in the implementation of the KMS a "black box" not only to the outsiders but also to the managers of construction organizations. In fact, many adopters do not measure the benefits of their KMSs.

As a response to the appeals of previous researchers [3,4,11], the objective of the current research are: (1) developing a quantitative model for measuring the direct benefits resulted from a KMS; (2) conducting a long-term comprehensive case study of a major engineering consulting firm to determine the de facto benefits of a KMS in terms of the measures defined in (1); (3) analyzing the quantitative analysis results to investigate the insights of the implementation of a KMS; (4) indentifying the most important impacts of a CBI-CPS both quantitatively and qualitatively.

三、文獻探討 (Literature Review)

Before planning effective methodology to fulfill the research objectives stated previously, the nature of construction problems, the problem solvers, and the construction industry should be taken into consideration as addressed both by Smith [12] and by Li and Love[2] in their proposals to establish a theory of problem solving. Li and Love found that construction problems pose several characteristics that should be tackled in order to solve them quickly, correctly, and cost-effectively; these characteristics include [2]: (1) ill-structure nature—thus experimental knowledge plays important roles; (2) inadequate vocabulary—thus communications between researchers and practitioners is important; (3) little generalization and conceptualization—first solution is usually adopted, no guarantee on optimal solution; (4) temporary multi-organization (TMO)—relevant organizations have to work together in order to reach a consensual solution for all parties; (5) uniqueness of problems—it is hard to accumulate experiential knowledge from construction practices; and (6) hardness in reaching the optimal solution—adequate measures are required to evaluate the performance of problem solving, including quality of resultant solutions and their benefits.

In addition to the nature of construction problems, Dave and Koskela addressed that the fragmented nature of the industry and the ad-hoc nature of the construction projects make capture and reuse of valuable knowledge even more challenging [6]. Such a nature results in a "dynamic knowledge" that needs constantly be updated to create new practice for enhanced solution [13]. Moreover the uncertainty and equivocality in interpretation of construction solutions may also affect the performance of problem solvers (i.e., the engineers and managers) [14].

Finally, a very important characteristic of construction problem solving, but not recognized by most previous researchers, is the nature of emergency of the problems [15]. That is, the construction problems usually need to be solved quickly and effectively; otherwise, the solution may be useless at all. No matter the solution for a problem regarding to the requested information of bidding or a remediation treatment for a construction disaster, it should be provided immediately or it would be of no value. An effective solver of construction problems should be able to tackle the nature of construction problem solving as described above.

四、研究方法 (Proposed Methodology)

The concept of CBI-based Construction Problem-Solver (CBI-CPS) was first explicitly proposed by Yu et al. [15] in their work to solve emergent problems encountered by an engineering consulting firm. The basic idea for a CBI-CPS is to integrate the KMS, through a specialized community of practice (CoP), in the mechanism of the organization's problem-solver. In this section, the underlying model, the generic framework, and the operational procedure of a CBI-CPS are described.

4.1 Underlying Model Behind CBI-CPS

As a problem-solver, the CBI-CPS founds its theoretical backgrounds on the traditional models of problem solving. According to the reviews of Smith [12] there were several existing models for problem solving including Decision Theory, Organizational Decision Making, Individual Traits, and Cognitive Process. Lang et al. classified the existing problem-solving models into three ontological levels: individual, group, and organizational levels [16]. Li and Love crystallized the above models, according to the characteristics of construction industry, into two most relevant categories: the Cognitive Processing and Decision Support System (DSS) [2].

The second viewpoint of underlying model for the CBI-CPS is the knowledge creation perspective. This model can be traced back to the four-dimensional model for organizational knowledge creation (also known as “spiral of the organizational knowledge creation”) proposed by Nonaka [17]. The concept of Nonaka’s spiral of organizational knowledge creation is depicted in Figure 1, where the vertical axis discriminates the knowledge type into “explicit” and “implicit”. The horizontal axis differentiates the ontology of knowledge creating entities, e.g., individual, group, organization and inter-organization. An engineering problem is solved via the process of knowledge creation. That is, the problem is posed by a questioner and then communicated between the questioner and the problem-solver through “Socialization”—transferring the personal tacit knowledge to tacit knowledge of the other individuals; then, the socialized individuals document the problem or the solution in words or drawings through “Externalization”—transferring individuals' tacit knowledge to explicit form so that the public can access and utilize; with some aids of external databases/knowledge bases, the problem-solver figures out the solution through “Combination”—transferring explicit knowledge to explicit knowledge by combining two or more sources of codified explicit knowledge to generate a new entity of explicit knowledge; finally, the experience of problem solving is accumulated in the problem-solver’s mind for future use through “Internalization” —transferring explicit knowledge to tacit knowledge of the problem-solver. The operation of the four types of knowledge conversions in the process of knowledge creation may be dynamically shifting from one another depends on the problem-solver's need. For example, the problem-solver may socialize the problem with the other solution-knower first before externalize his/her knowledge to the original questioner, and so forth.

From Nonaka’s perspective, problem-solving is viewed as a process of knowledge creation through the knowledge creation spiral. Modern KMSs are built on the Communities of Practice (CoPs), which provide forums for members of the organization (or temporary multi-organization) to participate in problem-solving process in a virtual or real world community. Such a phenomenon is also called the "Medici Effect" described by Johansson [18], which states that the innovators are changing the world by stepping into the "Intersection": a place where ideas from different fields and cultures meet and collide, ultimately igniting an explosion of extraordinary new discoveries. Johansson addresses that three driving forces (the movement of people, the convergence of scientific disciplines, and the leap in computational power) are increasing the number and types of intersections people can access. The Medici effect provides the theoretical explanations for how the CoPs work in a CBI-CPS, where the members are from different departments of disciplines. It creates an opportunity for idea collisions and intersections of people with different contexts.

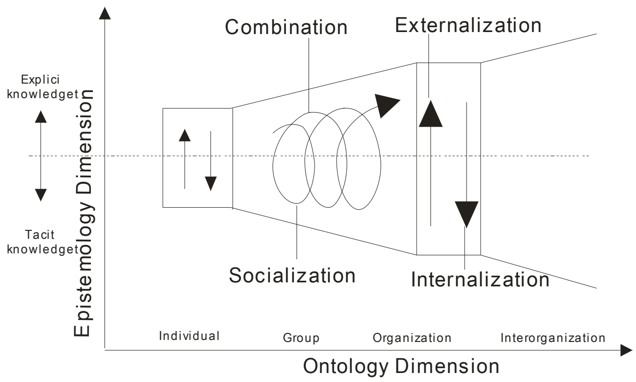

Figure 1 Spiral of organizational knowledge creation [17]

Finally, as the CBI-CPS is a problem-solver enabled by a CBI system, there are two strategies for adopting a CBI system [4]: (1) the information technology (IT)-centric strategy—which focuses on the use of IT tools to facilitate the capture, access, and reuse of information and knowledge; and (2) the human resource management (HRM)-centric strategy—which focuses on the establishment of the means to motivate and facilitate knowledge workers in developing, enhancing, and using their knowledge. The IT-centric strategy usually leads to the adoption of the KMS software and platform, and the HRM-centric emphasizes on the establishment and fostering of the Cops. In a CBI-CPS, the both strategies are integrated; i.e., a hardware platform and a operation software system required for a CBI system are established first, then specific CoPs are developed and fostered to encourage knowledge sharing among the CoP members. Similarly, both models, Cognitive Process and DSS, recognized by Li and Love [2] are incorporated in a CBI-CPS. The CBI platform provides functions for searching and accessing the previous lessons-learned (the DDS perspective), while the new problems are resolved cooperatively by the participants (members) of the CoP through the individual cognitive processes and a cyclic procedure of the knowledge conversions described by Nonaka [17].

4.2 A Generic System Framework

The system framework of a generic CBI-CPS is depicted in Figure 2, where a CBI-CPS is comprised of four major elements: (1) Problem diagnosis module—a pre-screening procedure that assesses the level of emergency of the posed problems; (2) Emergent problem-solving unit (EPSU)—a specialized community of practice (CoP) with the top priority on the firm's enterprise information portal (EIP), which provides a forum for all staffs and domain experts to participate in the problem-solving process; (3) Domain experts (DEs)—a pool of firm's internal and external specialists in all areas related to the services provided by the firm; (4) CBI system—a collection of CoPs and the knowledge- and data-bases supported with the CBI system of the firm. The generic system framework for a CBI-CPS can be easily implemented in any construction organization with a pre-established CBI system such as KMS.

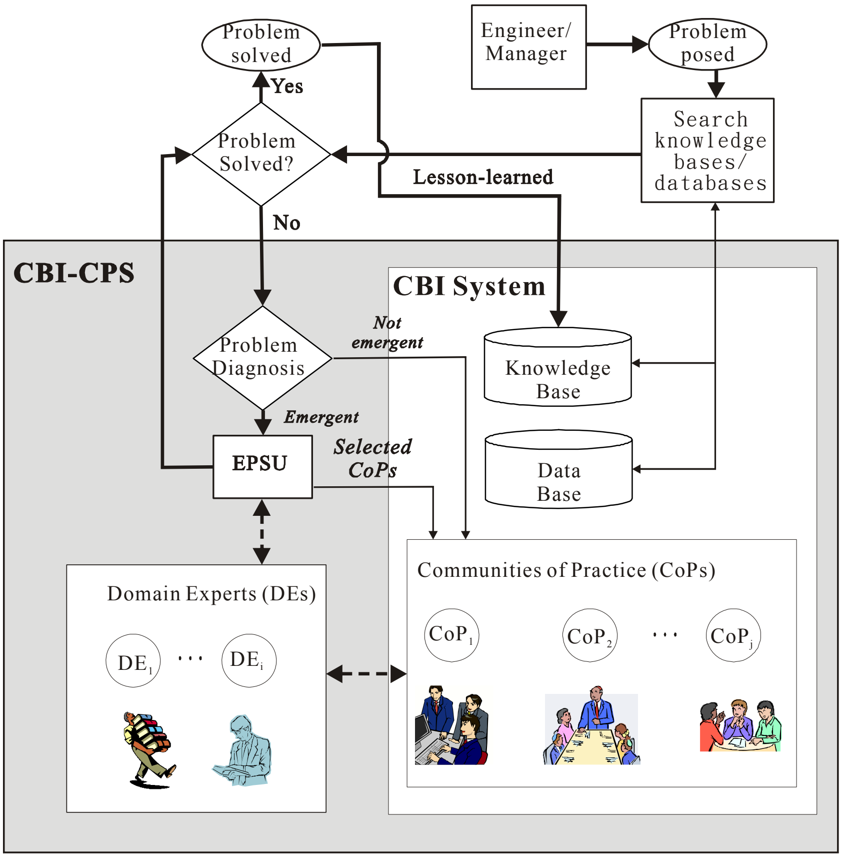

Figure 2 The generic system framework of a CBI-CPS

4.3 Problem-Solving Procedure of CBI-CPS

The problem solving of a CBI-CPS shown in Figure 2 follows the procedure: (1) as a problem is posed by an engineer/manager (the questioner), he/she should search the knowledge bases and databases of the firm first to find out any available knowledge and experience document (usually stored as a lesson-learned file) that help solve the posed problem; (2) if the problem is solved then a new lesson is recorded and stored into the related knowledge base; otherwise, if the problem is not solved then it enters the CBI-CPS to be diagnosed; (3) the diagnosis module assess the emergency level of the posed problem to determine if the problem should be posted in the EPSU; (4) should the emergency level of the posed problem is low, it is posted in the related regular CoPs of the CBI system, otherwise the problem is posted in the EPSU on the first page of the EIP and the selected CoPs of the CBI system simultaneously; (5) the domain experts (DEs) from internal and external organizations participate in discussions of the posed problem to provide their solutions (or the ideas help solve the problem) through an organizational knowledge creation process; (6) should the questioner find any of the posted solutions be useful enough to solve the posed problem, a final solution is developed based on that solution and a lesson-learned from the problem solving is documented into the related knowledge base of the CBI system for future uses.

五、結果與討論 (Results and Discussions)

5.1 System Implementation Case Study

5.1 Background of the Case Engineering Consulting Firm

The case engineering consulting firm selected for case study is one of top three engineering consultants in Taiwan. It was established with government funding in 1969 primarily for the purpose of promoting Taiwan's construction technology and assisting in the nation's economic development. The current number of full-time staffs of the firm is about 1,800. Among those around 900 are in-house staffs in headquarter located in Taipei, the other 900 are allocated in branches and site offices around the island and overseas including south-east , south and mid-east Asia and in Mainland China. Headquarter, braches, and site offices are connected by Intranet.

The structure of the case Engineering consulting firm consists of five business groups: (1) Civil Engineering Group; (2) Railway Engineering and Architecture Group; (3) Systems and Electrical & Mechanical Engineering Group; (4) Construction Management Group; and (5) Administration and Management Group. Each business group comprises several functional departments.

The annual revenue of the case engineering consulting firm is around USD 161.3 million in Year 2009. According to the information disclosed by the firm, more than 1,700 projects were finished by the firm in the past forty years. Totally volume (construction budget) of the finished projects exceeds USD 200 billion.

5.2 The CBI System and CBI-CPS

The implementation of CBI system in the case engineering consulting firm started in 2001. The case firm selected to implement its own CBI initiatives as a KMS. Unlike most other CBI implementations, the case engineering consulting firm chose to develop the CBI system completely by their own staffs without the help from external consultants. In the beginning, the CBI system was proposed by the Department of Business and Research. Soon, it was realized that engineers of Department of Information Technology (IT) should be included in order to tackle the technical problems encountered during implementing the prototype system. The commercial software, Microsoft SharePoint®, was adopted to develop the first version of its CBI system. The system development took one year to establish the prototype. The hardware investment (for both platforms and Microsoft SharePoint system) was about USD 177,420; the labor investments (including programming, training, and maintenance costs) was about USD 612,900. Total installation cost summed up to USD 790,320.

The prototype CBI system began to operate company-wide after one year of the project commencement. It was found quickly that development of the CBI system was not a tough job compared with the creation of the culture and atmosphere for successful operation of a CBI system. 36 CoPs were established in the beginning. The number of CoPs was varying based on an enter-and-exit rule. That is, a continuous evaluation of CoPs is conducted to determine whether they should be maintained or be closed down. Currently, thirty-two CoPs are maintained in the CBI system. The manager of the CoP is in charge of all activities for promotion of the knowledge creation in that CoP. Incentives are provided by the company to stimulate the establishment of knowledge-sharing atmosphere. To date, the CBI system has been operating for eight years. The CBI system has been modified significantly from its prototype version. One of the most significant modifications was the introduction of the Emergent Problem-Solving Unit (EPSU), namely "SOS system", for emergent problem solving in 2003.

The SOS system is a specialized CoP of the CBI system, which provides a tentative forum for emergent problems encountered by the engineers and managers of the firm. Once the problem is posed as a SOS-problem, it is posted in the SOS board on the first page of the CBI system for emergent discussions. Such an arrangement forces all users of the CBI system to take a look at the posed problem, so that it generally receives attentions and usually has a better chance to be solved. Problems posed on the SOS board receive no response within one working day (24 hours since it was posted) will be automatically removed and transferred to ordinary CoPs. After then, it becomes a regular topic for discussion in the relevant CoPs.

5.3 Type of Emergent Problems

There are basically eleven categories of emergent problems facing the case engineering consulting firm: (1) Request of client—request of the client can be very diversified, e.g., an assessment of the impact of a change order, preparation for a RFP that was not included in the contract, evaluation of a set of different alternatives, etc.; (2) Reaction to an accident—accidents are always omnipresent and emergent on construction sites, problems in this category may include the rescue process and remediation method for the accident; (3) Dispute resolution/Contract execution—problems in this category may relate to the interpretation of contract articles and should be determined within a time-bound; (4) Material and equipment—problems in this category are mostly related to onsite activities or a pre-construction planning; (5) Safety/Environment matters—problems in this category may relate to requirement of government regulations; (6) Request of engineering information—problems in this category are also diversified, which include the information of price of bid items or a design, construction method, etc.; (7) Completion and transfer—the problems that may happen when the project is completed and is transferred to the client; (8) SPEC and code—problems relate to technical specifications or design codes; (9) Problems with contractors/sub-contractors—problems in this category are those raised by the contractors or sub-contractors, such as schedule extension or claims of additional cost reimbursement; (10) Internal process of the firm—problems in this category are related to the business/administration processes of CECI; (11) the others—all problems not belonging to the above categories.

Table 1 Distribution of the selected 968 emergent problems of case study

No.	Type of emergent problem	Count	%
1	Requests of client	62	6.38%
2	Reaction to accident	10	1.06%
3	Dispute/Contract execution	39	4.04%
4	Material and equipment	145	15.00%
5	Safety/Environment	42	4.36%
6	Request of engineering information	368	37.98%
7	Completion and transfer	5	0.53%
8	SPEC and criterion	267	27.55%
9	Problems with contractors/sub-contractors	14	1.49%
10	Internal process of the firm	12	1.28%
		968	100%

In this case study, totally 987 problem-solving cases of CECI were collected from 2005/1 to 2010/8. Totally, 987 emergent cases were collected. Some of the problem were mainly computer-related questions, (e.g., edition of word processor, rescue of crashed operating system, saving of CAD drawing processing, etc.), which were excluded from further analysis. Only 968 engineering-related problems were selected. The distribution of the 968 emergent problems in the eleven categories is shown in Table 1. It was found the most beneficial benefit is undoubtedly the time benefit (TB). It is noted that most design/engineering departments (e.g., Structural, Geotechnic, Hydraulic & Environmental, Harbor, MRT, Railway, etc.) have benefited significantly with the CBI-CPS in solving the problem timely. The field-related department (including braches and Construction Management) also benefited. The least beneficial department is the Material Testing department. No department, company-wide, has realized positive benefit either on MHB or CB. It revealed the fact that the CBI-CPS may not justify its investments based on the proposed quantitative model. The least beneficial department for these two criteria were Material Testing and Construction Management (CM), the Railway department and one local branch office followed.

5.4 Quantitative benefit analysis

In order to measure the benefits resulted from the CBI-CPS system, all three measures (TB, MHB, and CB) defined in a previous research [20] were calculated for all selected cases. The overall quantitative benefits for the firm are: (1) 42.22% of time benefit; (2) (-251.21%) man-hour benefit; and (3) (-64.28%) cost benefit. It is noted that except the time benefit, the surveying results of the other two measures, MHB and CB, were not pleasant at all. It should of no surprise that the quantitative model was defined based on the parameter values of the traditional problem-solving approaches. As the CBI-CPS involves almost all staffs of the firm to participate in the problem solving, the man-hours and cost spent tended to be higher. While interviewing with the managers of the CoPs, some complained that their staffs were more enthusiastic in solving problems of the EPSU than in their own jobs.

5.5 Qualitative benefit analysis

In contrast to the quantitative benefits, the qualitative benefits resulted from a CBI-CPS are not so transparent to most users; however, they are nevertheless significant. Identification of the qualitative benefits is difficult. In the current research the qualitative benefits were identified through interviews with the engineers/managers of CECI who participated in the CBI-CPS problem solving and through "focus-group meetings" with the managers of the CoPs. The interviews were conducted from 2010/03~2010/06. The managers of all thirty-two CoPs of the firm were interviewed. The major qualitative benefits identified include: (1) increase of the firms intellectual assets—during the process of organizational knowledge creation, all participants (including whom read but didn’t participate in discussions) accumulate their knowledge related to the posed problem, and the accumulated knowledge may be useful in the future; (2) solving of problems that cannot be solved before—in the traditional approach, the problems are discussed and solved by a taskforce with only limited members from selected disciplines, which may sometimes exclude the real experts (who have solved the similar problems before) of the problem due to any unavailability reason; (3) increase of the Medici Effect—when integrated with a KMS, the CBI-CPS can incorporate all staffs within the firm and increase the frequency of intersections and thus maximize the Medici Effect, and thus increase the probability of problem solving; (4) improvement of client's satisfaction—as the CBI-CPS shortens the required problem-solving time, client satisfaction is significantly improved (this is supported by almost all managers of CoPs); (5)

improvement of the sense of belonging—the “sense of belonging” to an organization is a spiritual property that promotes the competitiveness of the firm; with the CBI-CPS engineers/managers and other staffs share the pressure of work and the pleasure of problem solving, which improve the “sense of belonging” of all participants to the organization.

5.6 Discussions

From the case study and the specialized emergent problem-solving system, CBI-CPS, it is found that many issues in problem solving have been improved or tackled properly. In this section, limitations of the analysis methodology and findings of the improvements of CBI-CPS in problem-solving are discussed.

5.6.1 Major Benefits and Problems with the CBI-CPS

It is transparent from the case study results that the major benefit of the CBI-CPS over the traditional problem solvers is the timeliness. Based on the survey results, a 42.22% of time benefit was achieved for the 872 analyzed data. It was found that the estimated average problem-solving estimated by the traditional approach was 4.64 days; while the average problem-solving time for the selected cases was 2.68 days. However, according to the opinions of the managers from focus-group meetings, the 2.68 days problem-solving time was still not satisfactory for their clients. Many managers suggested that most time was wasted in waiting for the "real domain experts" (the staffs who solved the similar problem before). A method to quickly identify the most relevant experts should be provided.

Although many qualitative benefits were identified from the focus-group meetings, the man-hour and cost benefits were far below acceptable. It was pointed by some managers that the historic lessons-learned should be recorded and provided instead of the electronic files currently stored in the databases of the KMS. Other managers reflected that the searching engine of the current KMS was not efficient at all. It is not very helpful to the engineers merely by providing him/her with the available files. What is really helpful is the "exact location of the needed knowledge in the document", addressed by one senior engineer participated in the focus-group meeting.

5.6.2 Other Impacts to the Traditional Construction Problem Solvers

1. Other Impacts to the Traditional Construction Problem Solvers

The CBI-CPS adopts both the cognitive and information processing problem-solving perspectives. It utilizes the KMS (an advanced information technology) for information processing (searching of knowledge bases and databases, and providing forums for problem communication); however, the knowledge representation problem of traditional Information Processing approach is tackled with nature language in the CoP. Moreover, problems with traditional cognitive science approach of problem solving are improved with formulated lessons-learned of solved cases, so that the lessons-learned can be retrieved and reused by the questioner.

2. Improvement of generalization and conceptualization

Traditional DSS approach suffers in the generalization and conceptualization of the proposed and implemented solutions to the posed problems [2]. Such drawbacks are improved with the CBI-CPS by inducing the domain experts in tuning the solution for a specific problem. The problem of no optimizing or improvement mechanism mentioned by Li and Love [2] is also improved in the CBI-CPS by a recursive process of solution discussions, where the Questioner "socializes" with Responders via a series of discussions in the CoP. As a result, the Responder can improve his/her solution based on the solution of previous Responders; and the Questioners can select the best solution (based on his/her own knowledge and experiences) before he/she develops the final solution. This is how the improvement and optimization mechanism is realized in a CBI-CPS.

3. Improvement of temporary-multi-organization

The problem of "temporary-multi-organization (TMO)", addressed by Li and Love [2], in construction industry is also better tackled by the CBI-CPS, since the previous problem-solving cases are recorded with the KMS and modified by the Questioners and Responders participating in the CBI-CPS problem solving. Such accumulation of lessons-learned does not only provides a source of organization's intellectual assets, but also develops the learning capability of an organization to become a learning organization (LO) [19,13]. This is very different from traditional information process approaches that relies on machine learning, and also expands the learning scope of traditional individual cognitive problem-solving approach.

5.7 Limitations of the Proposed Model

The analysis of benefits generated by the CBI-CPS is based on the proposed quantitative model. In that model, the benefits of a CBI-CPS are measured by questionnaire surveying with problem-solving participants to compare the required efforts for problem solving between the traditional and the CBI-CPS approaches. An essential assumption for this model is that the participants should be able to provide the unbiased required parameters of the two approaches correctly. Although strategies were adopted to mediate the bias and errors made by the questionnaire responders, residual errors may still exist.

A second limitation resides in the quantitative model itself, since many benefits are not quantifiable with the proposed model. For example, the benefits of knowledge learned from the problem-solving process by the participants for solving similar future problems without reporting to the CBI-CPS are not recorded and thus are not measured, don't mention the intangible and qualitative benefits described previously in this report. Moreover, the results reported in this paper are based on a case study of a local engineering consulting firm. Different results may be obtained due to the types of firms, the culture and scale of the organizations, and the CBI platform adopted. However, similar methodology can be applied to measure the benefits of other implementations of CBI-CPS, too.

六、結論與建議 (Conclusions and Recommendations)

6.1 Conclusions

As the Knowledge Management Systems (KMSs) are widely adopted by construction organizations, mangers of the construction organizations were faced with an essential question: "Does a KMS worth for the money spent?" Very few literature have reported the benefits of the KMS implementations. Even rare was found on quantitative measures of KMS performance. This paper presents a quantitative model for measuring three most concerned tangible benefits (time, man-hour, and cost) of a Construction Business Intelligence based Construction Problem Solver (CBI-CPS) and an in-depth case study of a major engineering consulting firm in Taiwan. The results of the case study show that only the time benefit is remarkable among the three tangible measures. The major problems with the current CBI-CPS are identified through focus-group meetings with the managers of the Communities of Practice (CoPs) of the CBI system. The problems include wasting time for the "real domain experts", historic lessons-learned are not recorded and stored appropriately for retrieval and reuse, difficulty to locate the needed knowledge even if the document is found, etc. A more "proactive" approach that can improve the above-mentioned problems should be provided.

Unlike the tangible measures, the qualitative benefits were widely approved by the interviewed managers, including the increase of the firms intellectual assets, solving of problems that cannot be solved before, the increase of Medici Effect, the improvement of client's satisfaction, the improvement of the sense of belonging for the organization.

6.2 Recommendations

Some limitations are addressed for the proposed benefit quantification model. Biases and erroneous estimations made by the responders are found in the surveying results. It indicated that an improved model is expected. The current model does not measure the benefits resulted from a

CBI-CPS if the problem-solving activities are not recorded but conducted by the participants of the CBI-CPS. An organizational macro measure may be developed in the future to include the contributions of problem-solvers who benefit from the CBI-CPS but unrecorded. Finally, the current research focuses on the engineering consulting firm, the same model can be applied to measure the benefits of the CBI-CPS in the other construction organizations, too.

七、誌謝 (Acknowledgement)

The valuable case study information presented in this paper was provided by CECI, Taipei. The authors would like to express sincere appreciations to Mr. Chen, G. L., and other staffs of the Department of Business and Research and Department of Information Systems, China Engineering Consultants, Inc., Taipei, Taiwan.

八、參考文獻 (References)

[1] Runeson G. (1994). "The future of building research." *Australian Institute of Building Papers*, 5, 3-8.

[2] Li, H. and Love, P. E. D. (1998). "Developing a theory of construction problem solving, *Construction Management and Economics*." 16(6), 721-727.

[3] Mezher, M., Abdul-Malak, M. A. Ghosn, I., and Ajam, M. (2005). "Knowledge Management in Mechanical and Industrial Engineering Consulting: A Case Study." *Journal of Management in Engineering*, ASCE, 21(3), 138-147.

[4] Carrillo, P. and Chinowsky P. (2006). "Exploiting knowledge management: The engineering and construction perspective." *Journal of Management in Engineering*, ASCE, 22(1), 2-10.

[5] Lin, Y. C., Wang, L. C., and Tserng, H. P. (2006). "Enhancing knowledge exchange through web map-based knowledge management system in construction: Lessons learned in Taiwan." *Automation in Construction*, 15(6), 693-705.

[6] Dave, B. and Koskela, L. (2009). "Collaborative knowledge management-A construction case study." *Automation in Construction*, 18(7), 894-902.

[7] Yu, W. D., Yang, J. B., Tseng, J. C. R., Liu, S. J., and Wu, J. W. (2010). "Proactive Problem Solver for Construction." *Automation in Construction*, 19(6), 808-816.

[8] Swaak, J., Lansink, A., Heeren, E., Hendriks, B., Kalff, P., Den Oudsten, J-W., Böhmer, R., Bakker, R., and Verwijs, C. (2000). "Measuring knowledge management investments and results: two business cases." *paper presented at the 59th AEPF-Tagung*, Bremen, 3rd,

Germany.

[9] Bassion, H. A., Price, A. D. F., and Hassan, T. M. (2005). "Building a conceptual framework for measuring business performance in construction: an empirical evaluation." *Construction Management and Economics*, 23(5), 495-507.

[10] del-Rey-Chamorro, F. M., Roy, R., van Wegen, B., and Steele, A. (2003). "A framework to create key performance indicators for knowledge management solutions." *Journal of Knowledge Management*, 7(2) 46–62, 2003.

[11] Yu, W. D., Chang, P.L., Yao, H. H., and Liu, S.J. (2009). "KVAM: Model for Measuring Knowledge Management Performance of Engineering Community of Practice." *Construction Management and Economics*, 27(8), 733-747.

[12] Smith, G. F. (1992). "Towards a Theory of Managerial Problem-Solving." *Decision Support Systems*, 8(1), 29-40.

[13] Chinowsky, P., Molenaar, K., and Realph, A. (2007). "Learning organizations in construction." *Journal of Management in Engineering*, ASCE, 23(1), 27-34

[14] Chang, A. S. and Chiu, S. H. (2005). "Nature of engineering consulting projects." *Journal of Management in Engineering*, ASCE, 21(4), p 179-188.

[15] Yu, W. D., Lin, C. T., Yu, C. T., Liu, S. J., Luo, H. C., and Chang, P. L. (2007). "Integrating emergent problem-solving with construction knowledge management system." *Proceedings of the CME 25 Conference*, University of Reading, Reading, UK, 10.

[16] Lang, J.R., Dittrich, J.E. and White, S.E. (1978). "Managerial problem solving models: a review and a proposal." *Academy of Management Review*, 3(4), 854-66.

[17] Nonaka, I., (1994). "A dynamic theory of organizational knowledge creation." *Organization Science*, 5(1), 14-37.

[18] Johansson, F. (2002). "*The Medici Effect: Breakthrough Insights at the Intersection of Ideas." Concepts, and Cultures*, Harvard Business School Press, Cambridge, MA, USA.

[19] Senge, P. M. (1990). "The leader's new work: Building learning organizations." *Sloan Management Review*, 32(1), 7-23.

[20] Yu, W. D., Chang, P.L. and Liu, S.J., "Quantifying Benefits of Knowledge Management System: A Case Study of an Engineering Consulting Firm," Proceedings of International Symposium on Automation and Robotics in Construction 2006 (ISARC 2006), Edited by Kano, N. and Arai, T., Session A4—Planning and Management (1), Oct. 3~5, 2006, Tokyo, Japan, pp. 124~129, 2006.

九、相關著作發表表列

期刊論文

1. **Yu, W. D.**, Yang, J. B., Tseng, J. C. R., Liu, S. J., and Wu, J. W. "Proactive Problem Solver for Construction," *Automation in Construction*, Vol. 19, No. 6, pp. 808-816, 2010. (SCI, EI, IF=1.66) (NSC 97-2221-E-216 -039)
2. **Yu, W. D.**, Chang, P.L., Yao, H. H., and Liu, S.J. "KVAM: Model for Measuring Knowledge Management Performance of Engineering Community of Practice," *Construction Management and Economics*, Vol. 27, No. 8, pp. 733-747, 2009. (EI)
3. 姚宣合、**余文德**、楊智斌、曾秋蓉、劉沈榮、張佩倫，「營建知識社群知識加值績效量化評估模式之研究」，*中國土木水利工程學刊*，第 22 卷，第 1 期，pp.365-379，2009。(EI) (NSC 96-2221-E-216 -054)

研討會論文

4. **Yu, W. D.**, Yang, J. B., Tseng, J. C. R., and Yu, C. T., "Model of Proactive Problem-Solving for Construction Knowledge Management," *Proceedings of International Symposium on Automation and Robotics in Construction 2007 (ISARC 2007)*, Session 1-C—Management and Production Aspects (1), Sept. 19~21, 2007, Kochin, India, pp. 493~500, 2007.
5. **Yu, W. D.**, Yao, H. H., Liu, S.J., and Chang, P.L., "Knowledge Value Adding Model for Quantitative Performance Evaluation of the Community of Practice in a Consulting Firm," *Proceedings of The Sixth International Conference on Engineering Computational Technology (ECT 2008)*, Session VIII—Decision Making in Engineering Management, Sept. 2~5, Athens, Greece, 18 pp., 2008.
6. **Yu, W. D.**, Yao, H. H., Liu, S.J., and Chang, P.L. "Measuring Performance of Knowledge Community of Practice in an Engineering Consulting Firm," paper submitted to the *Journal of Management in Construction*, ASCE, for review and possible publication, 40 pp., 2008/8.

7. Yu, W. D., Lin, S., T.., Liu, S. J., and Chang, P. L., "Mining Knowledge Management Strategies from the Performance Data of CoP," *Proceedings of the International Symposium on Automation and Robotics in Construction 2009 (ISARC 2009)*, June 24~27, 2009, Austin, Texas, USA, 5 pp., 2009.
8. Yu, W. D., Yang, J. B., Tseng, Judy C. R., Liu, S. J., and Chang, P. L., "Enhancing Engineering Services with Integrated Proactive Knowledge Management Model," *Proceedings of the 14th International Symposium on Advancement of Construction Management and Real Estate (CRIOCM 2009)*, Oct. 29~31, 2009, Nanjing, PRC, pp. 2409-2416, 2009. (ISTP)

十、可供推廣之研發成果資料表

□ 可申請專利　■ 可技術移轉　　日期：98 年 09 月 28 日

國科會補助計畫	計畫名稱：營建企業智能為基礎之專業服務平台技術研究—以工程顧問緊急問題解決為例 計畫主持人：余文德 計畫編號：NSC 97-2221-E-216 -039 學門領域：土木(營建)
技術/創作名稱	營建企業智能為基礎之專業服務平台模式暨系統
發明人/創作人	余文德、曾秋蓉、劉沈榮
技術說明	中文： 本「營建企業智能為基礎之專業服務平台模式暨系統」結合知識分析、專家人力分析、資訊再取、問題分派以及經驗學習等功能，成為一具有主動問題能力之企業智能系統。本系統對於營建產業(含工程顧問業)業務執行過程所遇到之問題的解決效率甚具提升效益，對於產業競爭力之提升亦具成效。

	英文： The proposed Construction Business Intelligence-based Professional Service Platform Model and System combines knowledge analysis, expertise analysis, problem answering, problem dispatching module, and a lessons learning. Such a system has been proved to be very beneficial for construction firms (including engineering consultants) in improving their problem-solving capability and efficiency, and thus enhancing their competitiveness.
可利用之產業 及 可開發之產品	本產品可以結合現有之知識管理系統(KMS)或獨立開發成為一網路服務系統(Web Service System)，可以輔助營建產業之業務執行(含緊急問題解決、備標、估價、監造...等)功能，亦可獨立開發成為單一專業服務功能(例如估算、求償、工程法律諮詢等)之系統。
技術特點	具有知識分析、專家人力分析、資訊再取、問題分派以及經驗學習等五大功能模組，可分析組織之智慧資產、人力資產，具有累積與再利用過去經驗與知識之功能，並能連結具有相關知識之專家的能力。
推廣及運用的價值	本系統可以推廣至國內、外之營建產業、顧問服務業以及任何已經推行知識管理之組織與單位，對於提升知識管理加值運用之價值顯著。

※　1.每項研發成果請填寫一式二份，一份隨成果報告送繳本會，一份送　貴單位研發成果推廣單位（如技術移轉中心）。

行政院國家科學委員會補助國內專家學者出席國際學術會議報告

99 年 7 月 27 日

附件三

報告人姓名	吳誌銘	服務機構及職稱	中華大學科技管理研究所營建管理組博士候選人
時間 會議地點	2010/6/29~2010/7/2 美國佛羅里達州，奥蘭多市	本會核定補助文號	NSC 98-2221-E-216-044
會議名稱	(中文) 第三屆國際多領域工程與技術創新研討會 (英文) The 3rd International Multi-Conference on Engineering and Technological Innovation(IMETI 2010)		
發表論文題目	(中文)自動產生創新方案模式之初步研究 (英文) Preliminary Study on the Model for Automatic Generation of Innovative Alternatives		

報告內容應包括下列各項：

一、參加會議經過

第三屆 2010 國際多領域工程與技術創新研討會舉辦時間為 6 月 29 日至 7 月 2 日於美國佛羅里達州奧蘭多市 Rosen Centre Hotel 飯店舉辦，6 月 29 日主要為註冊與報到日，該研討會為 6 月 30 日正式舉行，該日上午為各主題之專家學者特邀演講，本計畫所發表之研究論文為 7 月 1 日下午，該場次主題為 Disciplinary Research and Development II（學科研究與發展），本次計畫人員與美國喬治亞理工學院(Georgia Tech)航太工程系 Narayanan Komerath 教授一同受邀擔任該場次的主持人（co-chair），負責主持該場次五篇論文發表。發表與主持完該場次後，學生後續亦參加研討會其餘天數之研討會活動。

二、與會心得

該研討會至今年雖僅舉辦已經第三屆，(多達四十餘國專家學者參與，共計約兩百餘篇文章發表，台灣計兩篇論文，佔 1.59%)，相較於去年第二屆研討會更具規模，相關主題演講更具吸引性，另一方面，本次計畫人員受邀擔任國際研討會的場次主持人（Co-chair），因此除發表本計畫之論文外，並更要了解同場次其他人員所發表之論文，除需介紹各篇論文之發表人員外，並於發表後於適當之時機提問與評述，並控制研討會進行的秩序，過程使計畫人員參與國際研討會之實務經驗獲益良多，並於發表與擔任主持工作後，持續聆聽各場次之報告，整體而言，創新對於企業的影響力已經無庸置疑，然而如何有效的針對各種不同之領域（如工程、管理等）提出有效的創新方法與經驗，為此次研討會之宗旨，在與會過程中看到各國之研究學者提出各項關於創新之新觀點，皆有助於本計畫相關人員思考未來之研究方向以及增加思考完整性。

三、考察參觀活動(無是項活動者省略)

無

四、建議

由於該研討會可說是草創期間（第三屆），但與會人員與國家則有增加之趨勢，該研討會具有不同工程與不同領域等之創新理念，與中華大學發展創新創意校園方向一致，因此建議本計畫主持人持續投入參與外，國科會以及學校可將研討會相關訊息發佈給有興趣之計畫主持人參考。

五、攜回資料名稱及內容

Keynote Speech 講義、IMETI 2010 論文集書面資料、IMETI 2010 論文集光碟資料

無研發成果推廣資料

98 年度專題研究計畫研究成果彙整表

計畫主持人：余文德	計畫編號：98-2221-E-216-044-
計畫名稱：營建企業智能為基礎之專業服務平台技術研究—以工程顧問緊急問題解決為例(II)	

成果項目			量化：實際已達成數（被接受或已發表）	量化：預期總達成數(含實際已達成數)	量化：本計畫實際貢獻百分比	單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
國內	論文著作	期刊論文	1	1	100%	篇	1. 姚宣合、余文德、楊智斌、曾秋蓉、劉沈榮、張佩倫，「營建知識社群知識加值績效量化評估模式之研究」，中國土木水利工程學刊，第 22 卷，第 1 期，pp. 365-379，2009。(EI) (NSC 96-2221-E-216-054)
		研究報告/技術報告	2	2	100%		1. 余文德,「營建企業智能為基礎之專業服務平台技術研究—以工程顧問緊急問題解決為例(第一年)」,行政院國家科學委員會專題研究計畫成果報告,計畫編號：NSC 97-2221-E-216-039，18 pp.，2008。 2. 33. 余文德,「營建企業智能為基礎之專業服務平台技術研究—以工程顧問緊急問題解決為例(第二年)」，行政院國家科學委員會專題研究計畫成果報告，計畫編號：NSC 98-2221-E-216-044，18 pp.，2009。

		研討會論文	3	3	100%		1. 姚宣合、余文德,「工程顧問公司社群知識加值績效評估模式之研究」,2008年7月31日,2008營建管理研討會論文集,斗六市,雲林科技大學,10 pp.,2008。 2. 魏宇德、余文德,「文字探勘技術應用於自動建立經驗學習檔案之研究」,2008年7月3日,第十二屆營建工程與管理學術研討會論文集,Session 05 營建資訊科技,高雄市,蓮潭國際文教會館,10 pp.,2008。 3. 張佩倫、余文德、劉沈榮,「工程顧問導入知識管理系統個案探討—台灣世曦工程顧問之經驗」,2008年7月3日,第十二屆營建工程與管理學術研討會論文集,Session 05 營建資訊科技,高雄市,蓮潭國際文教會館,10 pp.,2008。
		專書	0	0	100%		
	專利	申請中件數	1	1	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	2	2	100%	人次	
		博士生	1	1	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

國外	論文著作	期刊論文	2	2	100%	篇	1. Yu, W. D., Yang, J. B., Tseng, J. C. R., Liu, S. J., and Wu, J. W. 'Proactive Problem Solver for Construction,' Automation in Construction, Vol. 19, No. 6, pp. 808-816, 2010. (SCI, EI, IF=1.66) (NSC 97-2221-E-216-039) 2. Yu, W. D., Chang, P.L., Yao, H. H., and Liu, S.J.' KVAM: Model for Measuring Knowledge Management Performance of Engineering Community of Practice,' Construction Management and Economics, Vol. 27, No. 8, pp. 733-747, 2009. (EI)
		研究報告/技術報告	0	0	100%		

								1. Yu, W. D., Yang, J. B., Tseng, J. C. R., and Yu, C. T., ’Model of Proactive Problem-Solving for Construction Knowledge Management,’ Proceedings of International Symposium on Automation and Robotics in Construction 2007 (ISARC 2007), Session 1-C—Management and Production Aspects (1), Sept. 19~21, 2007, Kochin, India, pp. 493~500, 2007. 2. Yu, W. D., Yao, H. H., Liu, S.J., and Chang, P.L., ’Knowledge Value Adding Model for Quantitative Performance Evaluation of the Community of Practice in a Consulting Firm,’ Proceedings of The Sixth International Conference on Engineering Computational Technology (ECT 2008), Session VIII—Decision Making in Engineering Management, Sept. 2~5, Athens, Greece, 18 pp., 2008. 3. Yu, W. D., Yao, H. H., Liu, S.J., and Chang,

		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	本研究提出「主動式問題解決模式(Model of Proactive Problem Solver, MPPS)」，此一模式改善了傳統被動式知識管理系統之缺點，整合知識地圖、知識管理績效評估、經驗學習、文字探勘等技術領域，成為主動式之知識管理模式。此一系統已經為產業界應用於實際工程專問題之解決。最近二年內，本人進一步改善 MPPS，針對營建工程技術智慧資產(包括已外顯化之書面報告、計畫書、圖說等，以及隱性之智慧資產等)進行「智慧資產化(Intellectualization)」，如此可大幅度加快營建企業智能(Construction Business Intelligence, CBI)之建立與累積。目前本人所領導之研究團隊正在發展可應用於熱帶及亞熱帶地區之「企業智能為基礎之專業服務平台系統(CBI-based Professional Service Platform, CBI-PSP)」，並期待將 CBI-PSP 系統發展成為營建企業智能之萬用系統，以支援營建企業營運所需之所有活動，提升國內營建產業之國際競爭力。

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

　　□實驗失敗

　　□因故實驗中斷

　　□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：■已發表 □未發表之文稿 □撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 ■洽談中 □無

其他：（以 100 字為限）

已發表三篇 SCI/EI 論文：

1. AutoCON,19(6), pp. 808-816, 2010； 2. CME, 27(8), pp. 733-747, 2009； 3. 中國土木水利工程學刊，22(1)，pp.365-379, 2009.

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

本研究之成果提出「主動式問題解決模式(Model of Proactive Problem Solver, MPPS)」，此一模式改善了傳統被動式知識管理系統之缺點，整合知識地圖、知識管理績效評估、經驗學習、文字探勘等技術領域，成為主動式之知識管理模式。此一系統已經為產業界應用於實際工程專問題之解決。最近二年內，本人進一步改善 MPPS，針對營建工程技術智慧資產(包括已外顯化之書面報告、計畫書、圖說等，以及隱性之智慧資產等)進行「智慧資產化(Intellectualization)」，如此可大幅度加快營建企業智能(Construction Business Intelligence, CBI)之建立與累積。目前本人所領導之研究團隊正在發展可應用於熱帶及亞熱帶地區之「企業智能為基礎之專業服務平台系統(CBI-based Professional Service Platform, CBI-PSP)」，並期待將 CBI-PSP 系統發展成為營建企業智能之萬用系統，以支援營建企業營運所需之所有活動，提升國內營建產業之國際競爭力。