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BENCHMARKING THE PREPROJECT PLANNING PRACTICE FOR THE BUILDING CONSTRUCTION INDUSTRY IN TAIWAN

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ABSTRACT: Significant decisions are made by the project team during the early planning phase of capital facility project developments. The preproject planning phase begins after a decision is made to proceed with a project concept and continues until the detail design stage. Many of the industry practitioners and researchers have recognized the importance of preproject planning and that inadequate early planning is one of the key factors affecting project success. Nevertheless, the preproject planning practices vary significantly for the construction industry in Taiwan and the quality of preproject planning relies heavily on individual project team's experience. This research sets out to benchmark the preproject planning practice for the building construction industry in Taiwan. From late 2007 to early 2010, the researchers collected information from a total of 92 building construction projects using questionnaire survey. The analysis results show that the surveyed projects with better preproject planning have better cost and schedule performances on average. It is recommended that project team spend more efforts in the preproject planning stage to have a better chance of achieving project success.

Keywords: Preproject planning; Benchmarking; Project success; Project definition

1. INTRODUCTION

The Construction Industry Institute (CII), based in Austin, Texas, has been studying preproject planning related issues since the early 1990's. Significant decisions are made by the project team during the preproject planning phase of capital facility project developments. The preproject planning phase begins after a decision is made to proceed with a project concept and continues until the detail design stage. The research results at CII have shown that preproject planning is a key process in the project life cycle and how well it is performed will affect cost and schedule performance [1] [2]. Other researches also indicate that better preproject planning will improve efficiency and thus lead to profitability [3] [4]. Nevertheless, the preproject planning practices very significantly from one company to another for the construction industry in Taiwan. There have also been very few related researches conducted relating to this topic. Therefore, this research set out to benchmark the current preproject planning practices for the building construction in Taiwan.

From late 2007 to early 2010, the researchers collected information from a total of 92 building construction projects using questionnaire survey. The sample covers a wide variety of projects such as schools, houses, apartment buildings, hospitals, offices, temples, recreational facilities, hotels, and department stores. A scope definition tool, Project Definition Rating Index (PDRI), was incorporated in the survey questionnaire to collect preproject planning related information. Developed by the Construction Industry Institute, the PDRI is a comprehensive, weighted checklist of crucial scope definition elements that have to be addressed in early planning process. It is a simple and easy-to-use tool to assist with preproject planning process and objectively evaluate the status of a project during the early stage [5]. Since its development, it is widely adopted by the construction industry in the U.S. Therefore, the PDRI is adopted as the survey instrument to measure the status of preproject planning practice for this benchmarking research in Taiwan. In addition to the PDRI evaluations, project basics and information related to project performance was also collected during the survey. Statistical analysis is conducted to investigate the relationship between the status of preproject planning and final project performance.

2. PREPROJECT PLANNING AND SCOPE DEFINITION

The early planning phase of capital facility projects is the main focus of this research. Significant decisions affecting project outcomes are made in this stage. The process of preproject planning constitutes a comprehensive framework for detailed project planning and includes scope definition. Project scope definition is the process by which projects are selected, defined and prepared for definition. It is one key practice necessary for achieving excellent project performance [1].

2.1 Preproject Planning

Preproject planning is a major phase of the project life cycle. It begins after a decision is made by the business unit to proceed with a project concept and continues until the detailed design is developed. In general, industry practitioners perceive that early planning efforts in the project life cycle have a greater influence on project success than planning efforts undertaken later in the project delivery process. Fig. 1 identifies the conceptual relationship between influence and expenditure in a project life cycle. The curve labeled "influence" in Fig. 1 reflects a company's ability to affect the outcome of a project during various stages of a project. The diagram illustrates that it is much easier to influence a project's outcome during the early project planning stage when expenditures are relatively minimal than it is to affect the outcome during project execution or operation of the facility when expenditures are more significant [6].

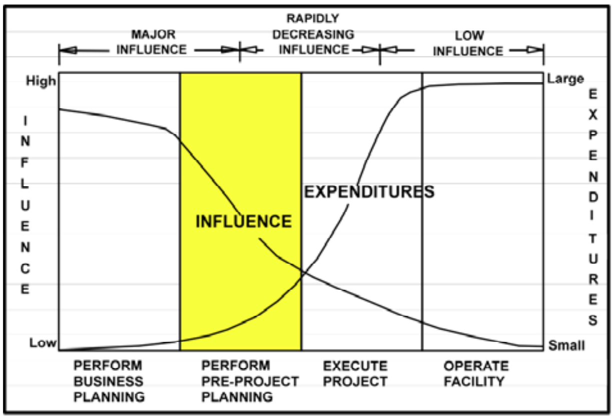

Fig. 1. Influence and Expenditure Curve for the Project Life Cycle

To further investigate the early planning efforts for capital facility projects, CII first chartered a research project to determine the most effective methods of project definition and cost estimating for appropriation approval in 1991. The research team defined preproject planning as "the process of developing sufficient strategic information with which owners can address risk and decide to commit resources to maximize the chance for a successful project" [6]. Other aliases for pre-project planning include front-end loading, front-end planning, feasibility analysis, programming/schematic design, and conceptual planning. The preproject planning process can be summarized into four major steps: organization for pre-project planning, selection of project alternative(s), development of a project definition package (which is the detailed scope definition of the project), and decision on whether to proceed with the project [7]. For each project, the results (or products) is a scope definition package.

2.2 Scope Definition

As defined by the Project Management Institute (PMI), project scope definition occurs early in the project life cycle when the major project deliverables are decomposed into smaller, more manageable components in order to provide better project control [8]. Project scope definition is the process where projects are defined and prepared for execution and is a key component of preproject planning. During this process, information such as general project requirements, necessary equipment and materials, and construction methods or procedures are identified and compiled in the form of a project definition package. This document consists of a detailed formulation of continuous and systematic strategies to be used during the execution phase of the project to accomplish the project objectives. It also includes sufficient supplemental information to permit effective and efficient detailed engineering to proceed [7].

Inadequate or poor scope definition, which negatively correlates to the project performance, is recognized as one of the most serious problems on a construction project [9]. As stated in the Business Roundtable's Construction Industry Cost Effectiveness (CICE) Project Report A-6 [10], two of the most frequent contributing factors to cost overrun are: poor scope definition at the estimate (budget) stage and loss of control of project scope. Therefore, the result of a poor scope definition is that final project costs can be expected to be higher because of the inevitable changes which interrupt project rhythm, cause rework, increase project time, and lower the productivity as well as the morale of the work force [11]. As a result, success during the detailed design, construction, and start-up phases of a project highly depends on the level of effort expended during the scope definition phase as well as the integrity of project definition package [12].

Several studies focusing on the project performance and success identified the major factors that cause project failure. These studies suggest that poor scope definition is one of the primary causes of unsuccessful projects [13]; Myers and Shangraw, 1986; Merrow, 1988; and Broaddus, 1995). According to these studies, cost growth and inaccurate estimations, as well as schedule slippage on most of the process plant projects are due to inadequate scope definition. These studies further conclude that the more time and effort invested in scope definition prior to authorization, the more accurate the construction estimation and scheduling. This research intends to investigate the current practice of preproject planning practice in Taiwan and to find out if similar results can be observed.

3. PDRI and DATA COLLECTION

3.1 Project Definition Rating Index (PDRI)

In order to evaluate the current practice of the preproject planning practice for the building construction industry in Taiwan, an easy-to-use tool, Project Definition Rating Index (PDRI) is incorporated in the survey questionnaire. Developed by the Construction Industry Institute (CII), the PDRI is a scope definition tool with which the project team is able to measure the completeness of a project's scope definition. When it was first developed in 1996, it is intended specifically for industrial projects only. With the success of the PDRI for industrial projects, many building industry planners wanted a similar tool to address scope development of buildings. Therefore, CII formed a team and funded a research effort to facilitate this development effort in 1998. The research effort included input from approximately 30 industry experts as well as extensive use of published sources for terminology and key scope element refinement. As developed, the PDRI for Building Projects consists of 64 elements, which are grouped into 11 categories and further grouped into three main sections. The 64 elements are arranged in a score sheet format and supported by 38 pages of detailed descriptions and checklists (CII 1999).

It was hypothesized that all elements are not equally important with respect to their potential impact on overall project success and each element needed to be weighted relative to the others. Higher weights were to be assigned to those elements whose lack of definition could have the most serious negative effect on the project performance. To develop the weights, seven "weighting" workshops were held and 69 workshop participants consisted of 30 engineers, 31 architects, and eight other professionals directly involved in planning building projects participated in the workshops. The element weights of the PDRI for building projects were established using the input provided by 35 owner and contractor organizations from the building sector (CII 1999).

The PDRI for building projects was validated through a total of 33 projects varying in authorized cost from $0.7 million to $200 million (representing approximately $896 million in construction cost). PDRI scores were calculated for each of these projects and compared to project success criteria, such as cost and schedule performance. The results showed that validation projects scoring below 200 outperformed those scoring above in three important areas: cost performance, schedule performance, and the relative value of change orders compared to budget (CII 1999).

Overall, the PDRI for building projects is a user-friendly checklist that identifies and describes the critical element in a project scope definition package to assist project managers in understanding the scope of work. It provides a means for an individual or team to evaluate the status of a building project during preproject planning with a score corresponding to the project's overall level of definition. The PDRI helps the stakeholders of a project to quickly analyze the scope definition package and to predict factors that may impact project risk specifically with regard to buildings (CII 1999; Cho 2000).

For illustration purposes, Section I – Category A of the PDRI for Building Projects (both elements and their weights) is shown in Fig. 2. Each element has a corresponding detailed description. Fig. 3 gives an example of an element description. Please refer to CII 1999 [?] for detailed information on development of the tool, all the element descriptions and application of the PDRI.

SECTION I - BASIS OF PROJECT DECISION

CATEGORY Element	Definition Level 0	1	2	3	4	5	Score
A. BUSINESS STRATEGY (Maximum = 214)							
A1. Building Use	0	1	12	23	33	44	
A2. Business Justification	0	1	8	14	21	27	
A3. Business Plan	0	2	8	14	20	26	
A4. Economic Analysis	0	2	6	11	16	21	
A5. Facility Requirements	0	2	9	16	23	31	
A6. Future Expansion/Alteration Considerations	0	1	7	12	17	22	
A7. Site Selection Considerations	0	1	8	15	21	28	
A8. Project Objectives Statement	0	1	4	8	11	15	
CATEGORY A TOTAL							

Definition Levels

0 = Not Applicable *2 = Minor Deficiencies* *4 = Major Deficiencies*
1 = Complete Definition *3 = Some Deficiencies* *5 = Incomplete or Poor Definition*

Fig. 2. PDRI for Building Projects – Category A

A. BUSINESS STRATEGY

A1. Building Use

Identify and list building uses or functions. These may include uses such as:

- ❑ Retail
- ❑ Institutional
- ❑ Instructional
- ❑ Medical
- ❑ Research
- ❑ Multimedia
- ❑ Office
- ❑ Light manufacturing
- ❑ Storage
- ❑ Food service
- ❑ Recreational
- ❑ Other

A description of other options which could also meet the facility need should be defined. (As an example, did we consider renovating existing space rather than building new space?) A listing of current facilities that will be vacated due to the new project should be produced.

Fig. 3. Element Description of A1: Building Use

This version of the PDRI for Building Projects is incorporated in the survey questionnaire for this research effort.

3.2 Data Collection

At the beginning of the survey, the purpose of the research and basic concepts of preproject planning were briefly introduced to the survey participants. They were asked to choose a completed project for the evaluation and read the description of each element in the questionnaire. Then, the respondents were required to think back to the initial planning and designing stage (just prior to Construction Documents development) and assess how well each scope element was defined at that time during this "after the fact" project data collection process. In the process, they were encouraged to collect all data that is needed for each scope definition evaluation and then definition level for each element was selected. Each element has five pre-assigned weights for the possible five definition levels for that element (illustrated in the bottom of Fig. 2). Level one represents complete definition for that element while level five means incomplete or poor definition. After the PDRI evaluation, a score was obtained for each project. The maximum score is 1,000 points (level five is selected for all elements), with a lower score indicating a better-defined scope. In addition to the PDRI evaluation, information related to the individual survey participant, his/her company basics, project basics and the final project performance was collected during the survey. It should be noted that there are two limitations for this research: (a) not a random sample selection and (b) nature of retrospective case studies.

From end of 2008 to beginning of 2010, information from a total of 92 building projects, representing a total cost of roughly 1.1 billion U.S.D.) is collected for analysis. The surveyed projects cover all the major metropolitan areas in Taiwan. Also, they cover a wide range of building types including: performance halls, recreational facilities, department stores, restaurants, hotels, schools, temples, hospitals, residential and apartment buildings, offices, clinics and high-rise buildings. Among them, 87% of the projects are new construction projects and 13% of them are retrofits. Thirty-two of them are public projects and 60 are private projects. The average total cost of the surveyed projects is 11.77 million U.S.D. and the average total project duration is 14.94 months. For the 92 surveyed projects, 74 of them experienced at least one change order (material, design or execution) before completion of the project.

4. ANALYSIS RESULT

The main purpose of this research is to benchmark the current practice of the preproject planning efforts for the building construction projects in Taiwan. With the assistance of the PDRI, the researchers are able to examine the status of scope definitions at the early stage of the project life cycle. The average PDRI score of the surveyed project is 251.64. The PDRI score histogram is shown in Fig. 4. Forty percent of the projects have PDRI scores between 200 and 300 points. Almost 90% of the project PDRI scores are within the 100 ~ 400 range. This indicates the surveyed projects do not vary significantly in defining the project scope at the early stage.

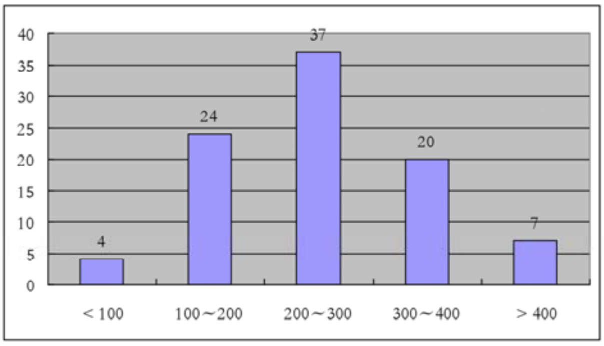

Fig. 4 PDRI Score Histogram (N=92)

The PDRI score of 200 is deemed to be the cutoff point between good and poor preproject planning practice (Wang 2002). As shown in Fig. 4, most of the surveyed projects have PDRI scores above 200. This indicates that these surveyed companies are not spending enough efforts at the beginning of the project and the potential negative impacts are examined below.

Firstly, the final project performances are compared between project PDRI scores above and below 200. Due to their distinct nature, cost and schedule performances are examined separately throughout this research. The cost and schedule performances are measured by cost and schedule growths using equation 1 and 2 below.

$$Cost\ \ Growth = \frac{Final\ Cost - Initial\ Estimated\ Cost}{Initial\ Estimated\ Cost} \quad (1)$$

$$Schedule\ \ Growth = \frac{Final\ Schedule - Initial\ Estimate}{Initial\ Estimate} \quad (2)$$

Table 1 below shows the cost and schedule performances for projects with PDRI scores above and below 200. For projects with PDRI score equal or lower than 200 (better defined projects), they have better cost and schedule growths (0.76% and 2.09% respectively) when comparing to those (6.61% and 9.17% respectively for cost and schedule growths) of the projects with PDRI score greater than 200 (poorly defined projects). It can also be observed that using the PDRI score of 200 as a cutoff point, the project performance differences (5.85% for cost and 7.62% for schedule) between the two groups of projects are statistically significant to the level of $p < 0.01$. That is, surveyed projects that are better defined outperform their counter part in both cost and schedule performances.

Table 1 Project Performance Comparison using PDRI Score of 200 as a cutoff point

Project Performance	PDRI Score	Avg.	Dif.
Cost Growth	> 200	6.61%	5.85%
	≦ 200	0.76%	
Schedule Growth	> 200	9.71%	7.62%
	≦ 200	2.09%	

Secondly, the project change orders are examined to see if there is any difference between better-defined projects and poorly defined projects. Table 2 below summarizes the change orders percentage (in dollar amount) for the two groups of projects using the PDRI score of 200 as a cutoff point. As shown, fewer better-defined projects (74%) experienced change orders throughout their project life cycle while 90% of the poorly defined project experienced at least one change order. In addition, the average change order percentage (change order amount / original total cost) is higher for poorly defined projects. This indicates that poorly defined projects not only are more likely to experience change orders but also have bigger impacts (in dollar amount percentage) once the change order happened.

Table 2 Change Order Summary using PDRI score of 200 as a cutoff point

PDRI Score	Change Order	Project Percentage	C.O. Percentage
> 200 (n=58)	YES	90% (52/58)	6.93%
	NO	10% (6/58)	-

≦200 (n=34)	YES	74% (25/34)	0.76%
	NO	26% (9/34)	-

Comparing to the results from the U.S. building construction industry (Wang 2002), similar trends are found in both studies that better-defined projects have better cost and schedule performances on average. Also, while better-defined projects are less likely to have change orders, the change order percentage (change order amount / original total cost) is smaller once the change orders did occur. The results have shown that regardless of location (U.S. or Taiwan), projects with better preproject planning are more likely to expect better results after project completion.

In order to identify the effect of scope definition on project performance, projects are first divided into two groups according to their cost and schedule growth, one group with cost or schedule growth equal or smaller than 0% and the other group with cost or schedule growth larger than 0%. The average scope definition level for the 11 PDRI scope categories are compared with each other for these two groups of projects. Table 3 and Table 4 list top the categories with average definition level difference greater than 0.3. These categories are, on average, better defined for projects with better cost or schedule performance.

Table 3 Comparison of Definition Level between two Cost Groups

Order	**Category**	**Avg. Definition Level**		**Dif.**
		Cost Growth >0% (n=64)	**Cost Growth ≦0% (n=28)**	
1	J. Project Control	2.26	1.53	0.73
2	K. Project Execution Plan	2.02	1.37	0.65
3	H. Procurement Strategy	1.99	1.41	0.58
4	B. Owner Philosophy	1.95	1.41	0.54
	F. Design Parameters	1.84	1.33	0.51
6	E. Architecture Plan	1.77	1.32	0.45
7	D. Site Information	1.68	1.30	0.38

Table 4 Comparison of Definition Level between two Schedule Groups

Order	**Category**	**Avg. Definition Level**		**Dif.**
		Schedule Growth >0% (n=53)	**Schedule Growth ≦0% (n=39)**	
1	K. Project Execution Plan	2.08	1.47	0.61
2	F. Design Parameters	1.87	1.44	0.43
3	E. Architecture Plan	1.81	1.40	0.41
4	D. Site Information	1.70	1.38	0.33

From Table 3, project control is the top one on the list, which means surveyed projects with less-than-successful cost performance (cost growth greater than 0) typically did not do well in defining scopes related to project control. This deficiency in defining project control issues is very likely to be a factor contributing to the cost overrun since the project team did not well consider scope elements such as cost/schedule control, risk management and safety procedures. Poorly-defined project execution plan, procurement strategy, owner philosophy and design parameters might also be the contributing factors to the final cost overrun.

From Table 4, project execution has the greatest average definition level difference between schedule successful and less-than-successful projects. That means projects with worse schedule performance typically did not do well in defining scopes related to project organization, delivery methods, design and construction plan and requirements for substantial completion. Other factors that might impact the schedule performances are project design parameters, architecture plan and site information. From the surveyed projects, projects with poor schedule performance typically did not do well in defining scopes related to the above-mentioned aspects. It is very interesting to find that all four categories listed in Table 4 appear in Table 3 as well. That means these four categories are both factors that could impact the final project cost and schedule performances. The project team is recommended to put more attention on defining project scopes within these four categories at preproject planning stage so that the project is more likely to have better cost and schedule performances at completion.

5. CONCLUSION

Decisions made in the early stage of the project life cycle have significant impacts on final project outcomes. To ensure better chance of achieving project goals, it is important to prepare a better set of project definition package after the preproject planning process. CII has developed the Project Definition Rating Index (PDRI) to assist the preproject planning process. This easy-to-use tool has been widely adopted for the building construction industry in the U.S. For that the preroject planning practices vary significantly throughout the building industry in Taiwan. This research benchmarks the preproject planning practices through industry survey while incorporating the PDRI in the survey questionnaire. From end of 2007 to beginning of 2010, data from a total of 92 building construction projects are collected in most metropolitan areas in Taiwan. The collected data is analyzed and compared with the results from similar researches conducted in the U.S. Both of the results from Taiwan and the U.S. have shown that surveyed projects with better preproject planning (as measured by the PDRI evaluation) outperform other projects in both cost and schedule performances. The average cost growth for the better-defined projects is 5.85% lower and the average schedule growth for the better-defined projects is 7.62% lower than poorly defined projects. In addition, better-defined projects are less likely to experience change orders or lower percentage (0.76% vs. 6.93%) in dollar amount (change order cost/original estimate). Statistical analysis has identified certain categories of project scopes are better-defined for projects with better cost/schedule performances and they are project control, project execution, owner philosophy, design parameters, architecture plan and site information. From the survey, only about 37% of the building projects are well defined and they experienced better project cost and schedule performance. It is recommended that the building construction industry in Taiwan should put more attention on the preproject planning processes and thus the possibility of better project performances can be improved. It time and resources are limited, attentions should be focused on the scope elements within the six PDRI categories identified in this research.

REFERENCES

[1] Merrow, E. W. and Yarossi, M. E., "Managing capital projects: where have we been – where are we going?" *Chemical Engineering*, pp. 108-111, 1994.

[2] Gibson, G. E. and Hamilton, M. R., "Analysis of pre-project planning effort and success variables for capital facility projects," A report to Construction Industry Institute, Source Document 105, Austin, TX, 1994.

[3] Menches, C. L. and Hanna, A. S., "Conceptual planning process for electrical construction," *Journal of Construction Engineering and Management*, Vol. 132 (12), pp. 1306-1313, 2006.

[4] Gigado, K., "Enhancing the prime contractor's pre-construction planning," *Journal of Construction Research*, Vol. 5 (1), pp. 87–106, 2004.

[5] Gibson, G. E. and Dumont, P. R., "Project definition rating index (PDRI)," A report to the Construction Industry Institute, Research Report 113-11, Austin, TX, 1996.

[6] The Construction Industry Institute, "Pre-Peoject Planning Handbook," Special Publication 39-2, Austin, TX, 1995

[7] Gibson, G. E., Kaczmarowski, J. and Lore, H., "Pre-Project Planning Process for Capital Facilities", *ASCE J. Construction Engineering and Management*, Vol. 121 (3), pp. 312-318, 1995

[8] The Project Management Institute, "Project Management Body of Knowledge", Newtown Square, PA, 2000

[9] Smith, M. A. and Tucker, R.a L, "An Assessment of the Potential Problems Occurring in the Engineering Phase of an Industrial Project", A Report to Texaco, Inc., The University of Texas at Austin, 1983

[10] The Business Roundtable, Modern Management Systems, Report A-6, 1982

[11] O'Connor, J. T., and Vickroy, C. G., "Control of Construction Project Scope – Source Document 6", Austin, Texas: Construction Industry Institute, The University of Texas at Austin, 1986

[12] Gibson, G. E. and Dumont, P. R., "Project Definition Rating Index (PDRI)", A report to the Construction Industry Institute, Research Report 113-11, Austin, TX, 1996

[13] Merrow, E. W., Philips, K. E., and Myers, C. W., "Understanding Cost Growth and Performance Shortfalls in Pioneer Process Plants", R-2569-DOE, Santa Monica, California: RAND Corporation, 1981

[14]

[15]

Berlin, S., Raz, T., Glezer, C., Zviran, M., "Comparison of estimation methods of cost and durations in IT projects," *Information and Software Technology*, Vol. 51 (4), pp. 738-748, 2009.

[7] Kim, D. Y., Han, S. H., Kim, H., Park, H., "Structuring the prediction of project performance for international construction projects: a comparative analysis," *Expert System with Application*, Vol. 36 ((2) part 1), pp. 1961-1971, 2009.

[1] Flynn, L., "Developing a Winning Combination", *Building Design and Construction*, Vol. 44(3), pp. 26-32, 2003.

[2] Bell, J., "A Mixed-use Renaissance", *Mortgage Banking*, Vol. 5(8), pp. 66, 2004.

[3] Royal Institute of Chartered Surveyors, *Mixed Use Development: Concept and Realities*, RICS Research, 1996.

[4] Schwanke, D., *Mixed-Use Development Handbook*, Urban Land Institute, Washington, D.C., 1987.

[5] Royal Institute of Chartered Surveyors, *Mixed Use Development: Issues and Practice*, RICS Research, 1998.

[6] Culp, L., "Mixed Results for Mixed-Use", *National Real Estate Investor*, Vol. 45(8), pp. 24, 2003.

[7] Bell, J., "Mixed-use Property Review E Pluribus Unum: The Synergies of Mixed Use", *Midwest Real Estate News*, April, pp. 35-57, 2000.