COMPUTER AIDED COLLABORATION IN MANAGING CONSTRUCTION

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PREFACE

This report summarizes the findings of the research study undertaken at the Harvard Design School by Professor Spiro N. Pollalis and doctoral student Burçin Becerik in the period 2005-2006. The research focused on the benefits of online collaboration and project management (OCPM) technology to the design and construction industry, and identified direct benefits and indirect benefits in providing better service and entering new frontiers, in an effort to justify the investment. The research was based on nine case studies of implementing OCPM in actual projects and on analyzing aggregate data of thousands of projects, provided by the sponsors of the research. The research was supported by a consortium of sponsors consisting of (in alphabetical order):

Business Collaborator
Constructware
eBuild.ca
Meridian Project Systems, and
Primavera.

We wish to thank our sponsors for their generous support, all of the case study interviewees and the numerous individuals who participated in various ways in this research study. Especially, we would like to thank Tim Blower of Business Collaborator, Natalie Cheney of Constructware, Steve Carter of eBuild.ca, Sue Watkins of Meridian Project Systems, Christopher Bell of Primavera, Debra Kunce of Schmidt Associates, Steve Young of Indianapolis Public Schools, Todd Wilson and Harold L. Helland of Abbott Laboratories, Ed Costanza of Kitchell Corporation, Marek Suchocki of Atkins Management Consultants, David Page and Charlie Anderson of Los Angeles Unified School District, Brian Killion and Mike Parkinson of Manhattan Construction Company, Steve Head of Nationwide Building Society, Brett Pitcairn and Dennis DiPalma of P.J. Dick Incorporated.

This research report constitutes part of Burcin Becerik's doctoral dissertation entitled "Implementation, Operation, Adoption and Value of Online Collaboration and Project Management Technology in the AEC Industry", to be completed by June 2006.

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1. INTRODUCTION

The architecture, engineering, and construction (AEC) industry operates in a project environment, where a collective achievement by a diverse team of participants is required. These team members represent different disciplines with diverse educational backgrounds and even with different goals. Successful completion of a construction project depends on accurate, effective, and timely communication, formation, and then exchange of critical information among these project team members. To make this happen, elements of the AEC industry have started to move away from traditional communication methods, which are typically time- and labor-intensive resulting in higher costs and inefficiencies, and have started to rely heavily on online collaboration and project management (OCPM) technology[1].

Despite the benefits and the increase in use of OCPM technology, there is still a resistance from industry participants to adopting this technology in its full capacity and changing how work has traditionally been done (Björk, 2003). One of the primary motivators for the actors in the AEC industry to adopt new technology would be the opportunity for direct gains and benefits in their own operations. In order for the actors to realize these benefits, there must be a framework in place to measure the relevant costs and benefits associated with the OCPM technology investment. The problem of identifying and quantifying relevant information technology (IT) investment costs and benefits is neither new nor unique to the AEC industry. In fact, it is a global problem experienced in all types of business sectors and organizations (Hochstrasser and Griffiths, 1991), as many of the IT investment benefits fall into the soft (intangible) category and therefore lack the weight of clear revenue improvements. IT evaluation in construction is a particularly difficult, complex, and time-consuming process (Andresen et al., 2000), and the problems associated with assessing its benefits and costs seem to be more acute than in any other industry (Marsh and Flanagan, 2000). The reasons for this are the industry's peculiar size and structure, its fragmented supply chain and undercapitalization.

Although there have been some initial efforts to calculate the value of OCPM technology, there are no valid results available today to spur industry stakeholders toward faster adoption. The metrics to measure the rather complex causal chain causing overall cost savings and quality improvements have only been sketched and reliable measurements with large enough data sets to isolate the effects of the learning curve or external factors are missing.

In an attempt to bridge the need for an objective and comprehensive OCPM technology value measurement, Harvard Design School conducted research in collaboration with five OCPM technology providers (the Sponsors). The research team worked with the participating Sponsors and their selected customers (1) to understand the OCPM technology needs, implementation, and use and (2) to identify and measure the value proposition of both web-based (vendor-hosted) and web-enabled (self-hosted) solutions for construction project management, project delivery, and team collaboration as they are applied today. This book summarizes the finding in three steps: by looking at industry practices in OCPM technology implementation and use; by identifying soft and hard (tangible, intangible, and quasi-tangible) benefits of this technology; and by evaluating the value of the OCPM technology in its real-life context.

2. STUDY OVERVIEW

This research conducted at the Harvard Graduate School of Design is based on actual project data analyses. The information is provided by the participating Sponsors (in aggregated data format), the investors[2]/users of the technology (in case study format), as well as other users and non-users of OCPM solutions. The information is used to measure and validate the value of OCPM technology. The data collection ran from November 2004 through August 2005. Sponsors of this study are (in alphabetical order): Business Collaborator[3] (UK), Constructware[4] (USA), eBuild.ca[5] (Canada), Meridian Systems[6] (USA), and Primavera[7] (USA). Besides providing information, the Sponsors were asked to provide feedback and to participate in discussions and interim meetings. The study takes hard benefits into consideration and also focuses on the future and long-term advantages of OCPM technology and looks at OCPM technology investment's impacts on organizational culture and work conditions (Van Grembergen, 2001). In other words, the characteristics of OCPM technology investments across the boundaries of individual organizations are also discussed and reflected in the study.

2.1 Need

Leading-edge companies all over the world in all industries have increased their overall IT expenditures by double-figure percentages annually (Zee, 2002). Despite large investments in IT over many years, it has been difficult to determine where the IT benefits have actually occurred (Willcocks and Lester, 1999), if indeed there have been any. The lack of IT evaluation studies reduces the motivation to innovate and translates into unfortunately missed IT business opportunities. The problem in construction businesses is that IT has often been implemented as an act of faith, without fully understanding how business values from investment can be shown (Baldwin et al., 1998). Investors feel sure that there must be benefits from keeping abreast of technological innovation but have neither been able to predict what these benefits will be nor been able to measure them after the investment has been made.

The lack of frameworks to measure the value of OCPM technology (Brynjolfsson, 1993) or inappropriate measures to determine the value of these tools (Keen, 1991) and resulting skepticism have caused strong resistance from industry participants to adopting OCPM technology in its full capacity. Although this issue has attracted much attention in both academic literature and the private consulting industry, little is known about what types

of analysis are performed on technology investments in the construction industry, and there is no single study specifically focused on OCPM technology. The research reported here attempts to meet the need for an objective and comprehensive study of the return on investment in OCPM technology for AEC industry stakeholders.

2.2 The Challenges

In most cases construction organizations cannot afford not to invest in OCPM technology for competitive reasons, but economically they cannot find sufficient justification and evaluation to underpin the investment (Van Grembergen, 2002). The difficulties in measuring benefits and costs are often the cause for uncertainty about expected investments and therefore are major constrains on the investments (Van Grembergen, 2001). Several interesting problems interfere with the value proposition study. One of them is the time lag involved. OCPM benefits are usually derived long after the cost of the project incurred, and organizations need to go through a learning curve, so the benefits are sometimes not immediately obvious. Another problem is intangible benefits: these seem important but are not amenable to strict cash analysis and therefore lack the weight of clear revenue improvements. In addition, as the OCPM technology infrastructure becomes an inextricable part of the organizations' processes and structures, it becomes increasingly difficult to separate out its impact from those of other assets and activities. Moreover, there is a serious lack of collected and structured data. Similarly to other types of IT investments, it is extremely difficult to acquire data with regard to OCPM benefits and costs. Therefore, evaluation models conducted and marketed usually consist of various assumptions.

2.3 The Goal

The goals of this study are:

- To explore how OCPM technology investments have been valuable for the stakeholders of the AEC industry;
- To set examples of OCPM technology implementation (and use) best practices on the technical, organizational, strategic, innovations and alternatives levels;
- To provide senior management with a framework to measure potential benefits of OCPM technology, provide good stewardship of resources, and develop improvement strategies;
- To help bridge the communication gap between business executives and suppliers of OCPM technology by replacing opinions by facts;
- To enable an organization to compare the merits of a number of different investment projects competing for limited resources;
- To provide a set of measures which enable the organization to exert control over the investment (Farbey et al., 1999);
- To serve as a learning device to improve their systems, implementations, and capability by looking at several OCPM technology implementations.

By having a better understanding of OCPM technology's capabilities and functionalities, organizations can support their business objectives and provide guidelines for future business expansions. The research seeks to set examples for organizations to gain competitive advantage, to develop new business, to improve productivity and performance, as well as to provide new ways of managing and organizing (Earl, 1988) their projects and business processes.

3. METHODOLOGY

3.1 Evaluation Methodology

There is no industry standard for the definition of investment value in the IT area. Andresen's literature search identifies as many as 82 methods and there are, without doubt, many more as new methods are being developed continuously (Andresen, 2002). In his research, he categorizes these methods in three areas: financial methods, qualitative methods, and quantitative methods.

The early financial investment appraisal methods are primarily based on financial measures such as return on investment (ROI), discounted cash flow, internal rate of return (IRR), net present value (NPV), profitability index, cost benefits, payback period, and present worth. These methods, however, are found to be inadequate when used to evaluate IT investments because of their use of only one measure: the monetary value. They largely exclude the significant problem of risk, as well as costs and benefits that may be difficult to quantify (Brown, 1994). Those benefits which are intangible (soft) appear to be written off as unquantifiable and thus beyond any effective measurement technique. As a result, more complex methods have emerged, designed for evaluation of IT investments. Some of these are information economics[8] (IE) (Parker and Benson, 1988), return on management[9] (ROM) (Strassmann, 1990), and scalable systems software measurement and evaluation[10] (SESAME) (Willcocks, 1992). These complex methods are, however, rarely used in the AEC industry for a number of reasons: because of lack of awareness of the methods; because of the methods' large operation requirements; and because some critical problems are still not solved with these methods.

In order to consider both quantitative and qualitative benefits, this study uses concepts from two evaluation methods: *measuring the benefits of IT innovation*[11] (Baldwin et al., 1998) and *information economics* (Parker et al., 1989). The goal is to demonstrate financial and non-financial impacts together to determine the (business) value of OCPM technology.

3.1.1 Benefit Analysis

Value is based on advantage achieved over the competition, and it is reflected in current and future business performance, which management should be willing to invest in (Parker et al., 1989). In other words, value is a function of keeping up with the competition

and a major source of pressure justifying investment in IT. Innovation is often viewed as something undertaken by very few within the construction industry (Baldwin et al., 1998). *Innovation* creates new functions within the business domain. It changes the way the enterprise conducts its business. Innovative IT applications provide a vehicle to change business strategy, products, and services. Cost is defined as a measure of the amount of resources required to obtain a product or service (here, OCPM technology). *Benefits* take the forms of cost savings, cost avoidance, generation of new revenues, and intangibles. Three types of benefits are identified and have been used as the framework for this study. These are:

(1) Tangible benefits, the rate at which inputs are converted to outputs. These are quantifiable and measurable in monetary terms.

(2) Quasi-tangible benefits, the rate of actual outputs compared to planned. The focus is most often on improving the efficiency of an existing organization and processes that are quantifiable but difficult to measure. They are the ability of a program, project, or work task to produce a specific desired effect or result that can be measured. The quasi-tangible benefit group has some measurable elements, but not in monetary terms. Some examples of quasi-tangible benefits are: improved resource control, improved information availability, enhanced decision making, etc.

(3) Intangible benefits, the level of new outputs enabled. The focus is most often on improving the effectiveness and performance of the organization. Intangible benefits are neither quantifiable nor easy to measure but are the most important benefits for the investor in the longer term. Intangible benefits are the reasons for doing things that measurable benefits can't justify. Intangible benefits include: better risk management, gained market access, improved competitive advantage, etc.

	New Frontiers – Intangible Benefits	Increased Value – Quasi-tangible Benefits		Savings – Intangible Benefits		
	SOFT BENEFITS	**SOFT BENEFITS**		**HARD BENEFITS**		
	new income / value	increased income / value	avoided costs	new income / value	increased income / value	avoided costs
Project Level Benefits	•ability to refer back to data •enables international links •better information version control •better forecasting and control	•decreased work flow turnaround •improved quality of the output •better communication; fewer information bottlenecks •greater integration and process automation •improved idea sharing among team members •improved capture of design/construction decisions	•reduced errors and omissions •minimizing project risks •advanced purchase of materials	•improved project delivery; early occupancy		•reduced/saved staff requirement •reduced transaction costs •decreased # of RFIs/Change Orders •reduced storage requirements •reduced litigations and discovery costs
Organizational Level Benefits	•Improved company image •Gained market access •Improved customer relationships •Gained negotiation power •Strategic competitive advantage •Claims mitigation and management •Forecasting •Knowledge management •Process re-engineering	•improved data availability •improved audit trail •improved information management •faster reporting and feedback •accurate/timely information to give valid/accurate decisions •improved process automation •improved version control •better project/program control •timely capture of decisions •fewer information bottlenecks	•reduced mistakes •better risk management			•decreased # of RFIs/Change Orders •decreased spending on administration staff & materials •reduced communication costs •less service workers •reduced litigations and discovery costs

Figure 1. Tangible, quasi-tangible, and intangible benefits at the project and organizational levels

Performing the right tasks correctly, staying consistent with the organization's mission, vision, and values, and supporting its goals and objectives – as well as providing an ability to measure all this – could be among investors' most important goals in deciding to implement an OCPM technology. The nature of modern business is such that, increasingly, senior managers are required to think beyond the direct tactical issues of tangible and quasi-tangible benefits, toward more strategic issues. Business performance, in its broadest terms, is a major strategic issue and one that OCPM technology has much to contribute to. A major argument of this study is that OCPM technology's benefits in construction extend beyond the tactical into strategic business performance improvement.

When considering the implementation of a new OCPM system, it is essential to understand whether the investors seek tangible, quasi-tangible, or intangible benefits, or a particular combination of these. In some cases, the focus is on *organizational-level benefits* rather than individual *project-level benefits*. In order to assess the value of OCPM technology, it is essential to identify and investigate real-life implementations. In order to do so, the research team worked closely with the OCPM technology providers, users, and investors, and identified potential benefits and values of OCPM technology as shown in the figure.

3.1.2 Cost Analysis

Cost is a measure of the resources required to obtain a product. The costs associated with IT are often perceived to be easier to estimate than the benefits, though Hogbin argues that this is rarely the case (Hogbin and Thomas, 1994). Identifying the costs related to an OCPM technology investment is challenging first because this is a sensitive issue for both the investors and the vendors. During data collection, some of the investors mentioned their desire not to publicly disclose the exact cost of their OCPM system: the costs associated are considered to be commercially sensitive due to some political and organizational factors. Second, there is no established structure for OCPM solution costs or cost structures. Third, a growing portion of the expenditures is invisible and therefore not (actively) managed by management.

Therefore, in this study the term "cost" is limited to the fees for licenses, ongoing maintenance (yearly service contract) fees, operating costs in terms of fees, implementation (installation and configuration), training, development, and customization (reengineering of business process to suit the solution, etc.) fees. Hardware costs, software costs (relational database software, additional networking software, etc.), overhead (electricity, toner cartridges, disks, etc.), staff and management resource costs (administration, marketing, procurement, dedication, employee training, etc.), indirect organizational costs (productivity losses during adapting to the system, procedures, guidelines, covert resistance to change, redesign of organizational functions, processes, and reporting structures, etc.) (Love and Irani, 2001) are not included in the study. Due to the sensitivity of the matter, some costs are given as a ratio to the overall project or program cost.

3.2 Data Collection

Four types of data collection methods were followed by the research team: case studies, a survey, interviews, and aggregated data analysis, each to some degree interlinked with the others. To define the linkage between the technology and business performance, some understanding is needed of the business itself, and of its structure, objectives, and interactions with customers, suppliers, and the rest of the economic environment (Parker and Benson, 1988). Therefore, the research team started with identification of the business cases in collaboration with the Sponsors. Potential benefits were identified and weighed.

The assessment technique was selected according to the investor's focus on intangible, quasi-tangible, or tangible benefits or a combination of these. Realized benefits were documented by following the right methodology as discussed in the following subsections. Finally, the benefits/values were evaluated in close consideration of the initial goal of the investor as well as their impact on the business goals and performance.

3.2.1 Case Studies

A highly appropriate method for satisfying the objective of the study is the case study method. The research team worked with the Sponsors to identify OCPM technology users and investors. As a result, a total of nine case studies were prepared as the basis of the study. While these organizations cover a range of industries (pharmaceutical, financial, construction, education, and manufacturing) and organizational structures, they still represent a reasonably homogeneous group in relation to the scale and complexity of their OCPM technology infrastructures and provide a rich source of data for development of the "best practice" sought. The names, locations, and business focuses of these firms are:

Construction:
- -Kitchell Contractors, USA – *general contractor/construction manager*
- -Manhattan Construction Company, USA – *general contractor/construction manager*
- -P.J. Dick Incorporated, USA – *general contractor/construction manager*

Financial:
- -Nationwide Building Society, UK – *public owner*
- -ITG Group[12], UK – *private owner*

Pharmaceutical:
- -TRM Healthcare[13], USA – *private owner*
- -Educational:
- -Indianapolis Public Schools, USA – *public owner*
- -Los Angeles Unified School District, USA – *public owner*

Furniture manufacturing:
- -Inscape Corporation, Canada – *supplier*

Semi-structured face-to-face and phone interviews with senior company personnel including business and IT managers as well as the users of the OCPM technology (project managers and collaborators of the selected projects; engineers, architects, suppliers, etc.) were conducted in order to obtain different points of view. In addition, access to selected projects' OCPM solutions was granted to observe, review, investigate, and record issues in more detail. Other documentation acquired in various case studies includes items such as agendas, meeting minutes, administrative reports, budgets, project statistics, and files.

Using these data collection methods, it has been possible to focus on the crucial issues of the research. It also helped to evaluate and compare data from the survey as well as from each interviewee, to clarify doubts, to ensure that the responses have been properly understood by repeating or rephrasing the questions, and to pick up nonverbal cues from the respondents (Sekaran, 2003). An overall structure to the interviews was given by a number of specific questions set up by the researcher before the interviews. Within this broad structure the interviewees were encouraged to talk about issues that seemed important to them (Burns, 2000). The main goal was to develop a framework based on the fit between theory and practice in the evaluation of OCPM investment in AEC projects. The complete interview protocol and specific questions include the purpose of the study,

the issues that need to be further clarified and interpreted from the results of the questionnaire, the propositions being investigated, the operational procedures for getting data, the sources of information, and the questions and lines of questioning.

3.2.2 Survey

An electronic survey was designed and emailed to all interviewees to measure quasi-tangible benefits of OCPM investments. Each respondent received an identical list of possible benefits, phrased in exactly the same way, which they were asked to rank for their relevance to their own project. Errors resulting from the recording of responses by interviewers were thus reduced, and respondents were given the freedom to rank these benefits at their own pace. To get more truthful responses, it was guaranteed that the answers would be kept confidential. Personal appearance, mood, or conduct of the interviewer were not factors in completing the questionnaire. The survey covered several benefits that were brought into the conversation during the interviews. The aim of the survey was to uncover as much information as possible and to measure quasi-tangible benefits of OCPM technology investments. The responders were asked to rank the benefits on a scale of 1 to 5, where 5 is "very high," 4 is "high," 3 is "neutral," 2 is "low," and 1 is "very low." The results from the questionnaire were also compared to the results from the case studies. The benefits that project team members were asked to rank were:

- Improved process automation (RFIs/change orders, automatic updating of master budget, etc.)
- Provided accurate and timely information to give valid/accurate decisions
- Enabled fewer information bottlenecks
- Improved information management
- Improved data availability
- Enhanced working within virtual teams
- Improved timely capture of design/construction decisions
- Enabled faster reporting and feedback
- Reduced personnel costs due to improved efficiency
- Enabled having complete audit trail
- Improved idea sharing among team members/within organization
- Improved project relationships with strategic partners
- Enabled better project/program control
- Enabled better resource allocation; more effective assembly of project teams
- Enabled better forecasting and control
- Improved quality of the output
- Minimized project/business risks
- Enabled advance purchase of materials
- Reduced delivery lead times
- Reduced errors and omissions
- Enabled better inventory management
- Enabled more effective identification and assessment of new suppliers
- Enabled faster launch to market due to faster delivery
- Improved public relations
- Enabled quicker response to project status and budget
- Improved information version control
- Reduced rework/data reentry

3.2.3 Interviews

Besides the interviews for the case studies, a number of interviews were conducted with industry experts and with OCPM technology users and non-users who didn't or couldn't participate in the case studies for confidentiality reasons or due to insufficient resources. A total of 102 interviews (including case study interviews) were undertaken with 82 industry stakeholders from December 2004 through July 2005. These interviews were undertaken in order to obtain opinions of investors and users from different industries and/or those who were utilizing or not utilizing OCPM technologies. The research team made observations and then compared the results gathered with the case study and survey results.

3.2.4 Aggregated Data

Sponsors were asked to provide aggregated data from their databases. For each category of data, the team was able to analyze between 5,000 and 47,000 projects submitted by the Sponsors. The information asked was:

- Project type (retail, office building, industrial, educational, etc.)
- Project value (0-$1M, $1M-$10M, $10M-$50M, etc.)
- Project status (planning, design, bidding, permitting/approval, construction, close out, etc.)
- Number of clients, by type (subcontractors, consultants, general contractors, owners, CMs, etc.)
- Duration of use of OCPM solution (0-0.5 years, 0.5-1 years, 1-1.5 years, etc.)
- Type and percentage of entries in the OCPM tool (submittals, transmittals, drawings and specifications, documents, daily reports, correspondence, RFIs, submittals, meeting minutes, change order requests, etc.)
- Percentage of active users (define active as more than 10 logins per month)

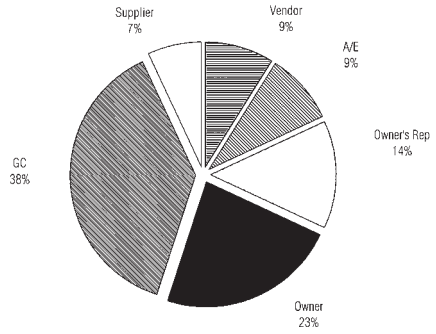

Figure 2. Backgrounds of the interviewees

4. INDUSTRY PRACTICES

4.1 Buyers and Users of OCPM Technology

The research shows that the major investors in OCPM technology are large and mid-size general contractors, and long-term owners whose core businesses are not construction but who need to keep and maintain buildings, such as banks, pharmaceutical companies, schools, and automobile manufacturers. Based on 46,500 projects, 67% of OCPM investors are owners, general contractors, or construction managers. Additionally, it is not a coincidence that investors in 5 out of 9 case studies are public and private owners, and in 3 out of 9 are general contractors and construction managers. The reason for this is the direct benefits these parties realize more than the other stakeholders. It is obvious that long-term owners are interested in having their buildings on time, on budget, with the highest possible quality. For some businesses such as manufacturing (e.g. pharmaceutical) and financial institutions (e.g. bank braches), it is crucial and very favorable to reduce project schedules, as each business day means additional revenue for these organizations. In addition, these investors consider details such the use of information created in design and construction phases in maintenance and operation phases.

The profile of OCPM technology users changes depending on several factors including project type, team and power structure, and implementation strategy. However, owners, general contractors, construction managers, and architects/engineers are among the most active users of OCPM technology. Additionally, general contractors and construction managers are, typically, mandated to use the OCPM solution by the owner. Subcontractors are usually not amongst the most frequent users; in fact, they usually have limited access to the OCPM solutions for cost and security reasons. When they do have access, they rarely use the systems because most are not technology-savvy, usually the benefits miss them, and they are not permanent members of the project team.

4.2 Need for OCPM Technology

Execution of construction projects requires working with several parties including owners, general contractors, subcontractors, architects, engineers, consultants, and suppliers. The ultimate reason for investing in OCPM technology is to facilitate transparent and continuous communication with the entire project team as well as with the internal staff. Another good reason is to facilitate construction workflows such as requests for information (RFI), change orders, and submittals and to share construction documents such as drawings and

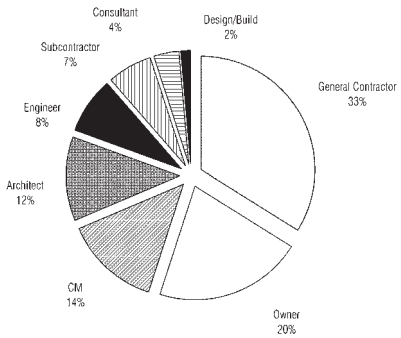

Figure 3. Clients of OCPM vendors by count, based on ~ 46,500 projects (Sponsors' aggregated data)

specifications. Besides facilitation of team communication and construction processes, organizations aim to:

(1) Create standards and specific policies: Unify the project execution and enforce the teamwork among project participants while providing a structured way of managing projects' information,

(2) Enable information availability and control: Increase information visibility by centralizing all project information. This enables the ownership and security of the project information by maintaining a complete audit trail (eliminating the risk of data being lost and not knowing who did what when),

(3) Improve project control and management: Record all activities happening on construction sites to monitor and control every project in a timely manner from the main office, especially when there are several projects in the portfolio,

(4) Gain competitive advantage: Provide a better service to the owner and increase market share by building and maintaining relationships,

(5) Gain efficiency: Improve collaboration, review, and turnaround time with version control, smooth information flow, and dynamic routing of documents and notifications.

4.3 Selection Process

Investors follow different strategies to select their OCPM solution. In several cases, renewed agreements based on experience with the OCPM solution and provider were observed by the research team. The selection process is carried out by *consultants*, the owner's *project/program managers*, and/or the *organization's technology department*. The first issue to consider is whether to implement a *web-based* or a *web-enabled* solution, depending on firewalls, security, sensitivity, and resources (hardware/software/personnel costs). The second issue is the *stability of the vendor*, including responsiveness, company stability, system integrity, and the company's training availability.

Usually, the investors start by reviewing the well-known OCPM solutions on the market. With an increasing demand and common understanding, investors search for a product that would match their processes. They believe that the system needs to be closely linked to the overall business strategy of their organization. Several systems' functionalities are, usually, compared against the organization's multi-project requirements and control capabilities. Although the level of integration depends on the organization's needs, *customization*[14] and/or *tailoring*[15] are usually asked from the vendor as part of their services. The investor's team usually formulates a list of assessment criteria and prioritizes them. Sometimes, investors issue a request for qualifications (RFQ) from the vendors. Some of the selection criteria are:

- Flexibility and usability,
- Customizability,
- Ease of use and learning,
- Features: document and process management features (built-in viewers, auditing and processes/documents supported, reporting, sorting and redlining drawings, version control, etc.),
- User interface: external email notification, client system/bandwidth requirements, intuitive "out of the box," content customizability on the personal level,
- System administration: multiple levels of security, audit trail, level of customization, the ability to browse external archives, broadcast messaging, etc.,
- Vendor stability: responsiveness, company stability, system integrity, training availability, etc.,
- Cost structure: both purchase and operation/maintenance costs.

Short-listed vendors are usually asked to give hands-on demonstrations of their solutions to clarify information. The investors usually ask additional questions and request vendors to walk them through some specific features during demonstrations. If the OCPM solution is customized, testing takes place on pilot projects. Regardless of an RFQ process, a demonstration, or a testing, the investors always rely on recommendations of past and current users of OCPM technology.

4.4 Cost Structure

The *cost*[16] is a sensitive issue both for the investors and the vendors. Some of the investors don't want to publicly disclose the exact cost of the systems. The costs associated with the developments, licenses, and training are considered to be commercially sensitive. There is no industry standard for OCPM solution costs or cost structures; there are several cost structures offered by the vendors.

(1) Subscription base: Based on memberships; there could be different kinds of memberships with different levels of functionality and access. Organizations can choose to subscribe on a monthly basis or prepay for an annual agreement and renew their agreement every year. This gives them flexibility based on work volume or whether they dictate the project management method used on a particular project.
(2) License plus maintenance fee: One-time user licenses are paid by the investor, maintenance and support fees are paid annually.
(3) Negotiated fixed cost: Corporate-wide agreement (enterprise license) negotiated with the vendor based on estimated number of users, customization level, etc. The contracts are either 3 or 5 years long with unlimited number of users, projects, and storage or a combination.
(4) Exclusive business partnership agreement: Fundamentally a license re-sell agreement. The investor acts like an agent of the OCPM vendor and gets a percentage of the sold fees.

If the owner is providing the OCPM solution, they usually cover the costs for the rest of the team, provide the tool, and mandate the use of it to all project participants. They believe this will enable them to realize problems early in the process and that they will be able to monitor the overall program in a more efficient way. If an AEC stakeholder brings the tool on board, they usually bill the cost to the owner.

4.5 Implementation Practice

Project teams increasingly realize the importance of allocating resources in OCPM solution implementation. For better buy-in, the investor purchases the rights to use the software and make it available to the entire team and provide training sessions for all. In successful implementations we notice a steering committee within the company – executives, project managers, secretaries, IT and accounting professionals – to oversee the implementation and use of the tool internally. This committee develops and reviews the implementation checklists and defines how the solution will be set up and used, how the business will be run, what features are going to be used and how. If the investor doesn't have resources to handle the implementation in-house, usually an implementation service from the vendor or recommended third party is purchased. Successful implementations need identification of an application sponsor, a champion (Castle, 1999), on a team and definition of the processes and procedures for the project. An early tactical step is to contractually mandate the training and the use of the OCPM solution for every participant.

Customization or Tailoring:

Depending on the needs of the investor, the OCPM solution might need to be extended and enhanced to cover the activities involved in the organization's projects from physical delivery to implementation management, with a continuous improvement loop built in. Sometimes the whole program management regime has to be reengineered. Although project workflows are documented as best practices, they aren't defined in detail and implemented truly in the organization's projects prior to standardization of the OCPM solution. In this case, investors usually work with the vendor and consultants to customize or tailor the tool according to their needs or (if applicable) modify the process to suit the technology.

Evaluation and enhancement:

In some cases, after customization of the tool the organizations go through a testing by implementing the tool on pilot projects and organizing workshops with selected users to refine the system. If this is the case, analysis and evaluation are given a key focus. This might continue throughout the system implementation as the processes themselves might change by the introduction of new technology. Early users and those who attend evaluation workshops significantly influence the system functions. In these workshops, procedures, templates, and types of data to work with are established. In some cases, the processes are created if the organization is not working under a process model. This involvement of the first users helps encourage the adoption of the system. Essentially, it gives the organization an advantage to overcome cultural difficulties by engaging the key users in the development process and by providing them a more efficient working method.

Training:

Training and getting users to "buy in" to the system is crucial for gaining financial and process benefits from OCPM technology investments. Typically, it is either the owner or the general contractor who brings the OCPM solution on board. On a successful implementation all stakeholders – including subcontractors – get training by the OCPM investor's personnel (if available) at least once, if not more. If there are no in-house resources available for training, investors use a third-party provider recommended by the OCPM vendors for training the team members. These training sessions are usually private one-to-one sessions with flexible schedules that accommodate trainees' schedules. There might be extended training, whether one-to-one or over the phone if the users have additional questions or if they are not comfortable enough to use the system. Weekly continuing educa-

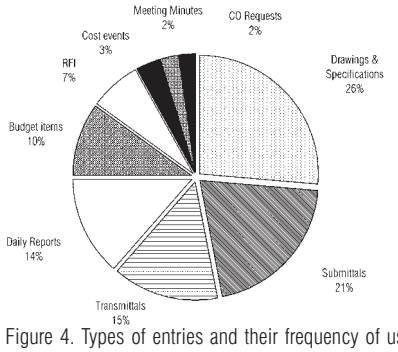

Figure 4. Types of entries and their frequency of use (number of projects using them), based on ~ 46,000 projects (Sponsors' aggregated data)

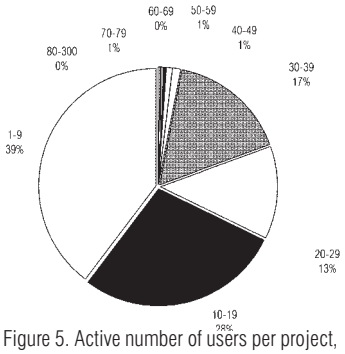

Figure 5. Active number of users per project, based on ~ 46,600 projects (Sponsors' aggregated data); the average number of users per project is 13.3 persons

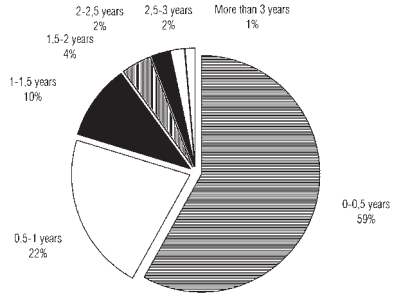

Figure 6. Duration of use, based on ~ 5,700 projects (Sponsors' aggregated data); the average duration of use is 8.2 months

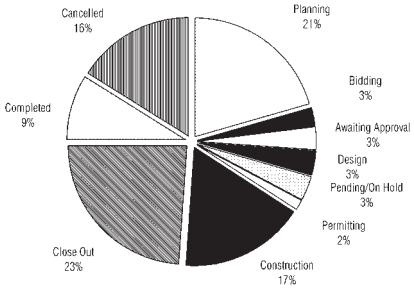

Figure 7. Project status, based on ~ 30,000 projects (Sponsors' aggregated data)

tion sessions are also available to the users via a free online meeting service provided by most of the solution vendors. Usually, the training costs are covered by the investor of the OCPM solution.

Administration:

The OCPM technology investor or the construction project usually has in-house administrators or assigned team members who are responsible for day-to-day operations, including the project's setup, administration, the tool's speed, etc., and they provide assistance to both internal and external users. The investor owns all the data at the end of the day. If the investor is the general contractor, typically they turn all project information over to the owner at project completion.

4.6 The Use of OCPM Technology

Projects use various modules. However, the most commonly used OCPM solution modules are the *document management* and *cost management modules*, including budget items, contracts, purchase orders, invoices, cost events, drawings and specifications, submittals, transmittals, daily reports, document and drawing logs, meeting minutes, and RFIs. Most projects use the OCPM solution to share cost information only in a limited way; usually, the cost-related information is for internal use. Most of the documents are created and transmitted electronically unless they are legal documents requiring signatures and/or stamps such as change orders, architect's instructions, shop drawings, etc. The traditional paper process is followed by the project teams (1) if the construction sites or all parties are not connected; (2) if the document size is too large to review through the OCPM solu-

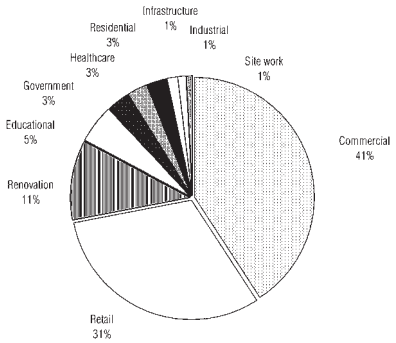

Figure 8. Project types, based on ~ 17,900 projects (Sponsors' aggregated data)

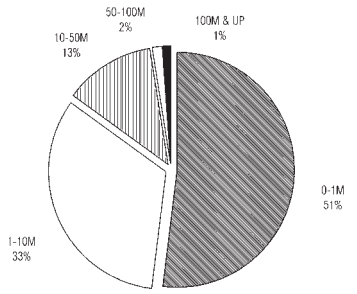

Figure 9. Project costs, based on ~ 10,000 projects (Sponsors' aggregated data); the average cost of projects is $7.3 million

tion, such as shop drawings, which are expensive to scan and print and reviewing them digitally is difficult; (3) if the submittal is a physical object, e.g. a brick sample; and (4) if the team wants to have a backup record for internal reasons.

The construction team, especially general contractors, project and construction managers, consultants, and owners, are among the most frequent users of OCPM solutions. Based on data from 46,600 projects, the average number of users is 13.3 persons per project. 67% of the 46,600 projects have 20 or fewer users. Although there are some examples of subcontractors having significant participation, subcontractor participation is rare compared to the rest of the team members. Some owners leave the level of use to the project managers and team members, while others mandate the use of the tool by making it a requirement in the contract. Successful implementations are the ones in which the managers make it clear that if a document is not in the OCPM solution, it is not official and it doesn't exist.

Some investors have a certain dollar value threshold – e.g. $100,000 – to implement and use the solutions. Others use the tool regardless of the dollar value of the project or the number of participants. Average duration of use is 8.2 months, based on 5,700 projects' data.OCPM solutions are used in most stages of projects but mostly in planning and construction phases. Out of 30,000 projects, 21% of the projects registered are in the planning stage and 49% are either in the construction or the close-out stage or already completed as of July 2005.

Besides the regular use of OCPM solutions for sharing information and for facilitating communication and construction processes, the research team observed some innovative ways of OCPM solution use, which will be discussed in detail in the following sections. Some examples are the use of OCPM technology:

(1) As a knowledge management tool: To capture and then distribute business knowledge and strategy, project information, best practices, and experience gained from different consultants, suppliers, contractors, and projects;
(2) As a business development tool: To provide the OCPM solution as part of the organization's services in order to build long-lasting relationships with customers, increase the investor's negotiation power, and increase its market access;
(3) As a forecasting tool: To report and have accurate information. Used by some public entities. Categories for budget (current, pending, estimated, adjustments, projected) and commitments (original, approved revisions, pending revisions, estimate to complete,

anticipated) are built to compare anticipated costs vs. projected budget so that the managers have a good track of what funds are available for each project and what has been spent to date in any given region/project.

4.7 Suitability of OCPM Technology

According to the interviews, case studies, and aggregated data analysis, it is evident that OCPM technology is suitable especially for multiple repetitive projects, for several reasons. Obviously, economies of scale is one of them. Having several projects in one system gives control to the owner; they can look across projects and compare very quickly, stop and divert something before it happens. In addition, this gives owners the advantage of reduction in construction management costs with the assumption that these systems will reduce the number of construction managers in a program and lower the transaction costs. The investor can learn from their mistakes as well as other peoples' experiences. In addition, the investor can have the leverage to set standards for repetitive projects such as renovations. Having several projects in one system also gives an advantage in negotiating the cost with the OCPM vendor and enables the investors to customize the solution according to their needs.

In addition to the advantage of having multiple and repetitive projects in one system, the research shows that these tools are used very extensively during the construction phase as opposed to the design phase. The reason for this could be the nature of design and construction. In the design phase, there are fewer players collaborating. Although these parties are quite advanced in using design related software, they have only touched the surface as it relates to using tools to improve productivity and collaboration. In construction, however, information needs to be in one place and controlling dissemination of the information is crucial for transparent communication and execution of work. There are many parties who execute orders and they are interdependent; the work of one depends on the other. In addition, having a complete record of the communication during the construction phase is advantageous in case there are any construction disputes.

4.8 In the Absence of OCPM Technology

The question: *"what would you lose if you didn't have the system in place?"* was asked to all interviewees. According to the top management, not having the system is a major risk. Those interviewed commented that without an OCPM system, they would lose:

(1) The ownership of the data, and therefore *an advantage in resolving disputes:* Interviewees mentioned several times that if they didn't have the OCPM solution in place, they would have to use hard copies and multiple technologies, which would result in disadvantages in resolving disputes because they wouldn't have records of the timing and sequence of things happening and who was involved. They would lose the ownership of the data, and if the project went to litigation getting the information from vendors and collaborators would be extremely hard, as unfortunately many have experienced before.

David Page, Los Angeles Unified School District's Facilities Information Systems' OCPM implementation leader, comments, *"The lack of communication in the project will create confutation and if you have confutation, you will have separation. If you have any of these three then you have a problem in the project. Separation creates the lack of communication so you get into the cycle. What you want to do is to break that cycle and make sure that everybody is getting the information they need." And he adds, "I would pay whatever the price is to use the system if we stop using it, because I believe it will save me in the long*

run. I have seen cases where one claim can save the entire system's costs. And I don't have any headaches. As a matter of fact, if they don't want to do that I might pay for the application out of my pocket."

(2) The control of the overall program: According to upper-level management, the greater value is the ability to manage a program's risk. The solution provides visibility and awareness to all parties inside and across the project team. Having knowledge of the contractors' progress helps the managers to control the projects better, especially when there are many projects and contractors in the portfolio. Knowing what your status is day-by-day is critical to ensure that your projects are on track and under budget.

Debra Kunce, program manager at Schmidt Associates, says, *"Our OCPM solution is a central point of information. From the owner's perspective, you can look across projects and compare very quickly. At some point we knew it would get overwhelming for communication among numerous parties, and we wouldn't be able to handle it. At that point these systems are priceless."*

(3) The decision-making advantage: The ability to get the information in front of the right people immediately has been very important for users and investors. In most construction projects, managers run into situations where there are disputes among the professionals and contractors. Having an OCPM solution in place provides the right information to evaluate the situations and to give the right decisions. Michael Imbergamo, project architect of SmithGroup, confirms, *"The tool really helped us with the schedule. For example, there have been critical issues. We don't have to follow the normal way of processing the information. We are not tied to the individuals as we used to be in the past. The information is readily available with a couple of clicks."*

(4) The efficient communication and coordination: The ability to fast-track information in and out between contractors and subcontractors and have timely access to project-related information is very convenient with the OCPM technology. The system ensures that when a participant runs into a problem, at least one person from that company sees that issue the same day it occurs and responds to it immediately. The other team members are also able to notice that information within a couple of hours. This is very critical for keeping construction projects on time. Users think that without the OCPM solution they would lose the accountability and the accessibility of the information, which would result in mediocre communication and less trust between the collaborators. Ed Costanza answers the question from the Kitchell Contractors' point of view: *"If we didn't have a system like this, we would be less efficient, and efficiency is critical when you're dealing with liquidated damages contracts. For us, this is the best system."*

(5) The information accessibility and availability: If project teams didn't have the system, the distribution of documents would be a problem, whereas with the OCPM solution the teams can do it in real time instead of needing 2-3 days to update technical documents, print, and send them. By implementing the system, project teams eliminate the whole distribution and administrative exercise. The ability to have a single reference point and depository for each project reduced the turnaround time for RFIs, submittals, and change orders. The information is available to everybody anywhere; there are no physical boundaries or worries about transfers. If they didn't have an OCPM solution, the people would be less responsive because they would be less aware of the issues.

Steve Young, program manager of Indianapolis Public Schools, says, *"Frankly it keeps people honest, and that is difficult to quantify. I cannot say what my cost would be if I didn't have the OCPM solution, but the savings are sufficient for me to make the investment."* Brett Pitcairn, project manager of P.J. Dick, comments, *"If we didn't have the system in the CMU project, we would lose our ability to maintain the tight schedule. It helps us to expedite compared to traditional methods."*

(6) The ability to enforce workflow and data population: Most importantly, if project teams hadn't implemented the system, they wouldn't have the work processes rethought and reengineered. They would lose the ability to enforce data population, and information management would be chaotic again. Marek Suchocki, research and innovation manager at Atkins Management Consultants, says, *"Although the work was considered well understood, adoption of the OCPM tool provided an appreciation of the wider business process."*

(7) The standardization: Some teams achieved standardization throughout their projects by implementing an OCPM solution, which would not have been possible without a system in place. Robert Harrison, support manager of Nationwide's OCPM solution, comments on what would have happened if they hadn't implemented the solution: *"We would lose time, quality, cost, ability to talk directly with a large number of people at any time, accessible record and data storage facility, performance enhancers, members' experience enhancements, technology and project management improvements, contractors' key performance indicators, and best practices capture."*

(8) Individuals' time: If the investors didn't have an OCPM system, the level of frustration would increase, the productivity would decrease, and therefore both teamwork and collaboration would lose operational capabilities. They would be spending more time using less fluent and more cumbersome ways of communication, and the project participants would be wasting their time working on different versions of the drawings.

Julie Ernzen, project engineer of Kitchell Contractors, comments, *"If I didn't have the system in place, I would have 10 times more paperwork. I would spend more time sending documents back and forth. The tool gives us an opportunity to work in a more structured way."* Harold Heit, manager of project engineers at TRM Healthcare, says, *"We would be back where we were before implementing our OCPM solution. People would be looking at different versions of the drawings. We would be spending a lot more money to ship drawings all over the country. And we would be spending a lot more time because not everybody would be working on the issue from the same drawing."* Jacquie Spencer, project coordinator of Inscape, comments, *"If we don't have the tool we will go back to extended response times because we will be dealing with overnights and time zones. Not having an OCPM system in place can slow down our process seriously."*

(9) Competitive advantage: In some cases, if the organization didn't have the system, they would lose an opportunity to increase their sales and enhance their relations with their customers. They would lose their responsiveness to customer needs and requests. Dan Kennedy, sales analyst at Inscape, comments, *"Getting involved in the project sooner! This is one way that we can spark up in the conversation sooner. And this is extremely important for our sales."*

4.9 Success Factors

Successful implementation of a new and innovative technology in construction requires development of strategic implementation plans ahead of time (Betts, 1999). There are three cornerstones of a successful implementation: vision; commitment; and reengineering possibilities (Stewart et al., 2002). The success of OCPM solution implementation depends on the project manager's and the owner's willingness to use this technology. Having senior management heavily involved in the development effort helps overcoming hidden phobias, thereby reducing the resistance to changes.

The OCPM solution should be factored into the overall program plan early on. Business processes should be designed around the solution's capabilities or the tool should be customized to fulfill the organization's processes. The organization's corporate culture, planning and control style, organizational size, organizational structure (e.g. mechanistic vs. organic), and management style (e.g. entrepreneurial vs. conservative) should be considered. Evaluation of budgetary requirements, the study of time and organizational constraints, the elaboration of human resource issues, management and plan coordination, migration and diffusion are important factors to consider (Stewart et al., 2002). There should be proactive arrangements for training users and companies that will be executing the work. Successful implementations need clear definition of the processes and procedures and identification of an application sponsor (champion) on a team. An early tactical step is to contractually mandate the training and the use of the OCPM solution for all parties. Consideration should be given to the continual performance monitoring of the implemented OCPM technology over its life cycle. There should be performance measures and data collection strategies in place to get continuous benefits from the OCPM technology investment.

4.10 Plans for the Future

The study shows that the investors and users of OCPM technology are convinced that this technology contributes positively to their business and operations. At the same time, they are aware of changes they should implement. There are several trends developing currently in the industry. Some are:

(1) Applications integration: Integrating an OCPM solution with several applications including financial, contracting, purchasing, facilities management, assets management, enterprise content management and enterprise resource planning solutions. The organization's software should talk together and pull everything together under one database so there is no room for mistakes and data reentry;

(2) Optimization: A policy of having all official communication on a project go through the OCPM solution. Most of the organizations are rethinking their implementation and use of their OCPM investment. Therefore, investors are going through an optimization to extend the use of their solutions. They are starting with the most-used modules and functions (in most cases this is the document management module) and they are expanding the use to several other modules (bid and cost management) as well as to more projects and users;

(3) Benchmarking: Using the OCPM solution to set benchmarks for future projects and performance;

(4) Overcoming change and cultural barriers: Continuously training the employees and the supply chain to use the system, make proactive arrangements, and provide a steady point of contact;

(5) Knowledge management: Revisiting the data on past projects; using the OCPM solution as a universally accessible reference library; eliminating loss of useful information created in design and construction once the project is over;

(6) Making the OCPM solution a contract requirement: Utilizing the OCPM technology as part of a contract requirement. Managers agree that the owners increasingly would like to know what tool the contractor will use to control a project. Therefore, contractors would like to increase the use of their OCPM tool modules in order to maximize their benefits;

(7) Exporting information from the OCPM solution to other applications: For example, capturing and using the information generated during the management and execution of projects; attaching intelligent data as equipment changes in buildings; using the information as a reference for facility management; having electronic data and electronic access;

(8) Developing communications specifications: Formally documenting and contractually binding all parties on how to facilitate communication on a project: what modules will be used and how;

(9) Reusing and reconfiguring the tool for future projects: Using the OCPM solution and the information generated in other areas such as validation, capital planning, and facilities management;

(10) Bringing mobility to construction sites: Having portable devices that have a connection to the OCPM solution on the construction site to address issues directly, e.g. electronic requests for information.

5. OCPM TECHNOLOGY VALUE ASSESSMENT

5.1 Tangible Benefits

Of the three types of benefits (tangible, quasi-tangible, and intangible), only tangible benefits have a known financial impact on cash flow. OCPM technology investments are largely known and have traditionally been made for the generation of tangible benefits, which are based on direct financial project costs (Irani, 2002). These tangible benefits usually have an effect on operational efficiency. However, although these benefits are measurable and quantifiable, the savings overall to the project are hard to calculate without going through a series of assumptions. For example, traditionally the cost of sending a request for information (RFI) or a shop drawing is assumed by the sender. One might infer that the sender may be more willing to share information with an OCPM technology in place, since then they do not need to assume the cost. Cost savings (whether to print or not) is under the recipient's control with the OCPM system in place, which makes accurate calculations difficult as the savings differ from participant to participant. After breaking down the efforts on the basis of the work functions affected by OCPM technology implementation in construction projects, the research team identified and focused on three specific job processes where dramatic savings become possible. These processes as discussed in the book are: electronic request for information (e-RFI), electronic bidding (e-bidding), and electronic document transfer.

5.1.1 Electronic Requests for Information (e-RFIs)

Requests for Information (RFIs)

An RFI is one of many documents generated during the construction period. It occurs when a contractor, a subcontractor, or a supplier finds an unclear element or dimension in construction drawings, a conflict between specifications and drawings, or any question related to the construction site. The number of RFI documents varies from project to project. In small construction work, the number might range from 50 to 300. RFI documents are related to many parties. Therefore, they take time to generate and respond to. Sometimes not answering an RFI on time might cause delays in construction work. The average industry RFI turnaround time is around 14 days based on the information gathered through interviews, case study and survey analyses.

Questions asked have traditionally been sent by fax or in paper format to the construction/project manager or to the architect, depending on the procurement method. These

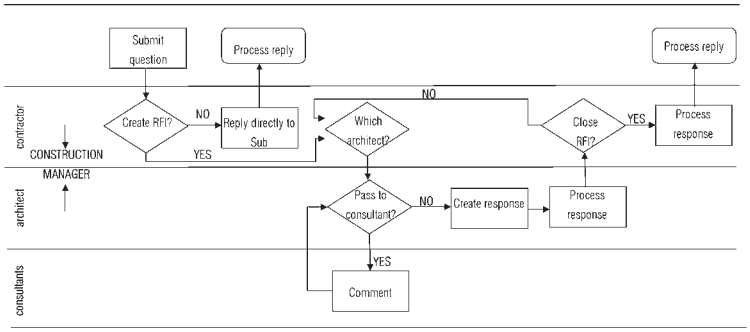

Figure 10. Lengthy and linear paper-based RFI process

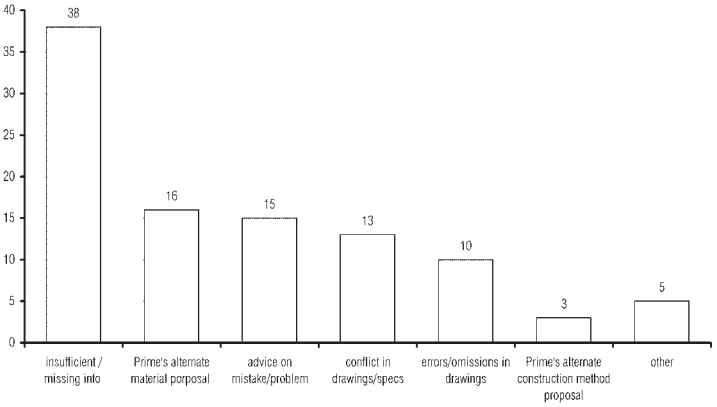

Figure 11. Reasons for RFIs in one of the construction projects

questions are then passed to relevant parties. The party issuing the RFI, usually the general contractor or a subcontractor, has to wait for the answer, which might take a long time depending on the responding party. After receiving the answer, the construction manager or the architect passes the question file and attached answer information to the inquiring party with the name of the answering party, and the time and date it was received. Usually RFI documents are bound in three-ring binders, which occupy space. The responsible party has to look at all documents (specifications, drawings, etc.) and answer the question. While some of the questions might be easy to answer, some might take longer. In response to an RFI, a drawing or specification might be changed, modified, or the answer might cause a change order, which needs the owner's approval. The time needed to issue and answer an RFI is usually critical as it might affect the overall construction schedule.

Reasons for RFIs

- *Design intent and clarification:* Consultation with architect/engineer (A/E) for questions regarding the design intent in case clarification is required, there is insufficient or missing information, or there are errors, omissions, or conflicts in architectural drawings, specifications, structural drawings, etc.
- *Subcontractor information:* Access to any information that the contractor has about any of their subcontractors. Information about a subcontractor's activities at any given time.
- *Contract specifications and drawings:* Access to specifications or information regarding specifications, contract or shop drawings, and if necessary to personnel that can answer questions regarding the drawings.

- *Work package information:* Access to work package information, including scope of work, materials and equipment required, etc.
- *Means and methods:* Consultation when field personnel discover that an item cannot be installed according to the owner's plans or contractor's methods and/or an item cannot be found in the market as proposed or required in the specifications. Contractor's alternate proposal regarding construction execution method and/or model/size.
- *Guidance:* Consultation regarding a mistake made or a problem that has occurred on the construction site.

Problems with paper-based RFIs

RFIs are usually issued in paper form, sent by fax or handed in, and they take a long time to process. The time spent to answer a question is unpredictable. There is always a possibility that someone will forget to answer it or will lose the question. There are no mechanisms to track down which questions have been answered or not answered. There are no ways to accelerate the process. The parties who are answering a question have to go back and reexamine all relevant documents, which are in different formats and stored in different places. Project managers have to spend time managing RFIs, both the questions and the answers. The project manager has to manually attach the answers to the original questions, with other details such as who answered the question and the date and time of the answer. In addition, the project manager has to keep all records of RFIs even after the project is finished in case of claims. Although some large construction companies use stand-alone systems to manage RFI documents, these usually aren't fully integrated with other systems. Moreover, it is sometimes difficult to define who will answer the questions. RFI is a critical process, to which more attention should be paid by the construction staff.

e-RFIs

The RFI module is one of the most-used modules of the OCPM solutions. With the use of OCPM technology, the lengthy and linear RFI process can be shortened dramatically. These tools bring efficiency to the process by providing *automation* as soon as the sub/general contractor starts filling in the electronic RFI form. For example, areas such as the RFI number, the date the RFI is created, and the author's company and personal information are automatically filled in by the tool with the author's log-in information. This provides a complete *audit trail*. Contact information for all participants is usually built into the solutions in advance so that the person who issues the RFI can select the "corresponding company" and "corresponding person" from the contact list. This lets the system forward the RFI to the recipient's OCPM inbox and also send notifications to the recipient's email inbox. These tools also enable the author to consistently use the same recipient and set the same review time[17]. In addition, the need for the RFI (confirmation, clarification, inconsistency, field condition, errors/omissions, site condition, etc.) and the discipline involved (architectural, civil, electrical, plumbing, structural, landscaping, etc.) could be selected from the built-in list. The author can type in his question, add notes (suggestions and comments), attach related drawings/documents/sketches, and mark the importance of the RFI, the RFI's impact on budget, schedule, and drawings, and whether that specific RFI record will require drawing updates.

The minute the RFI is posted, the recipient receives a notification in his email inbox indicating that there is an RFI he has to answer. The recipient can click on the link in the notification email or log in to the tool and view the RFI automatically. Then he can fill in the answer and reference/attach any specifications/drawings/documents/sketches. As

soon as the recipient (responder) posts the document, the author receives a notification indicating that his question has been answered and is ready for viewing. Notifications are also sent to other users for RFI updates (such as project managers who need to review the RFIs). RFIs usually involve some form of collaboration with at least one other person. Some RFIs might require one answer or response from a single contact, while others may have to be redirected to several contacts before reaching the appropriate person who can answer the RFI question. Similarly if the recipient believes that the question should be answered by another party such as his consultant, he can forward the RFI to the appropriate person by selecting from the list. The whole process is done automatically and the history of all actions is recorded. The user can view either all RFIs in a project (if he is granted access) or those specifically assigned/redirected to him.

The solution could be set up in such a way that every RFI can go through e.g. the construction manager (CM), though other parties can also be copied. The reasons for having the CM at the center of communication might be as follows: (1) the CM reviews both questions and answers; (2) the CM becomes aware of the issues; (3) the CM knows the issues that involve more than one party, so he makes sure everyone affected is in the loop; (4) the CM always has the power to add, copy, or phrase answers in such a way that the parties will understand. The CM might be able to answer the question, depending on the nature of the RFI. In this case he would answer and forward a copy to the A/E. If the CM doesn't know the answer, he makes the contractor RFI into a formal RFI and forwards it to the A/E. The same path is followed for the answer.

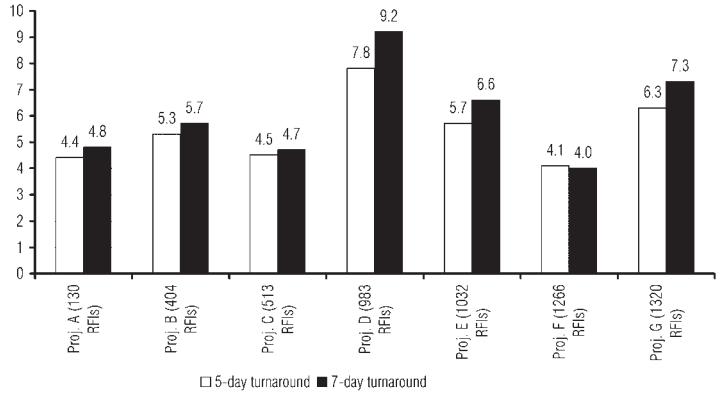

Figure 12. 5-day and 7-day turnaround time of 7 construction projects' e-RFIs

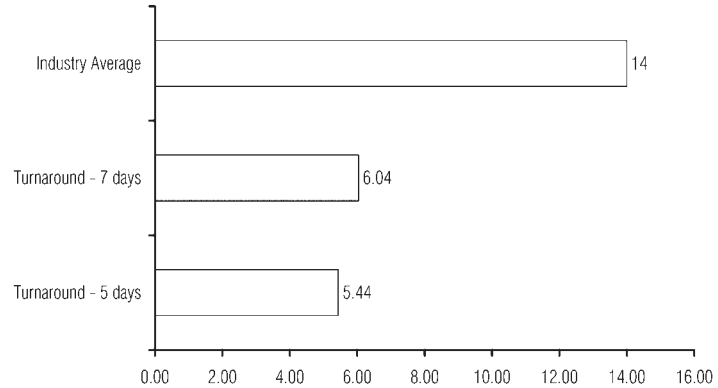

Figure 13. Electronic RFI turnaround time, based on 5,648 RFIs in 7 construction projects

Realized benefits of e-RFIs

(1) Reduction of RFI turnaround time: OCPM technology brings speed to issuing and answering questions as the process is very well automated. It enables team members to type in the question in an electronic form and to send the question to the relevant parties by just pressing a button rather than faxing, emailing, or mailing the documents back and forth. OCPM technology prevents any mail delay or risk of an RFI not being answered on time thanks to its real-time communication features and automated notifications. The interviewees agree that there is no comparison between paper and electronic RFIs. Electronic RFIs are much faster and they enable instantaneous communication. Jack Jones, the Carnegie Mellon University Collaborative Innovation Center project superintendent, comments: *"There is no doubt the tool improves the RFI process. We used to have 12 days turnaround time but now it is possible within hours."*

The average e-RFI turnaround time is 5.44 work days and 6.04 week days, based on 5,648 e-RFIs in 7 construction projects.

According to the interviewees, OCPM technology is helpful in workflows when several parties need to be aware of the issues simultaneously. Depending on the issue, architects and engineers agree that they can send the answer back to the contractor or to the construction site literally within a minute. The process of answering an RFI also becomes very efficient. One of the construction administrators interviewed indicated that working on an electronic RFI would take him *5 minutes* instead of *45 minutes*. Reasons for increased efficiency in the e-RFI process are:

- All project information is at a central location, stored in a structured way. For example, construction administrators don't have to leave their desks and search folders for information;
- There is no faxing or illegible handwriting. One doesn't have to create a spreadsheet to list RFIs, do binders, and send them;
- These tools are web-based. One can just pull the information from one's computer, view it, issue it, and send it;
- The entire process is enhanced and controlled by instant notifications;
- Managers can be aware of pending RFIs by running reports on the status of RFIs.

This may reduce the number of administrative staff in an office, or the same number of staff can spend more time on other issues due to the efficiency gained. While these staff savings may not directly impact the investor (assuming the investor is the owner), one hopes that efficiency will impact future projects and their costs. For example the CM will be willing to negotiate a lower contract price because they know they will need to spend less time.

Dollar savings based on reduced time spent on answering an e-RFI:
We can estimate the savings with a basic calculation. Let's assume there is a project that has 807 RFIs addressed within a year in the construction period.

Number of RFIs = 807
Average salary of construction administrator = $48,000/year ($25/hour)
Time spent to process a traditional RFI = 45 minutes (75% of an hour)
[75%x25] x 807 = $15,131 annual expenses to process a traditional RFI
Time spent to process an e-RFI = 5 minutes (8.3% of an hour)

[8.3%x25] x 807 = $1,674 annual expenses to process e-RFI
45 minutes vs. 5 minutes (89% more efficient process gained by e-RFIs)

SAVINGS: $15,131 - $1,674 = **$13,457** annual savings per project
Assume that the office has 10 same size/duration projects within a year:
13,457 x 10 = **$134,570** per year for 10 projects

The above calculation takes the construction administrator's time savings into consideration. Therefore, it assumes that the administrator will be able to support more projects, which potentially can reduce the number of construction administrators required in an office. However, the savings of e-RFIs are not limited to one party's time savings. As mentioned in the previous sections, an RFI process involves several parties including contractors, architects/engineers, and construction/project managers. The calculation above could be extended to efficiencies gained by other parties.

Dollar savings based on reduced RFI document printing, copying, mailing and faxing:
We know that the gains are not limited to time savings but also include reduced paperwork and transfer.

In all, we know there are 807 RFIs in our sample. Let's assume at least 400 of these RFIs have 2 pages.
Total number of pages = 407 + (400 x 2) = 1207 pages
Assume 80% of documents do not need to be printed and faxed when the e-RFI process is utilized:
1207 x 80% = 966 pages
Assume at least 3 different parties (A/E, CM, and GC) would print and fax 966 pages back and forth if the system wasn't implemented:
966 x 3 = 2898 pages of document
Assume printing cost $0.1 per page:
$0.1 x 2898 = $290 per project
Assume 50% of the documents were mailed before and they don't need to be mailed due to efficient electronic transfer, and that the mailing cost is $1 per envelope on average:
$1 x 50% x 807 = $404 per project
Total savings of printing, faxing and mailing per project:
290 + 404 = **$694** per project ~ **$6,940** for 10 projects

(2) Reduction in RFI numbers: There is no evidence that the OCPM technology reduces or increases the number of RFIs. However, it is agreed that these systems clear up the questions earlier in the process in a speedier manner. This prevents mistakes and solves problems early in the process. Some in the industry believe that the number of RFIs will increase since the OCPM technology makes it easier to ask questions. However, Brett Pitcairn of P.J. Dick Incorporated comments: *"RFIs are related to the quality of the documents. If someone has a question, he has a question. There is no correlation between the number of RFIs and the use of the system."*

(3) Audit trail: Interviewees agree that one of the most valuable benefits of e-RFIs is having a complete audit trail. Participants can easily track the dates when an RFI was submitted and returned. In addition, the history of who did what and when is traceable. Michael Imbergamo of SmithGroup, the architect of the Defense Intelligence Analysis Center project, says, *"If there is a discussion, it is very easy to find all related RFIs. If they are related,*

they are numbered as 5001a, 5001b." Russell Triplett of Perkins+Will, the designer of the Barrow Neurological Institute Tower project, comments, *"When the contractor sends a question, we get an email saying there is a new RFI. I can answer or direct it to other people if necessary. It is a great tool for automating and tracking everything."*

(4) Enforcing timely responses: OCPM technology provides managers a list of overdue RFIs and may request prompt actions of related parties to maintain a timely construction process. In addition, it can send letters that advise a company that their lack of response to an RFI is causing construction delays. Additionally, the technology can warn that the owner may be notified via an official delay claim. Tony Teritehau, US Navy project manager, indicates, *"We can run reports for returned RFIs or more importantly for outstanding RFIs, which helps us to take timely measures."*

(5) Impact on overall schedule and budget: It is difficult to predict the impact of reduced RFI turnaround time on the overall schedule and budget. In our analysis of project RFIs, we came across one RFI where an immediate response was required from one of the prime contractors. The question was about a connection detail showing how to anchor roof ladders into the hollow block. The question was asked on 10/28/2004 and the answer was required by 10/29/2004. The RFI was answered the same day it was asked, which prevented any delay in the construction sequence. The OCPM solution prevented any mail delay or risk of an RFI not being answered on time thanks to its real-time communication features and automated notifications. John King of J.J. Gumberg, Carnegie Mellon University Collaborative Innovation Center project developer, explains the necessity of the tool: *"These tools are critical to be on time. Our time frame for this project was very compressed in terms of meeting major goals. Without this tool, answering questions, getting information back and forth when people needed to, would be painful."* Michael McKay, TRM Healthcare's Methoda project manager, adds, *"Somewhere along the line, shorter RFI turnaround time should improve the construction schedule and reduce the costs if you are receiving hundreds of RFIs and reducing the turnaround time to 2 days."* However, interviewees also agree that the overall schedule of a construction project depends on several factors and that it is very difficult to prove the effect of reduced RFI turnaround time on project schedule.

5.1.2 Electronic Bidding

An essential stage in construction is the bidding process, during which the profit level is critically determined (Arslan et al.). The bidding process requires a great deal of time and effort. OCPM technology is increasingly used in the bidding process in order to reduce bidder query process costs and its onerous nature. OCPM technology reduces the demands of complex procurement processes by improving the efficiency, speed, and accuracy of the bidding process. E-bidding through OCPM technology is employed to facilitate the exchange of information, the submittal of prices in electronic format, and to manage the structuring and sharing of project information. The benefits of utilizing an OCPM technology in e-bidding are: enhancing time and cost saving for bid proposal preparation and reducing proposal litigations after the bid by having complete audit trail. E-bidding offers significant time and cost savings by reducing the paperwork, mailing, and copying. E-bidding also eliminates potential bidding errors through system checks and provides a reliable and quick information exchange medium among bidders. Easy and controlled access to archived data also increases the range of potential bidders. Comparison of price and technical data is much easier in the e-bidding process compared to the

traditional bidding process. Moreover, the procurement process is brought to a standard format with the OPCM technology.

An example of e-bidding through OCPM technology and its positive impact on cash flow is presented below[18]. Region 2 of the General Services Administration[19] (GSA) has a one-year subscription to an OCPM solution that includes a license for a 10GB site with up to 750 site members at a cost of $68,000 per year. Their site status as of June 2005 is 5+ GB of information stored with 500+ members involved in at least one project. About 80 members are GSA associates. The remaining members are either GSA customers or vendors, including A/E firms, general contractors, and subcontractors.

The following calculations reflect the base pay and benefits used for calculating the dollar value of time saved using the OCPM solution, as well as average values for direct costs:

Variables:
Engineer hourly rate: $37.00
Administrative staff hourly rate: $18.00
Printing 30 sets of plans (30 full-sheet pages) and specifications (200 pages) = $1,000
Overnight shipping of one bidding package: $15.00

Variables not included in cost estimating:
Normal print request and mailing varies between 30 to 50 packages, sometimes more for larger projects. Bidding amendments not included; average of two per bid sent overnight ($5) to prospective bidders: around 50 (estimated $6,000 additional cost)

Engineer administration time:
$37.00 x 6 hours = $222 x 8 projects = $1,776 x 6 project managers
= $10,656 (288 hours)

Contracting officer administrative time:
$37.00 x 6 hours = $222 x 8 projects = $1,776 x 4 project managers
= $7,104 (192 hours)

Administrative support time:
$18.00 x 8 hours = $144 x 20 projects = $2,880 x 6 project managers
= $5,760 (320 hours)

Total associate indirect costs: $10,656 + $7104 + $5,760
= **$23,520** (800 associate hours expensed)

Printing costs:
30 sets = $1,000 x 20 solicitations
= $20,000

Mailing costs:
30 sets x $15 (one box and one tube) = $450 x 20 solicitations
= $9,000

Total direct costs: $20,000 + $9,000
= **$29,000**

Direct and indirect costs associated with solicitations issued during one fiscal year (Oct - Sep):$29,000 (direct) + $23,520 (indirect)
= **$52,520** in realized savings (for one Service Center – Syracuse Service Center)

GSA doesn't have another Service Center using the OCPM solution for bidding to the same extent, which would easily increase the realized amount of savings without any increase in cost. There are six Service Centers in Region 2 that have the same project load with similar efforts as described above. If all six offices used the OCPM solution to the same extent as the Syracuse Service Center, the estimated savings would be upwards of **$300,000** without an increase in the cost of the OCPM solution.

Jay Burris of General Services Administration concludes, *"My description of how we save with the solution was based around the bid portion of our process. Any realized savings for the design review or project administration segments of a construction project only enhance our ROI. I usually quote a low $100,000 in savings that is realized over the cost of our OCPM solution. It does benefit me and I will continue to press to maintain this service as it saves the government time and money."*

5.1.3 Electronic Document Transfer

Ease of transferring documents, drawings, and specifications is definitely among the most important benefits of OCPM solutions. Budget items, contracts, submittals, transmittals, invoices, RFIs, daily reports, and meeting minutes are extensively used modules of OCPM solutions in construction projects. An example of e-document transfer through OCPM technology and its positive impact on the cash flow presented below[20].

TRM Healthcare[21] (TRM) is a broad-based health care company that discovers, develops, manufactures, and markets products and services that span the continuum of care from prevention and diagnosis to treatment and cure. TRM calculated their savings from reduced FedEx costs in their international projects. As can be seen in the figure, the design review process requires the attention of several parties. What happens usually is that the designer/engineer prepares the drawings and sends them to TRM by FedEx for review. TRM professionals review the drawings and make changes and/or add comments, then send them back to the designer/engineer by FedEx again. The designer/engineer's team interoperates the comments and sends the final copy to TRM by FedEx, which is then sent to the construction site.

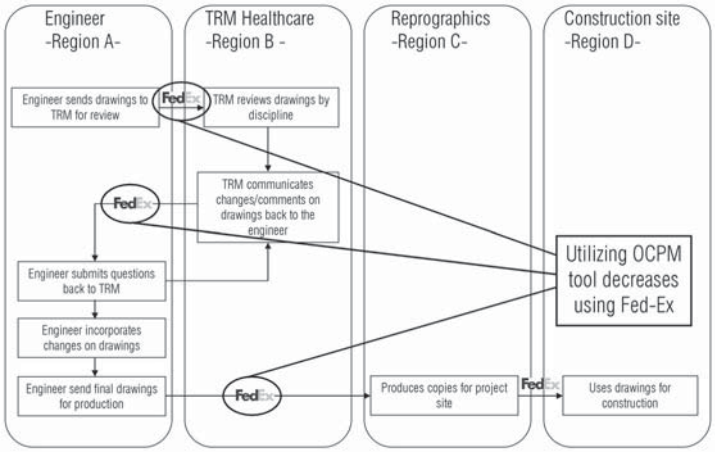

Figure 14. Drawing review process for an international TRM project

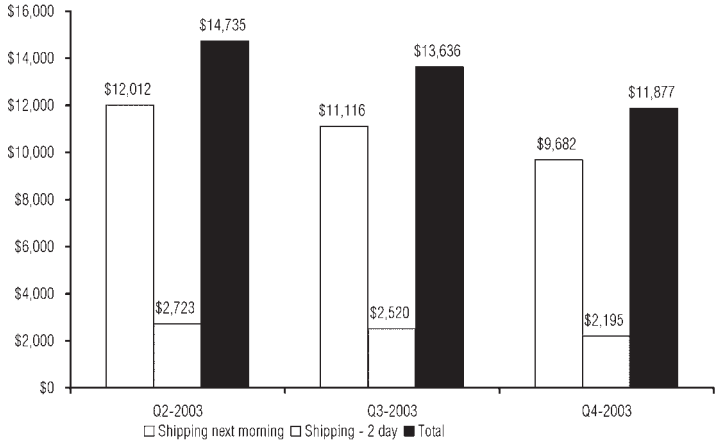

Figure 15. Estimated FedEx shipping charges

FedEx charges for 7 lbs between the destinations are stated below.

	Next day	2 day
Region A to Region B	$54.34	$11.55
Region B to Region A	$54.34	$11.55
Region A to Region C	$70.61	$17.54
Total	***$179.29***	***$40.64***

We will assume that a package of 50 drawings will weigh 7lbs. The number of drawings posted on the OCPM tool for this project is as follows, with an estimate of how many packages would have been shipped had the drawings not been posted electronically.

	# of drawings posted	# of packages shipped
2nd quarter of 2003	6742	134
3rd quarter of 2003	6271	124
4th quarter of 2003	5428	108

Let's assume half of the packages are sent by 2nd day shipping and the other half by next day shipping. Based on these assumptions, the savings are shown in the figure.

Total savings over a year and over three years for one project are as follows:
Total Savings:
9 months $40,248
1 year $53,664
3 years **$160,992**

We know TRM has 16 projects oversees that use the OCPM solution as of April 2005. If we assume that at least 10 of these projects will have a similar design review process and that it will last for at least a year, the savings will be around **$536,640** for 10 international projects.

Besides this specific example, let's assume that we have a project with a yearlong construction period where issues are addressed and documents are shared. The project has 5,000 documents (which is the average number of documents of 5 projects), including submittals, transmittals, meeting minutes, RFIs, drawings, specifications, etc. Estimating

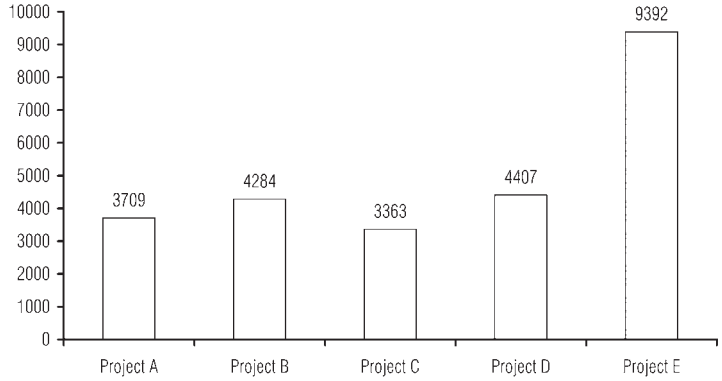

Figure 16. The number of documents stored in OCPM solutions of 5 construction projects

the reduction in printing and copying is a challenge, because most of the parties print the documents, either to have a record or back-up for internal systems or to communicate with upper management as they are not usual users of the tool. Brett Pitcairn of P.J. Dick comments, *"At some point they want to be paperless, but it is years away. There are still some executives who want to see information in paper and there are still some subcontractors who are not technology-savvy."* Therefore, we will assume that 50% of the documents are printed.

In all, there are 5,000 documents (we assume half are 1 page, the other half are 2 pages):
Total number of pages = 2,500 + (2,500 x 2) = 7,500

Assume 50% of documents do not need to be printed:
7,500 x 50% = 3,750 pages

Assume at least 3 parties would print if the system wasn't implemented:
3,750 x 3 = 11,250 pages of document
Assume cost of printing is $0.1 per page:
$0.1 x 11,250 = **$1,125** per project

Assume 75% of the documents don't need to be mailed due to efficient electronic transfer and that the cost of mailing is $1 per document:
$1 x 75% x 5,000 = **$3,750** per project
Total Savings:
3,750 + 1,125 = **$4,875** annually per project

Assume that the office has 10 projects of the same size and duration within a year:
4,875 x 10 = **$48,750** annually for 10 projects

5.2 Quasi-tangible Benefits

Although efficiency savings are quantifiable in monetary terms, they are minor both from the investors' and collaborators' points of views. Steve Head, service support manager at Nationwide Building Society, comments, *"We focused on organizational-level benefits rather than individual project-level benefits. The reason for this is that business benefits rather than cost savings have always been more important for our organization. Performing the right tasks correctly, staying consistent with our mission, vision, and values, and sup-*

porting our goals and objectives have been among our most important goals in deciding to implement this technology."

Like Steve Head, many managers are now appreciating the wider strategic implications of developing a robust and responsive technology infrastructure, yet this in turn presents businesses with the dilemma of how to assess, quantify, and accommodate the implications of infrastructural investments within traditional methods of appraisal. Simple calculations present an attempt to quantify as much as possible. However, simple return on investment alone cannot present all factors that management must consider during the OCPM technology investment decision-making process. Some of the most-cited benefits of this technology fall into two groups. The *quasi-tangible* group has some direct measurable elements in benefits. The *intangible group* has only indirect benefits. Some examples of quasi-tangible benefits are: more timely information, improved planning, faster decision making, etc. These benefits focus on making organizational assets more productive through leveraging OCPM applications. In this section, the quasi-tangible benefits are presented based on the results of the interviews, case studies, and the survey conducted.

5.2.1 Benefits Ranking

Effectiveness is the ratio of achieved outputs to planned outputs. These benefits are not quantifiable, but are valuable. Besides interviews, an electronic survey of quasi-tangible benefits was designed and distributed via email to all interviewees to measure the improvement in a more consistent and less subjective way. The aim of the survey was to uncover as much information as possible and to quantify quasi-tangible benefits of OCPM technology investments. Each respondent received an identical list of benefits, phrased in exactly the same way in order to reduce errors resulting from the recording of responses, and the respondents were free to rank the benefits according to their relevance at the respondent's own pace. The survey covered several benefits that were stated during the interviews. The respondents were asked to rank the benefits 1 through 5 (where 5 is "very high," 4 is "high," 3 is "neutral," 2 is "low," and 1 is "very low"). Below are some effectiveness benefits as realized and rated by OCPM technology investors and users.

Rate	Ranking	Quasi-tangible benefits
37/38	4.35/5	Improved data availability
37/38	4.19/5	Enabled having complete audit trail
37/38	4.00/5	Improved information management
36/38	4.00/5	Enabled faster reporting and feedback
38/38	3.97/5	Provided accurate and timely information to give valid/ accurate decisions
38/38	3.95/5	Improved process automation (RFIs/change orders, autoupdated master budget)
29/38	3.93/5	Improved information version control
37/38	3.84/5	Enabled better project/program control
36/38	3.61/5	Improved timely capture of design/construction decisions
37/38	3.57/5	Enabled fewer information bottlenecks
36/38	3.56/5	Enhanced working within virtual teams
32/38	3.47/5	Enabled quicker response to project status and budget
32/38	3.41/5	Improved quality of the output
28/38	3.29/5	Enabled better forecasting and control
35/38	3.26/5	Improved project relationships with strategic partners
30/38	3.20/5	Reduced rework/data reentry

34/38	3.06/5	Enabled better resource allocation; more effective assembly of project teams
22/38	3.05/5	Improved public relations
34/38	3.03/5	Reduced personnel costs due to improved efficiency
35/38	2.94/5	Improved idea sharing among team members/within organization
32/38	2.94/5	Minimized project/business risks
23/38	2.91/5	Enabled faster launch to market due to faster delivery
33/38	2.88/5	Reduced errors and omissions
23/38	2.87/5	Reduced delivery lead times
16/38	2.75/5	Enabled better inventory management
18/38	2.56/5	Enabled more effective identification and assessment of new suppliers
24/38	2.38/5	Enabled advance purchase of materials

Table 1. Quasi-tangible benefits: the number of people who rated the benefits (rate) and the average ranking for each benefit (ranking)

5.2.2. Top 10 Quasi-tangible Benefits

(1) Improved data/information/document availability: OCPM technology helps the users to reach and search the project information globally. The technology provides a common archive for information that could be reviewed off-site and after hours by the collaborators. For example, when a team member travels and he is in a remote location or at home, there is no need to carry any computer or hard copies. Any authorized user can access the network and download the most updated project information wherever they are as the entire project resides in the Internet. Kim Verdier, document control manager in a TRM Healthcare project, indicates, *"The fact that I don't have to be on the site in order to do my function is great. I can take work home on the weekends or at nights just by having a computer at home."* The technology also ensures and forces the data population and provides a structured and easy way to store it.

Adrian Wilson, the ITG project manager, comments, *"The tool is superb! It is very useful because all branch information is at one place and we don't have to create folders from scratch every time. Everything is in the library. If you send information regarding a certain branch, all the footnotes go to the library. That itself is a fantastic benefit. No matter where you are you can look at the project. The rest of the world sees it at the same time. I can go right now and use the information. If we were to send all of that information via email, we would lose track."* Michael Imbergamo, project architect of SmithGroup, indicates that the tool informs everyone about active development. He adds, *"I can go and take a look at the archive; what is open or active. I can find old but relevant information. It becomes a resource tool for all project members."*

(2) Enabled complete audit trail: Having an archive of all project information as well as project communication and tracking the history of the documents posted (e.g. RFIs and submittals) have been identified as very valuable in case of any reviews or construction disputes. If an investor needs to prove a point, the OCPM solution would give him access to final documentation as well as the previous communication in a structured and credible way. Michael McKay, project manager of TRM Healthcare's Methoda project, says, *"I think having an archive of the entire communication is among the important benefits of the tool. We didn't have any claims or a major problem that we had to go back and resolve. But if we did, if a document wasn't there, it wouldn't be anywhere."* From the owner's point of view, having access to all project information is also very crucial. For example, although the

owner doesn't usually get involved with the RFI process directly, they would have access to all modules and could track any RFI in case of any disputes.

According to John King of J.J. Gumberg (the developer of the Carnegie Mellon University project), with 30 years of experience in construction, it is hard not to have any unpleasant experiences during construction. He says, *"There are all kinds of things that can happen: litigations or weak memories. It is always good to have good record keeping. The Carnegie Mellon University project has been a very smooth project. But if there would be a structural problem 5 years from now, we would be able to go back and see if there were any questionable methods."* Dennis DiPalma of P.J. Dick asks, *"What if the key personnel who would solve the problem leave the company?"* Ed Costanza of Kitchell Contractors adds, *"We definitely have more documentation electronically than hard copies. We can build a catalog of documents in short order to argue a claim if needed."*

(3) Improved information management: OCPM tools provide an extensive file management system with granted accesses or restrictions to particular project areas and folders. User actions can be simplified to allow the reading or creation of data with the minimum of difficulty. The users have the ability to imply the rules on folder naming, folder structures, and folder length. They can find the information from the database easily, and notification rules provide them with certainty of the activity. Mark Bittner, one of the area directors of Catholic Healthcare West, comments, *"It is very beneficial for related parties to have access to the same documentation via logs for submittal processing, RFI processing, change management processing, and meeting minutes."* Scott Grissom, project management systems coordinator at Rooney Holdings, comments on achieved standardization through OCPM technology, which saves time and brings consistency to their operations: *"Team members go from project to project and everything looks alike. They will be using the same system for each project they work on. They don't have to learn things over again. ... In the old days every project manager had their own ways; project to project things were changing."*

(4) Faster reporting and feedback: Interviewees agree that the OCPM technology provides a faster and better way of working. Brian Killion, a senior project manager at Manhattan Construction Company, comments, *"The tool is saving time because everything is standardized. Take the meeting I was holding on Wednesday as an example. Before, I needed a certain amount of time on Tuesday and Wednesday to prepare for it. Now if I want, I can pull out some reports and understand where we stand."* Project teams are able to manage complex programs with decreased number of staff. They manage to be more effective as all of the external parties report through one system.

Steve Young, the Indianapolis Public School's (IPS) facilities director, says, *"The tool has a very positive impact on our ability to manage the IPS construction program. We are experiencing more timely and efficient communications between the parties involved in the program, and that translates into lowered administrative costs, reduced risks, and improved accountability."* Increased speed and effectiveness of communication among the team players as well as within the executive team is another benefit. Project teams believe that their jobs' schedules have improved due to the quick turnaround of questions and easiness of information transfer. Sean Mathurin, team leader of design and specification support at Inscape, says, *"I can see who has done what in a project. So if someone says he has never received the drawing or the specification package from us, I can pull it out and prove that he had a look at it yesterday."*

(5) Enabled valid and accurate decision making: OCPM technology facilitates faster decision making by enabling faster and more complete flow of information and speedier communication. Having a single source for the projects helps managers with general management information – what projects they have in the system and the status of those projects – which was previously managed usually by databases where all project participants had to rely on somebody updating the information. Luis Hernandez, the acting director of facilities information systems at Los Angeles Unified School District, comments, *"There is a variety of benefits, but the greatest is organized construction information, therefore project visibility. This allows the division to effectively mediate issues of construction concern that could potentially lead to costs, legal costs, and impact."* OCPM technology also increases awareness. With the tool in place, project managers can easily realize any changes that would affect a project or a contractor. Moreover, they can easily realize the effect on the whole program by having a better view of the program's progress.

Steve Head of Nationwide says, *"We now have an internal and external team who could previously only have coped with relatively low numbers of projects – now we estimate that with this tool in place we could considerably ramp up our activity with no loss of quality or loss of control."* John King of J.J. Gumberg agrees that the tool makes the job go as smoothly as possible: *"The information is available and understandable and makes the processes go efficiently. It is so much better than waiting for the telephone call. It makes the entire process more efficient."* He adds, *"The sooner you can get the information in front of the right people, the better you get them prepared for your next discussion as far as resolving a problem."*

(6) Improved process automation and standardization: OCPM technology allows project teams to monitor and guarantee a certain degree of consistency in their projects. These tools guarantee that everyone is aware of the issues and everyone is informed about a proposed correction and agrees that it is acceptable. For example, issues brought up by the craftsmen and foremen are addressed and discussed during the design and construction using the OCPM solution communication. Scott Grissom, project management systems coordinator at Rooney Holdings, comments that he gets a lot of feedback that once the OPCM solution is up and running and all of the contacts are in the system, it is very easy to issue or answer an RFI or write meeting minutes. Users can link their RFIs to other documents; or with a couple of clicks the system can create the letter template for you. He adds, *"The increased automation and having all information in one place are what the users like the most."* Mike Parkinson, project manager of Manhattan Construction Company, adds, *"Web-based is great because we didn't need to catch up with the owner's computer system. We have consistency in the document appearance and format."*

(7) Improved version control: In a construction project, it is important to make sure that all participants have access to the most updated documents to ensure that all parties are working from the same page. With the use of an OCPM tool, everybody can have access to the latest documents and files at the same time from anywhere in the world without waiting for the hard copies. Besides the cost savings from electronic document transfer, by utilizing OCPM technology the users can save an enormous amount of time – especially in international projects – by transferring and accessing drawings through the Internet. Ongoing availability of information when questions arise about a particular project has also been important to the team members. Marek Suchocki asks, *"If you have a dozen people working on the project, how can you be sure that all of them have the most up-to-date and relevant information? You cannot if you are doing it via emails or if you are mailing*

it and the drawings are sitting on the desk of somebody. With the tool, we are making sure that we are getting the correct information and we can see the previous history."

(8) Better project/program monitoring and control: OCPM technology automatically tracks everything related to the project. The single database model allows team members to create reports and easily search to find the documents they need. In addition, the tool increases team member awareness through instant notifications and provides easy access to information for consultants. Having all project information stored in one centralized space helps the project managers to control the budget and the schedule more effectively. For example, project managers can easily analyze the effects of delays on the contract completion date. This involves hypothetically imposing the delaying event and carrying out a critical analysis to determine the new completion date. By performing a number of *"what if"* analyses and storing the results, the manager can prove the effect of delaying events.

David Page of Los Angeles Unified School District comments, *"It is the small things that you don't see where the cost savings come in. For example, project managers don't have to go through everything; they just go to generate function. A meeting minute can take you half an hour to an hour. With this process, you just simply modify the items that are basically going on. The punch list, daily reports, meeting minutes. You are starting to save 30 minutes here and there, in total you are saving 2-3 hours a day, 2,000 hours of savings over the course of a year. If you have hundreds of projects, this is a substantial saving."* Karl Zook of Kitchell Contractors comments, *"The owner can look at the system and can tell if somebody is underperforming. It enables open communication and it is very beneficial to all parties."* Debra Kunce of Schmidt Associates says, *"It is a central point of information. From the owner's perspective, you can look across projects and compare very quickly. You can check how many RFIs and submittals you have and hopefully stop and divert issues before they happen."*

(9) Improved timely capture of design/construction decisions: The ability to review multiple projects, wrapping many projects into one site visit and avoiding the need to revisit for each separate project, provides for more effective management. The interviewees also believe that the implementation of online approvals and comments in real time helps reduce the need for meetings and travel in many cases. Marek Suchocki of Atkins Management Consultants agrees: *"Being able to monitor multiple projects at the same time reduces the administration staff and provides better construction management."* In addition, an improvement in teamwork and professionalism is experienced through a positive attitude to utilizing OCPM technology from the entire project team. More effective management can be achieved with easy overall project management and control.

(10) Reduction in errors and wastage/fewer information bottlenecks: Duplication of effort and wastage are key concerns on a construction project. OCPM technology gives all users certainty of information. The benefit isn't just having the correct version and having access to it but also having the ability to track the previous versions back and seeing who else has accessed or modified the information. Technology wastage has been addressed with a reduction in email and storage on personal computers. Michael Imbergamo, an architect from SmithGroup, confirms, *"The tool really helped us with the schedule. For example, there have been critical issues. We don't have to follow the normal way of processing the information. We are not tied to the individuals as we used to be in the past. The information is readily available with a couple of clicks."* He adds, *"It brought efficiency to our*

processes. We only had weekly meetings and there were no surprises. Information was available to everyone."

5.3 Intangible Benefits

Attempts to quantify intangible benefits in financial terms involve making assumptions and medium- to long-term forecasts in an environment that is very volatile (Milis and Mercken, 2004). These benefits are non-quantifiable in monetary terms, but represent soft return on investment or qualitative benefits. Business benefits rather than cost savings have been more important for the participating investors in most cases. Performing the right tasks correctly, staying consistent with the organization's mission, vision, and values, and supporting its goals and objectives have been among organizations' most important goals in deciding to implement this technology. Some performance benefits realized are: supply chain integration, process reengineering, gained market access, improved customer relationships, gained competitive advantage, performance measuring, knowledge management, and increased negotiation power. The intangible benefits realized in nine case studies are represented and discussed qualitatively in the following sections.

5.3.1 Knowledge Management

Data[22], information[23], and knowledge are terms that are often loosely used. Knowledge is information that is contextual, relevant, and actionable. It indicates recognition of the intellectual property rights that any organization owns (Sun and Howard, 2004). Knowledge is tied to the experiences, many years of work, completion of several projects, and it mainly resides in peoples' minds. For knowledge to be used for organizational success, it should be recognized as a form of capital, and must be exchanged between people and organizations. Managing knowledge assets can be a challenge, especially in the AEC industry where short-term working contracts and temporary coalitions of individuals can inhibit knowledge sharing.

Knowledge takes two forms: tacit[24] and explicit[25]. Explicit knowledge is the very factual information such as telephone numbers, details of previous contracts for a particular client, methods of repairing a common fault, etc. Tacit knowledge is widely celebrated as a vital element in improving competitiveness in an organization (Egbu and Botterill, 2002). It is increasingly being recognized as a vital organizational resource that provides competitive advantage. To make use of tacit knowledge for competitive advantage, it needs to be articulated and utilized by companies and their partners. This has compelled academics and practitioners to discuss the way in which knowledge can be managed; thus while knowledge management (KM) is fairly new to the AEC industry, it is emerging as a significant concept in management science.

OCPM technology provides a framework for creating, discovering, capturing, storing, transmitting, and reusing knowledge to gain competitive advantage. For example, determining who has what experience on past projects and providing ways of getting these people together with the others who need that knowledge. In other words, it provides a way to convert the tacit knowledge to explicit knowledge in order for it to be shared and utilized by others. The role of OCPM technology in KM is an essential consideration for any company wishing to manage their knowledge assets. The impact of IT could have a positive influence on KM applied to the construction process (Bush, 1999). The areas of this impact can be defined as: automating, informational, sequential, tracking, analytical, geographical, integrative, and intellectual.

Case Study:

After having the OCPM solution in place for their project and program management and realizing the benefits, Nationwide Building Society (Nationwide: UK's fourth largest mortgage lender and eighth largest retail banker) requested additional functionalities and space from the OCPM solution provider to facilitate KM. The goal was (1) to capture the knowledge that already exists within the organization and among wider groups involved in Nationwide's projects and (2) then to distribute business knowledge and strategy, project information, best practices, and experience gained from different consultants, suppliers, contractors, and projects. With their OCPM technology for KM (named TeamRoom) Nationwide not only aimed to capture comments and observations but also aimed to capture the knowledge in the spatial context of construction projects for purposes of understanding and delivering it to the right person at the right time.

Communities for special-interest areas and projects are built into the tool. As of March 2005, there were 15 different communities based on specific projects or special-interest subjects. With TeamRoom, one can open a discussion and have a chat room addressing questions and answers, and capturing people's ideas and experiences for future benefit. In TeamRoom, one can find agendas, project and contact information, etc. TeamRoom's communities include special interest groups, discussion rooms, news and event arenas, and a library where the participants can post documents. A participant can find all community members' names and contact information in TeamRoom. The tool also provides useful links and a search engine. Participants can address a question to an expert listed specifically in that community. For example, someone who needs to know something about schedule can search for the word "schedule." As a result of the search, a couple of people will appear with specific expertise from the management to whom one can address one's questions. This way one doesn't have to go though the process of brainstorming or research to solve the problem. TeamRoom helps to solve people's problems easily and intuitively by creating new solutions rather than repeating problems or wasting time by searching for solutions. Nationwide not only shares the knowledge within the organization with its employees but also shares it with its subcontractors and suppliers through discussion boards and libraries. Security companies working with Nationwide are the biggest contributors of TeamRoom.

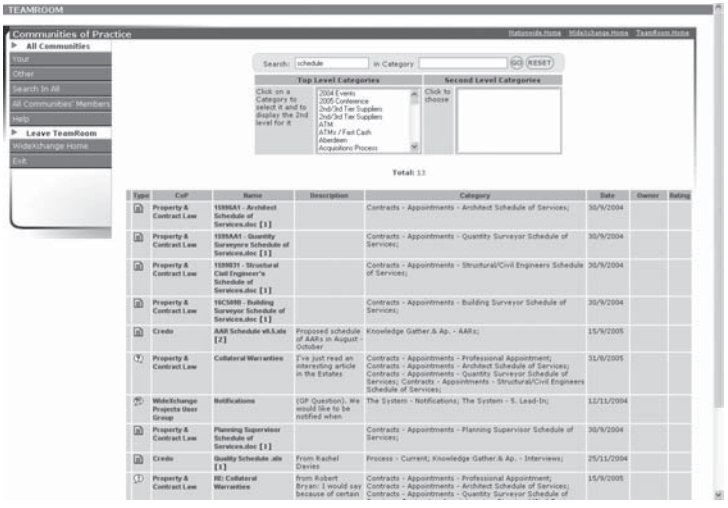

Figure 17. Results of *"schedule"* search: people, documents, discussions, categories, and dates

The tool proved to be very useful in terms of time and cost savings in practical issues. Steve Head, service support manager at Nationwide, comments: *"We have been feeding the learning gleaned from each project back into our knowledge store – for example how difficult-shaped branches were handled, imaginative use of materials, effective building techniques, etc. We have even had competitive suppliers learning useful tips from each other and sharing expertise!"* An example of knowledge sharing is a question asked by a contractor in the *"sustainability"* room about *"pest waste."* His question was answered by another contractor working in another project. Not only was this question answered in a short period of time, but some suggestions for where to find more information were provided by other people. Another example is immediate question and answer in the *"property and contract law"* community. If anybody has building-related legal issues, experts will answer these questions. For example, a question was asked by a supplier about field access. His question was answered immediately, free of charge. With the new version of TeamRoom, the relevant parties will be notified if a document is updated or a new version is added. Also, if a participant has a rough document that he wants others to comment on, he can post it in the library and open a discussion and link to the document.

Nationwide is pleased to assist this fruitful collaboration and to be able to work with its contractors in a better way. The OCPM tool saves time as people spend less time searching for information and more time applying it. It improves the quality as lessons are learned from past experiences. In addition, there is less dependence on an individual, as some of their knowledge is available to all. Nationwide sees this chance of collaboration as an important learning opportunity rather than a sharing of their competitive advantage. However, the question still remains: *How can you quantify the benefits of knowledge management?*

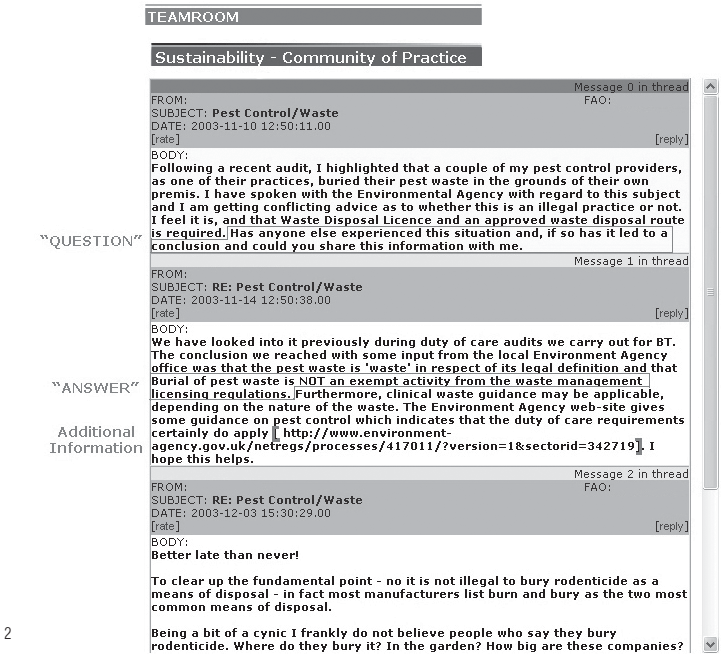

Figure 18. Answer and additional information to a question about pest waste

5.3.2 Process and Workflow Reengineering

Reengineering is a management approach that examines aspects of a practice and its interactions, and attempts to improve the efficiency of the underlying processes. It is rethinking and redesigning of a process or workflow to achieve improvements in critical, contemporary measures of performance such as cost, quality, service, and speed (Hammer and Champy, 2001). Workflow management is another process performance improvement in a cooperative networking environment (Aversano et al., 2002). There are very successful examples of OCPM technology implementations that have used the technology to create (if the organization was not working under a process model) or reengineer internal processes and workflows and establish procedures, templates, and determine the types of data to work with. In the context of this research, the research team came across two financial institutions that used the tool for this purpose. By doing so, the OCPM solution enabled organizations to review their existing processes and workflows, and provided a new way to reengineer them. Organizations gained the capacity to standardize and learn from what they have actually been doing for years. The approach was to configure the OCPM system to match the organization's processes rather than attempting to modify the processes to suit the technology.

Case Study 1:

Nationwide used their project and program management OCPM solution for refurbishment projects, of which they do about six thousand every year, and mandated that all contracted team members should use the OCPM solution for Nationwide projects. The OCPM implementation team first identified and explored Nationwide's refurbishment process, which has nine gates that the project actually goes through. These gates are: develop brief, allocate resources, feasibility, pre-contract period, lead-in period, site works, project review, performance review, and close out. Then, built these gates into the tool. For example, the project cannot proceed to the feasibility stage until a program plan for resource allocation is prepared and uploaded to the OCPM solution. Similarly, the site works stage cannot be complete until all snagging items are rectified. This first gave Nationwide a standard way of working, second assured a certain level of quality in all of their refurbishment projects while saving time by setting solid milestones, and third forced the information to be populated in these gates as the users cannot proceed from one phase to the next unless all the data is complete in the current phase. The main contractors are the biggest supplier of

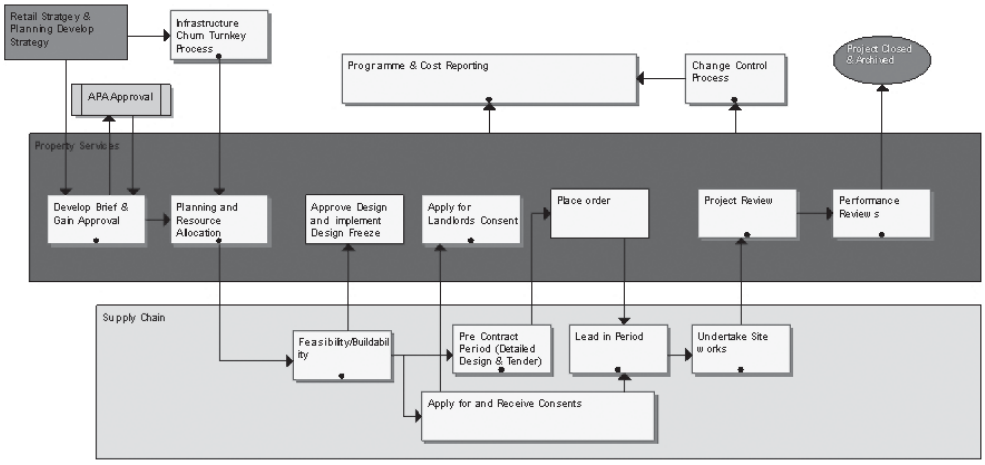

Figure 19. Refurbishment key gates/milestones (From Nationwide's OCPM solution)

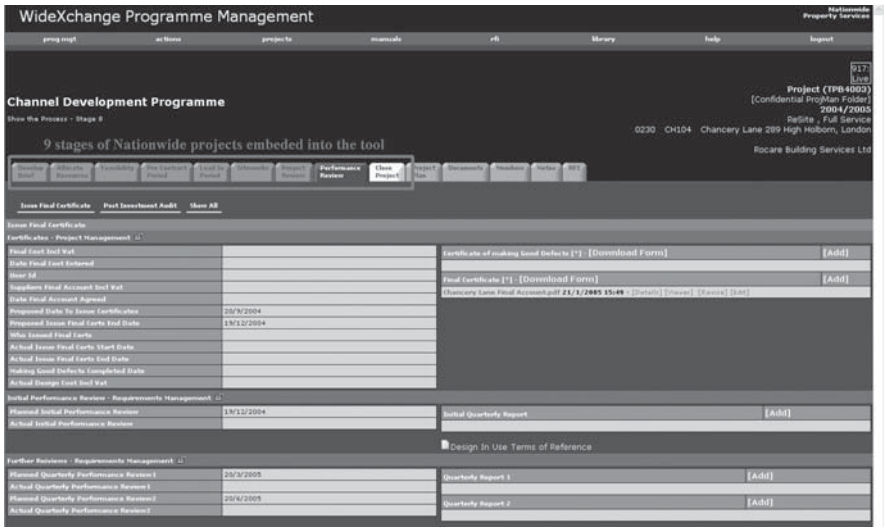

Figure 20. A screen shot of a project collaboration space in CDP; the project is in stage 9 (marked with white background)

the documents. The system is also used for all data-storing requirements in Nationwide refurbishment projects.

Case Study 2:

Another financial institution from UK, the ITG Group, reengineered their design approval process completely, this time to keep up with the accelerated schedule of 1,750 branch refurbishments in a 14-week period. Finishing the project as fast as possible was crucial for ITG because the bank advertised the bank's new image in the media and announced the acquisition of another financial institution. Furthermore, the bank wanted to publicize the acquisition in the stock exchange as soon as possible, which was dependent on the completion of the refurbishment project. The timing, image, and reputation of the bank were three concerns. And any delays in the program would potentially harm the bank's reputation and customer perception.

The project team developed a new *"design approval process"* where traditionally complex aspects could be carried out with *"one click."* Simultaneously, any amendments to rejected designs were supported by an exceptions database. The team agreed to work with photographs and PDF documents instead of traditional architectural drawings, and the whole process was facilitated through the OCPM solution. An assigned person traveled and took pictures of 1,750 branches all around the country. The designers worked on the photographs, and when they finished the design, they uploaded the proposal to the system as PDF documents. Each of the photomontages was supported with detailed design sheets, which included all changes to be made to the branch. The only thing photomontages offered was visual support, which satisfied UK planning authorities. A notification which included all iterations and revisions of the design proposal was simultaneously sent to the ITG project manager. If the ITG project manager approved the design proposal, the solution would send a notification back to the designer; otherwise the project manager would fill an exceptions log which includes the reasons for the rejection and recommendations. A notification would be sent to the designer informing him that the proposal was rejected, including the reasons for the rejection. The next step would be the designer's corrections to the original proposal. The same uploading, notification, and project manager's approval

or rejection would take place until the design was approved by the ITG project manager. Similarly all users would be notified of new documents, approvals, rejections, and changes to any branch that they were involved in. Each document was stored in its native format with the solution, providing full version control as well as a definitive audit trail to guarantee effective project control. Many phases of the project required contributions from multiple team members to ensure that deadlines would be met. For example, the preparation of a photographic montage for each of the 1,750 sites required the designers to work exceedingly long hours. When extra resources were required, another team based in Prague was commissioned. This very simple process enabled the ITG project manager to work from his home on the south coast of the UK and hastened the project schedule. The OCPM solution gave the bank a way to leverage their business processes.

Marek Suchocki, research and innovation manager at Atkins Management Consultants, says, *"This technology does certain things when you do the traditional process, but when you are looking at hundreds and thousands of projects in a small span of time, then one has to look at the technology and say 'how can we redo the old process?'"* Ben Myddelton, project coordinator at Atkins Management Consultants, says, *"The project would be possible but not with this schedule. It was a very speedy program."* William Lesley, the chief designer, agrees: *"It would be possible, but it would take a lot longer and it would be a lot more expensive."* Marek Suchocki searches and finds a project with a cost of £15,000. He says, *"What can you get for that money in a traditional project? You cannot actually get a consultant for that amount of money. That needs a lot of thinking."*

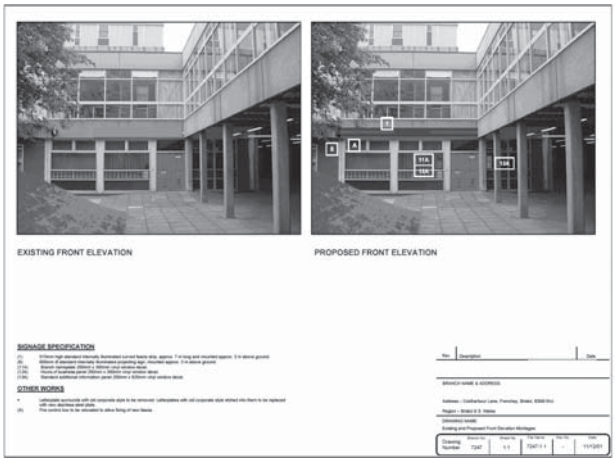

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Figure 21. A "photomontage" design proposal

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Figure 22. An exception's log

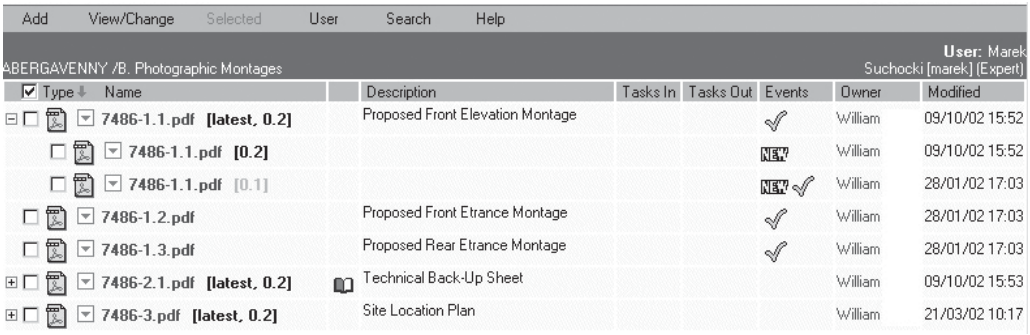

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Figure 23. Design approval page

5.3.3 Supply Chain Integration

Supply chain management is the coordination, integration, and revenue maximization associated with the flow of products, services, information, and money across trading partners. It reaches beyond the boundaries of a single company to share the information between suppliers, manufacturers, distributors, and retailers (Hardaker and Graham, 2001). Optimizing supply chain activities is critical to all industries since it saves money and increases revenues. The research showed that the OCPM technology provides a valuable approach to supply chain management by reducing the waste and problems caused by myopic control. The benefits are seen in purchasing, inventory management, transportation, order processing, customer service, vendor relationships, and production scheduling (Rahman, 2003). By utilizing OCPM technology, companies can target new markets by offering low entry costs and relatively minimal complexity with more flexibility and a convenient way to transact business (Hardaker and Graham, 2001). By outsourcing and forming strategic alliances, companies provide an impetus to support the sharing of supplier, customer, and corporate information that was once proprietary with competitors and other cross-industry players.

An example recognized in this research would be Nationwide's branch refurbishment project where collaboration is needed between internal staff (needs to know what's happening when and what it will look like), financial staff (needs to know the costs), and technical staff (installs the IT systems). In this and many other cases, not only do departments within the organization work together, but external parties (a wide range of suppliers and subcontractors) also need to collaborate in order to realize construction projects. An example would be the need for communication between the Automated Banking Department and the Technology Department in planning an ATM installation, and communication with the main contractors for execution of the work. Previously the organization didn't have a single source to monitor what was being done when and by whom. It was impossible for external parties to get through the organization's firewall. With the implementation of the OCPM solution and hosted databases by the vendor, the organization started pushing and pulling information not just to the internal parties, but also to the external parties. The tool brought multiple projects together and made them visible to the whole project team. The system is substantially supplementing the organization's delivery capability. The major benefit has been the improved communication both internally and across the supply chain. While this is a benefit, the more significant benefit is that it provides consistency in management and coordination in an efficient approach and, more importantly, enables knowledge exchange and management of risks. The tool brings reliability and easiness to information distribution and allows anyone in the supply chain with access to view all records and project and program progress. It ensures that information for all the projects is maintained and kept up to date at all times.

5.3.4 Competitive Advantage

Information technology (IT) helps companies to gain competitive advantage either by performing primary and support activities at a lower cost or performing these activities in a way that leads to differentiation and a premium price (Porter and Millar, 1985). The evaluation of IT is a perennial problem for businesses as they seek to improve their performance and sustain a competitive advantage (Love et al., 2004). While most industries are increasing their expenditure on technology, IT has not yet been recognized as a distinguishing factor that contributes to an organization's competitive advantage for some industries such as construction (Atkin, 1990).

However, it has been observed that many companies have implemented OCPM technology to save time and effort, to gain competitive advantage, to improve productivity, to better align objectives, and to improve product quality. Examples of competitive advantage gained through OCPM technology are competitive tender pricing, improved cost performance, high engineering standards, differentiated services, penetration of overseas markets, advantageous source of equipment, supplies and manpower development, and better service to the clients. Benefits are, mostly, realized by contractors, subcontractors, and construction management firms. These firms believe that they have gained competitive advantage by utilizing the OCPM tool earlier than their competitors. Many managers also agree that having an OCPM tool in place is becoming a contract requirement and a bigger topic of conversation with the owners; therefore it is becoming a larger part of the sales presentations. Clients are more interested in the use of OCPM technology, and how quickly a contractor can go live with the tool is very important, especially on large projects. From a new business standpoint, it is a huge plus to show what capabilities an organization can positively contribute to the owners beyond the standard way of thinking. Actually, some sophisticated owners already demand the use of an OCPM solution for the execution of their projects. The use of these systems is increasingly becoming part of the criteria of selection – if not of requests for proposals – and surprisingly a lot of contractors or construction managers are still not using anything similar to this technology.

5.3.5 Business Development

Besides the traditional implementation and use of OCPM systems, there are several innovative approaches followed by the AEC stakeholders. One of them is the use of an OCPM tool first to gain market share, second to build new relationships with end users, and third to bring visibility to sales. Inscape, a furniture manufacturer in Canada, wanted to use the OCPM technology to differentiate itself in the market by approaching clients to understand their needs and challenges in a construction project and providing them an OCPM solution as a solution to manage their projects. Inscape's main goal was to increase sales by gaining market access. They managed to achieve their goal by building relationships with potential customers and by bringing the customers' projects to Inscape's attention. While all competitors in their field was trying to communicate the value of their work, Inscape wanted to provide a way to create value by using OCPM technology.

Case Study:

Inscape Corporation (Inscape), headquartered in Holland Landing, Canada, is a leading designer and manufacturer of high-performance workplace solutions. Inscape offers a wide array of product solutions for modern office interiors, including movable walls, post-and-beam architectural products, office systems, storage products, seating, and ergonomic work tools. The increasing competition in the market squeezed Inscape, the smallest competitor, out of distribution. Therefore, Inscape decided that they needed to reinvent their marketing strategy and go ahead with a different marketing approach and out-innovate the competition.

Being the smallest player in the market took away the advantages a big player might enjoy such as a large sales force or competitive pricing. The company had never done two things: first, marketed to end users directly – they had always depended on channel partners for marketing as well; or second, tried to learn the needs of their clients. This caused a poor understanding of the market realities. As a result of a buyer behavior exercise conducted subsequently, they decided that their target should be the real estate brokers, building owners, and project managers, as these parties are the ones who know about a

project well before anybody else does and they are the decision makers or influencers. Inscape started to think about the difficulties these people faced, and quickly identified *"project management and communication"* as a common challenging task, and one that isn't the core competency of most owners or brokers. Therefore, Inscape determined to become a very *customer-centric* company where customer needs and challenges are the priorities.

As part of their *new marketing strategy*, Inscape would offer the OCPM technology to real estate brokers and project management communities as a new way of managing owners' projects and potentially helping them save time and money. So Inscape started setting up projects and giving access to team members very inexpensively for project teams' internal communication long before the teams started to think about furniture. Later, as part of the launch of this go-to-market strategy, Inscape also offered up to four "test-for-fit" services facilitated through the OCPM solution. In this case, a potential customer of Inscape uploads their base-building drawings to the system. Then Inscape works on the fit-ins and sends the drawings back to the designer through the OCPM tool or the brokerage house as the case may be, for the end users to review. The end users can mark up and discuss the drawings electronically and send them back to Inscape through the OCPM solution. While the tool provides a practical way to facilitate this exercise, Inscape learns about the project ahead of time. In addition, the tool offers a complete and comprehensive audit trail of any information exchange, including online meetings, which are recorded and can be replayed later. Inscape's only requirement is to be given an equal chance of being a party to the project with the other furniture manufacturers. If Inscape is not awarded the furniture contract for some reason, they still allow the owner to use the tool for the project. In this case, Inscape creates guest licenses and allows their competitors to work only in that particular project without being able to invite others.

With the industry growing and Inscape's innovative use of the OCPM technology, Inscape is again well positioned. Its sales are growing steadily (tripled their presence in Toronto alone), as they now have a new approach to market and each collaboration partner has their own relationships they bring to the table. Besides the increased market access, this tool substantially helped Inscape in building long-lasting relationships with their customers. As construction projects require the collaboration of numerous parties, the OCPM tool is exposed to more projects and so is Inscape, building more relations with owners, subcontracting trades, and contractors. As the OCPM tool brings several benefits to project teams from the project management standpoint, Inscape's negotiations for its product have become much easier. Inscape has noticed that the customers don't usually bargain for a price reduction on the furniture when they are enjoying efficient processes, shorter project cycles, and reduced costs. By offering this service to the project team, Inscape has gained access to the players down in the supply chain such as real estate brokers, designers, end users, and dealers. The tool and the service proposition enable Inscape to meet project stakeholders that they usually have no access to. Dan Kennedy, sales analyst at Inscape, says, *"Getting involved in the project sooner, this is one way that we can spark up in the conversation sooner. This is extremely important for our sales."* In addition, Inscape realized potential benefits in its own operations such as efficiency in its internal sales and design development. Internally, if they hadn't implemented the system they would have lost responsiveness to customer needs and requests, the speed and accountability of information transfer, as well as the audit trail. Jacquie Spencer, project coordinator, says, *"If we don't have the tool we would go back to extended response times because we will be dealing with overnights and time zones. It can slow down our process seriously."*

5.3.6 Forecasting

Another innovative use of OCPM technology is employing the solution for *forecasting*. For public entities such as the Los Angeles Unified School District (LAUSD), reporting and accuracy of information is critical as in most cases the success of the program depends on subsequent phases' success because funding for the new school construction program is primarily provided through tax revenues.

Case Study:

The Los Angeles Unified School District's (LAUSD) new construction program is a multi-phased, multibillion-dollar program to deliver new school facilities with the aim of relieving critical student overcrowding throughout LAUSD. This overcrowding has resulted from one, increased student enrollment; two, state-mandated class-size reduction; and three, lack of funding to expand capacity in the years prior to this effort. This new construction program requires LAUSD to identify target areas of need, acquire necessary sites, design and develop plans, and construct schools as quickly as possible. Over the next six years, LAUSD will complete 139 new construction projects to accommodate explosive growth in the student population. There are three finance mechanisms generating funding to meet the needs of a new construction program: first, bonds, which are issued by government agencies for the purpose of raising money; second, direct revenue generated from tax receipts and interest; and third, grants, which are gifts of money for a specified purpose from various sources. For public entities such as LAUSD, reporting and accuracy of the information is critical, especially in the preconstruction phase during which two factors, *design* and *acquisition of the land*, affect 95% of the total project costs. In the first six to eight months of construction projects, LAUSD certifies and makes its budget commitments. Therefore, accurate forecasting of the costs of a project is extremely important. LAUSD utilizes the OCPM solution in order to control the budget activity in an easier and more precise way.

Using the OCPM tool also as a forecasting tool required some degree of customization. LAUSD brought in experts to set up the entire set of budget constraints and a layer that shows all the potential costs. This allowed managers to check the budget of each project as well as the master budget for the overall program. LAUSD uses the OCPM tool to create a series of cost codes and ties the costs to LAUSD's accounting system. LAUSD built nine phases of construction into the tool. These phases are actually a crosswalk definitions table that ensures consistency between LAUSD's accounting system and the OCPM solution. Since LAUSD's accounting system is set up primarily for operating a school district (with teachers' salaries, etc.), they have attached the capital construction program on top of this system using only selected cost codes for proper coding.

The phases refer to the work areas that occur throughout the entire life of a project, including the site, environmental, plans (architectural, structural, etc.), construction (contracts, utilities, demolition, design and construction costs, etc.), management (real estate, design, project management, construction management), tests (soil, structure, other), inspection (construction, technology), furniture and equipment, and community outreach.

		BUDGET				COMMITMENTS					OVER / (UNDER)
PHASE	Cost Code	Current Budget (C)	Pending Revisions (D)	Estimated + Adjustments (E + F)	PROJECTED C + D + E + F (G)	Original Commitment (H)	Approved Revisions (I)	Pending Revisions (K)	Estimate to Complete (L + M)	ANTICIPATED H + I + K + L + M (N)	Anticipated Costs vs. Projected Budget (N - G)
2 ENVIRONMENTAL											
2.E.1-71	DTSC (DEPT TOXIC SUBSTANCES CONTROL)										
2.E.1-72	PEA (PRELIM ENVIRONMENTAL ASSESSMENT)										
2.E.1-73	RAW (REMOVAL ACTION WORK PLANS)										
2.E.1-74	RAP (REMEDIAL ACTION PLAN)										
2.E.1-75	CEQA (CALIF. ENVIRONMENT QUALITY ACT)										
2.E.1-76	AIR TOXICS										
2.E.1-77	EHS OTHER										
2.E.1-7A	SITE - EHS OVERSIGHT-PRECONSTRUCTION										
2.E.1-7B	SITE - EHS OVERSIGHT-CONSTRUCTION										

Figure 24. Example of one category and some of its subcategories from OCPM solution of LAUSD

LAUSD is planning an Oracle-based automatic upload from the accounting database to the OCPM system to include project contract commitments, expenditures, and encumbrances. LAUSD managers use the tool as a way to predict future costs. The tool has categories for budget (current, pending, estimated + adjustments, projected) and commitments (original, approved revisions, pending revisions, estimate to complete, anticipated). By comparing anticipated costs to projected budget, LAUSD managers have good track of what funds are available for each project and what has been spent to date in any given region. Charlie Anderson, LAUSD Program Manager, says, *"The single biggest benefit is that we can see where the trends are going and we have the power to do something before it is too late."*

5.3.7 Risk Management – Claims Mitigation and Management

Changes are major sources of construction claims and disputes. Many cases indicate that the main cause for claims is disagreement between the parties about equitable compensation. Timely and accurate project information is the cornerstone of a successful claims resolution in today's fast-paced, information-intensive projects. In broad terms documentation is essential to support the claims management process. During litigation planning, a claim analyst will rely on documentation to define the disputed issues, establish production facts, plan a case scenario, etc. Moreover, documentation is instrumental for discovering the relevance of a claim, establishing a damage value for the facts under dispute, setting up a credibility standard for proof of entitlement, ascertaining the impacts or damages, and supporting claims for additions or omissions for changes. The problems with claims management are most profound in the areas of claims justification and quantification and are acute with respect to retrieval of supporting information and adequacy of information (Vidogah and Ndekugri, 1998).

All project groups are susceptible at one point or another to becoming involved in a claim. Suppliers, subcontractors, trades, consultants, and owners need quick and easy access to the wealth of knowledge that exists within the collective documentation of the project operations in order to make claim decisions and realize their damages. The claims management stages involve: ensuring compliance with provisions of contract, justification of the claim principle, and quantification of the claim. On a major construction project, the main contractor has to assimilate paper-based documentation of, say, a dozen subcontractors as well as the design team, and manage subsequent changes. It is no surprise that vital evidence required to substantiate claims takes ages to identify, retrieve, and assemble. OCPM technology removes a major obstacle to preparation of well-substantiated claims less likely to be disputed. Absence of necessary information is particularly the case with information that establishes a casual link between the amounts claimed and the events giving rise to the claim. This absence forces contractors to use questionable approaches to the quantification of claims. In all cases of this research study, the projects' team members stressed the importance of the OCPM solution one, to prevent potential claims, and two, to manage the review of construction disputes.

With the use of the OCPM solution, project teams minimize the risk of losing data. Considering the number of projects and the size of the construction programs, it has been very important for the investors that the information is centralized, recorded, and never lost. David Page of LAUSD, OCPM tool implementation leader, explains from his own experience: *"I was involved with a project in which we had everything in the tool. There was the first series of heavy storms. The contractor had started the excavation but they actually lost part of their job site because of flooding. The question came up about who*

is responsible for the erosion control. It was the time when most files were displaced and some were destroyed due to flooding. What we found out is during the pre-bid process, there was a significant RFI that came in from one of the contractors asking if erosion control is supposed to be in the earthwork contract. The response came back from the owner that it was. [Until then,] we didn't know that the same contractor who filed the claim had written a letter stating that they wanted to verify that the erosion control would in fact be included in their contract even though it wasn't stated in the bid documents. It was signed by the same gentleman who was filing the claim. The overall claim was about $300,000. The district paid $35,000 because we considered it as a natural disaster. ***That one claim itself paid for the entire system.****"*

Having an archive of all communication and information is important in case of any reviews and construction disputes. If the teams need to prove a point, the OCPM tool would give them access to final documentation as well as the previous communication in a structured and credible way. Michael McKay, TRM Healthcare's project manager, says, *"I think the increase of communication and having an archive of all of this communication in case of reviews are important benefits of the tool. We didn't have any claims or a major problem that we had to go back and resolve. But if we did, if a document wasn't there it wasn't anywhere."* According to John King of J.J. Gumberg, Carnegie Mellon University Collaborative Innovation Center project developer, with 30 years of experience in construction, it is hard not to have any unpleasant experiences during construction. He says, *"There are all kinds of things that can happen; litigations or weak memories. It is always good to have good record keeping. The Carnegie Mellon University project has been a very smooth project. But if there would be a structural problem 5 years from now, we would be able to go back and see if there were any questionable methods of doing something."* This means that, in case of any claims or disputes, the investor doesn't have to go back and spend a lot of time trying to research their archives or the email files of their employees. Dennis DiPalma of P.J. Dick Incorporated asks, *"What if the key personnel to solve the problem left the company?"* If all the information is in the system, it is documented and nothing can be deleted. From the owner's point of view having access to all project information is also crucial. For example, although the owner doesn't usually get involved with the RFI process directly, they would have access to all modules and could track any RFI in case of any disputes.

In most projects, all documents that are part of the contract and any information that is specified by the contractors are being tracked through OCPM solutions. Rodger Hughes of LAUSD, owner's authorized representative, says, *"You don't have to go and dig into a file cabinet. This is a great legal tool. Any backups the contractor has – sketches, letters, documents – are always in the system."* Charles Wren, LAUSD's on-site representative, adds, *"We don't have any formal claims in the project yet, but we have several construction disagreements. I think the records will help us in case they turn into claims. All parties know we register everything to the system. The best way to stop a claim is to stop before it happens."*

5.3.8 Performance Measuring – Setting Incentives

Another innovative use of OCPM solutions is for reviewing the performance of the project and the main contractors once the project is completed. If the data from earlier work is integrated into the system, these solutions can enable measuring contractor performance against past performance. The tool can measure how they performed on a particular project. This enables the organization to set a benchmark of their work performance and evalu-

ate main contractors' performances. According to these assessments, the investor can reward some contractors with more projects if their performance is good or improved, and reduce the workload of others if their performance level is low. There are several benchmarking capabilities built into these tools that allow the investor to manage the process and key drivers.

Contractors and all other nominated parties are also able to manage their own key performance indicators (KPIs) to ensure that they can also manage their individual processes and make changes as necessary. KPIs are measures of different aspects of a project that can be used to monitor how a project or a program is performing against targets to review the delivery efficiency. For example, the investor (in this case the owner) could assess how accurate the final cost is compared to the budget cost as a percent of accuracy. This would enable the investor to assess and compare accuracy across all projects. Similarly the investor can measure the number of defects on completion as a score, to assess and compare the impact on the end user of any defects at the time of handover. Measures like this would enable some key performance statistics to be generated on a project or a program to assess how it has performed across a number of different categories. The investor in turn can track these changes through the tool. The performance module allows the investor to mine its project data to see whether it is hitting KPIs at project and also program level. They can also generate performance reports based on these KPIs.

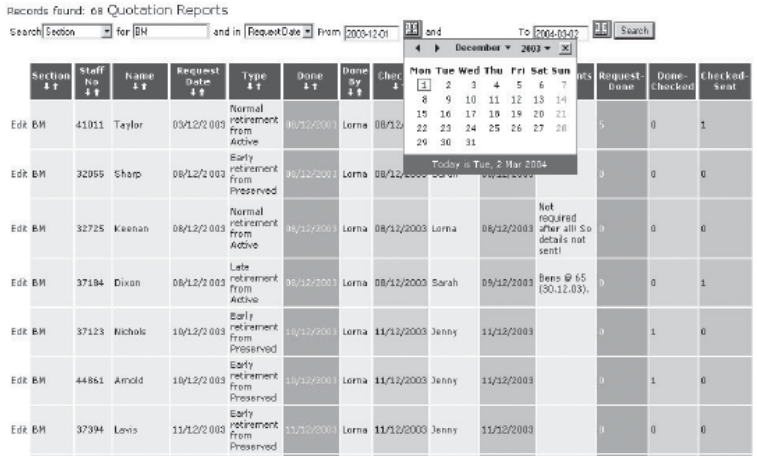

Figure 25. OCPM technology enables the team to run reports on progress and calculate KPIs

6. CONCLUSION

The evaluation method, explained in the previous sections, was successfully completed in nine case studies. The outputs of the OCPM technology evaluation method in each of these nine case studies can be seen in Table 2.

In four out of nine case studies, the investors hadn't focused on tangible benefits during or after the investment decision regarding the OCPM technology; therefore these savings weren't and couldn't be considered in the study. In these cases, investors focused on organizational-level business benefits rather than project-level benefits. This has been experienced as a clear tendency among the investors. It was found that two major difficulties are making the OCPM evaluations problematic to complete. The first difficulty is the process of identifying the benefits. It was secondly found difficult to estimate the value of the economic benefits. The evaluators often felt that the estimations given were too imprecise and therefore required a further examination.

If we examine the findings in depth, we realize that the tangible benefits vary between $42,000 and over $500,000. Even the lowest figure for the tangible benefits is more than the investment cost itself, which justifies the investment without any need to explore further. Quasi-tangible and intangible benefits become pluses of the investment after the break-even of tangible benefits. However, the research team finds tangible benefits arbitrary to a certain degree as they are based on some degree of assumptions such as percentage of printing and mailing. In addition, in some case investors don't get the direct benefits in savings but other team members realize them. For example, if the investor is the owner, most savings from printing, faxing, copying, etc. would be realized by the other team players.

However, the positive impact of OCPM tools on construction processes is quite obvious. Among these are electronic RFIs, bidding, and document transfer. The research findings show that the new RFI turnaround time is as low as *5.4 days* compared to 14 days of the industry average. Although it might be difficult to project reduced RFI turnaround time on the project schedule, most users believe there should be a positive correlation between the gained efficiency in the critical processes such as RFIs and the project's overall timeline. In addition to reduced turnaround of construction workflows, OCPM solutions bring enormous efficiency and savings to the document exchange process as well. As calculated by one of the investors, these savings can get as high as $536,500 depending on the organization's project portfolio, processes, and team members' number and locations. OCPM technology is also used commonly in the bidding process due to the efficiencies gained in preparing, distributing, and organizing the bid documents. Time

Case Name	Tangible Benefits ($)	Quasi-tangible Benefits (rating)	Intangible Benefits (identification)	Cost/Program Ratio
Indianapolis Public Schools **Owner**	**$59,000/year** (10 projects)	**3.94/5.00** 20 benefits out of 27	Not identified	**0.07%** (considers 1st phase program)
Inscape Corporation **Supplier**	Not considered	**3.48/5.00** 12 benefits out of 27	*4 identified:* Increased sales, Market access and exposure, Better customer relations, Negotiating power	Pass the cost to the owner
ITG Group **Owner**	Not considered	**4.04/5.00** 21 benefits out of 27	*2 identified:* Process reengineering, Realization of ambitious schedule	**0.1%** (the cost includes development of the software)
Kitchell Contractors **GC/CM**	**$42,000/year** (10 projects)	**3.50/5.00** 15 benefits out of 27	Not identified	Pass the cost to the owner
LA Unified School District **Owner**	Not considered	**3.80/5.00** 19 benefits out of 27	*2 identified:* Forecasting, Risk management	**0.02%** (considers 2nd phase program & includes develop. fees)
Manhattan Construction Company **GC/CM**	**$59,000/year** (18 projects)	**3.64/5.00** 14 benefits out of 27	Not identified	**0.04%** (assumes the firm has at least 4 $100mil. projects every year)
Nationwide Building Society **Owner**	Not considered	**3.90/5.00** 25 benefits out of 27	*4 identified:* Supply chain integration, Knowledge management, Performance measurement, Process reengineering	**0.15%** (the cost includes development of the software: PM & KM)
P.J. Dick Incorporated **GC/CM**	**$47,100/year** (10 projects)	**3.50/5.00** 20 benefits out of 27	*1 identified:* Competitive advantage	*"not released"*
TRM Healthcare **Owner**	**$536,500/year** (10 projects)	**3.65/5.00** 13 benefits out of 27	Not identified	*"not released"*

Table 2. Tangible, quasi-tangible, and intangible benefits, and cost-to-project/program ratio, for nine OCPM technology investment implementations

and dollar savings are enormous. According to the calculations of one of GSA's Service Centers, the savings could be around $52,000 without any additional increase in cost of the investment. The research team came across similar use and benefits in several other implementations, one of which is an implementation by a government agency in the UK. The solution was successfully used in transferring over 3,000 data files, internal and bidder queries and answers, invitations to bidders, exchange of the documents, and

circulars. As a result, the investor reduced the cost of the bidder query process and its onerous nature and realized cost savings in excess of $500K in document production and distribution alone. Besides the monetary savings, having a complete audit trail, controlled access to information, improved processes; clearer documents, up-to-date information, and faster RFI turnaround were among the most-quoted benefits of utilizing these tools in the bidding process.

In all, the average savings per project is $149,000. One may argue that this figure is subjective, because savings pass from one to another and it is very difficult to document how much is being printed, mailed, and copied between parties. Although efficiency savings are quantifiable in monetary terms, they are minor as compared to the rest both from investors' and collaborators' points of views.

If we look at the "non-quantifiable" benefits of OCPM technology, we realize that the quasi-tangible benefits were ranked 3.50 (out of 5.00) at the lowest end. The highest ranking for quasi-tangible benefits was 4.04 (out of 5.00). Intangible benefits were not identified in all of the cases. Again, the main goal of the investor is extremely important when evaluating the benefits of OCPM tools. Special attention should be given to the drivers behind the investment decision: whether tangible, quasi-tangible, or intangible benefits, or a combination of these. In most cases, implementation beyond the regular use of OCPM technology was realized. Some examples of these are: increased sales and improved customer relations, forecasting, risk (claims) management, process reengineering, supply chain management, and competitive advantage. Although these benefits are not quantifiable or measurable, it has been experienced that they are extremely critical for organizations' business goals and profitability.

The cost information is considered to be commercially sensitive from both the investors' and the vendors' points of views. In two case studies, the cost of the system wasn't released upon the request of the investor and the solution vendor. However, in all, the highest cost-to-program ratio is 0.15%, which is quite small when information technology investments are considered. It should be noted that in this ratio, the cost includes a serious level of customization of the solution, which eventually increases the percentage. The smallest cost-to-program ratio realized was 0.02%. This number is quite low for any kind of efficiency realized in return. It is evident that once the investment is made, it is important to roll it out to as many projects as possible so that the investor can enjoy the benefits of economies of scale.

In terms of common trends in the implementation and use of OCPM technology in the AEC marketplace, there are several promising developments. First of all, the investors and users are fully convinced about the benefits of these tools in their operations. OCPM technology is becoming a standard way of managing construction projects, and going back to paper-based management systems seems almost impossible. However, the importance of the implementation has also been realized by the investors and users. Therefore, in most cases, the research team realized a verbalized need or action for new implementation strategies. The teams are considering optimizing the use of their OCPM solutions and starting with rolling out the most used modules, which generally include the document management module. In most cases, reimplementation is carried out by a staged strategy. Serious importance is given to training the users, mandating use of the tool, and supporting the implementation by top management. Overcoming change and cultural barriers are amongst the hottest topics of OCPM implementation.

In addition, the investors realize that integration of their OCPM solution with their other key software is critical for getting the best desired results. Some efforts in the industry are integration of the OCPM solution with accounting, contracting, and purchasing solutions. Many investors are considering ways to easily reuse and reconfigure their OCPM solu-

tions for future projects. Being able to use the data, information, and knowledge collected throughout the construction projects by the OCPM technology is an area that investors pay serious attention to. For example, investors want to import information to their facilities management software and attach intelligent data to it. Knowledge management, revisiting data on past projects, and having a universally accessible library are common thoughts among the investors.

In summary, OCPM technology is an invaluable asset for AEC industry organizations and projects. Investors and users agree that if they didn't have their OCPM solution in place, they would lose:
- their control of the overall program,
- information availability to make valid decisions,
- advantage in resolving disputes,
- efficient communication and coordination,
- their ability to enforce the workflow and data population,
- individuals' time,
- accountability and accessibility,
- ownership of the data,
- decision-making advantage, and
- standardization throughout their projects.

The owners and general contractors are among the common investors and users of these tools. Architects, engineers, and construction/project managers are also frequent users of these tools. However, it is rare that the suppliers and subcontractors use the tools, mostly due to security, cost, and technology-proficiency-related reasons. OCPM technology seems more appropriate for repetitive and multiple projects, as owners are more willing to invest due to the ability it gives them to have easy control over the project or program, to look across projects and make comparisons very quickly, and to stop and divert something before it happens. In addition, having an OCPM solution in place gives an advantage of learning from their previous mistakes and other peoples' experiences, helps to set standards, enables negotiating the cost with the vendors, and enables customizing the tools according to investors' needs.

In conclusion, the research shows that these tools will be the new way of managing construction projects in the future. Common sayings in the industry are that "it is not only the technology!" and "the next big step is the implementation!" Users acknowledge that it is important to match the process rather than attempting to modify the process to suit the technology. In addition, integration of several applications and expanded use of the tool with added modules by more collaborators will be realized more commonly in the industry. And eventually, the use of OCPM tools will become a requirement in construction projects.

7. REFERENCES

ANDRESEN, J. (2002) How to select an IT evaluation method – in the context of Construction. International Council for Research and Innovation in Building and Construction, CIB w78 Conference 2002, Aarhus School of Architecture, June.

ANDRESEN, J., BALDWIN, A., BETTS, M., CARTER, C., HAMILTON, A., STOKES, E., & THORPE, T. (2000) A Framework for Measuring IT Innovation Benefits. ITcon Vol. 5, 57-72, http://www.itcon.org/2000/4.

ARSLAN, G., TUNCAN, M., BIRGONUL, M. T. & DIKMEN, I. E-bidding Proposal Preparation System for Construction Projects. Building and Environment, In Press, Corrected Proof.

ATKIN, B. (1990) Information Management of Construction Projects, Sydney, T W Crow Associates and Crow Maunsell.

AVERSANO, L., CANFORA, G., DE LUCIA, A. & GALLUCCI, P. (2002) Business Process Reengineering and Workflow Automation: a Technology Transfer Experience. Journal of Systems and Software, Vol: 63, pp: 29-44.

BALDWIN, A., BETTS, M. & BLUNDELL, D. (1998) Measuring the Benefits of IT Innovation, Construct IT, Centre of Excellence.

BETTS, M. (1999) Strategic management of IT in construction, Oxford ; Malden, MA, Blackwell Science.

BJÖRK, B. C. (2003) Electronic Document Management in Construction: Research Issues and Results.

BROWN, A. (1994) Appraising Intangible Benefits from Information Technology Investment. Proceedings of the 1st European Conference on IT Investment Evaluation. Henley, UK.

BRYNJOLFSSON, E. (1993) The Productivity Paradox of Information Technology. Communications of the ACM, Vol: 36, pp: 67-77.

BURNS, R. B. (2000) Introduction to Research Methods, London, SAGE.

BUSH, I. (1999) A Proposal for a Feasibility Study for an Application of Knowledge Management. School of Construction and Property Management. Salford, UK, University of Salford.

CASTLE, C. M. (1999) Construction project Networks: a Study of Internet-based Interorganizational Information Systems in the Building Industry. Harvard University. Graduate School of Design. Doctor of Design Program.

EARL, M. J. (1988) Information Management: the Strategic Dimension, Oxford [Oxfordshire], New York, Clarendon Press; Oxford University Press.

EGBU, C. O. & BOTTERILL, C. (2002) Information Technologies for Knowledge Management: Their Usage and Effectiveness.

FARBEY, B., LAND, F. & TARGETT, D. (1999) Moving Information System Evaluation Forward: Learning Themes and Research Issues. The Journal of Strategic Information Systems, Vol: 8, pp: 189-207.

HAMMER, M. & CHAMPY, J. (2001) Reengineering the Corporation: a Manifesto for Business Revolution, New York, Harper Business.

HARDAKER, G. & GRAHAM, G. (2001) Wired Marketing: Energizing Business for e-commerce, Chichester ; New York, Wiley.

HOCHSTRASSER, B. & GRIFFITHS, C. (1991) Controlling IT Investment: Strategy and Management, London ; New York, Chapman & Hall.

HOGBIN, G. & THOMAS, D. V. (1994) Investing in Information Technology: Managing the Decision-making Process, London ; New York, McGraw-Hill.

IRANI, Z. (2002) Information Systems Evaluation: Navigating Through the Problem Domain. Information and Management, Vol: 40, pp: 11-24.

KEEN, P. G. W. (1991) Shaping the future : business design through information technology, [Boston, Mass.], Harvard Business School Press.

LOVE, P. E. D. & IRANI, Z. (2001) Evaluation of IT costs in construction. Automation in Construction, 10, 649-658.

LOVE, P. E. D., IRANI, Z. & EDWARDS, D. J. (2004) Industry-centric benchmarking of information technology benefits, costs and risks for small-to-medium sized enterprises in construction. Automation in Construction, 13, 507-524.

MARSH, L. & FLANAGAN, R. (2000) Measuring the Costs and Benefits of Information Technology in Construction. Engineering, Construction and Architectural Management, Vol: 4, pp: 423-435.

MILIS, K. & MERCKEN, R. (2004) The Use of the Balanced Scorecard for the Evaluation

of Information and Communication Technology Projects. International Journal of Project Management, Vol: 22, pp: 87-97.

PARKER, M. M. & BENSON, R. J. (1988) Information economics : linking business performance to information technology, Englewood Cliffs, NJ, Prentice Hall.

PARKER, M. M., TRAINOR, H. E. & BENSON, R. J. (1989) Information Strategy and Economics: Linking Information Systems Strategy to Business Performance, Englewood Cliffs, N.J., Prentice Hall.

PORTER, M. E. & MILLAR, V. E. (1985) Information for Competitive Advantage, Boston, Mass. (Soldiers Field, Boston 02163), Division of Research Graduate School of Business Administration Harvard University.

RAHMAN, Z. (2003) Internet-based Supply Chain Management: Using the Internet to Revolutionize Your Business. International Journal of Information Management, Vol: 23, pp: 493-505.

SEKARAN, U. (2003) Research Methods for Business: a Skill-building Approach, New York; [Great Britain], Wiley.

STEWART, R. A., MOHAMED, S. & DAET, R. (2002) Strategic implementation of IT/IS projects in construction: a case study. Automation in Construction, 11, 681-694.

STRASSMANN, P. A. (1990) The Business Value of Computers, New Canaan, Conn., Information Economics Press.

SUN, M. & HOWARD, R. (2004) Understanding IT in Construction, London, Spon Press.

VAN GREMBERGEN, W. (2001) Information Technology Evaluation Methods and Management, Hershey, PA, Idea Group.

VAN GREMBERGEN, W. (2002) Information Systems Evaluation Management, Hershey, PA, IRM Press.

VIDOGAH, W. & NDEKUGRI, I. (1998) A Review of the Role of Information Technology in Construction Claims Management. Computers in Industry, Vol: 35, pp: 77-85.

WILLCOCKS, L. (1992) Evaluating Information Technology Investment: Research Findings and Reappraisal. Journal of Information Systems, Vol: 2 pp: 243-268.

WILLCOCKS, L. & LESTER, S. (1999) Beyond the IT Productivity Paradox, Chichester, England ; New York, Wiley.

ZEE, H. (2002) Measuring the Value of Information Technology, Hershey, PA, Idea Publishing.

END NOTES

1. OCPM technology refers to any of various web-based (in which information generated by project team members is automatically saved to the OCPM solution on the web) and web-enabled (in which the Internet is used to connect directly to remote applications and self-hosted client databases) technologies that offer communication platforms, project management functionalities, and hosted collaboration spaces for capital construction projects.

2. "Investor" in this book is referred as "buyer" of OCPM technology.

3. www.groupbc.com/

4. www.constructware.com/

5. www.ebuild.ca/

6. www.mps.com/

7. www.primavera.com/

8. IE seeks to identify and measure or rank the economic impact of the changes brought about by the introduction of the new system on an organization's performance.

9. This metrics measures how technology is benefiting management decisions. ROM assumes that managers are the processors of all of a company's inputs and ultimately account for returns instead of capital investments or technology.

10. The goal of SESAME has been to create a set of tools to study the performance of operating systems. IBM developed this method in order to provide a more flexible approach to cost/benefit analysis. Here the costs and benefits of an IT-based system are compared against an equivalent manual system. This method bases much of the assessment on user opinion, which may involve users more in the process of assessment.

11. The method considers three ways in which IT can improve investors' business: efficiency ("doing things right"), effectiveness ("doing the right thing"), and performance ("doing better things").

12 & 13. At the request of the investor, names of these organizations, their projects and

participants were changed for confidentiality reasons.

14. Design and creation of software to meet a customer's specific needs; an application- or company-specific interface and/or database design.

15. Process of making optional minor changes to defaults of software that is installed and configured on a system.

16. Includes the development, levels of customization and/or tailoring, ongoing redevelopment (if any) costs of the solution, implementation, training, and maintenance fees.

17. Review time is the number of calendar days after the creation of an RFI by which a response needs to be received. This value automatically populates the date required.

18. Courtesy of Jay Burris of General Services Administration.

19. www.gsa.gov

20. Courtesy of Todd Wynne and Harold Heit of TRM Healthcare.

21. The name of this company and the names of the people and organizations involved with this company were changed for confidentiality reasons.

22. Data is collections of facts, measurements, or statistics.

23. Information is organized or processed data that is timely and accurate.

24. Tacit knowledge is a cumulative store of experiences, mental maps, insights, acumen, expertise, know-how, trade secrets, skill sets, understanding and learning that an organization has (Sun and Howard, 2004).

25. Explicit knowledge can be captured, stored and used without reference to others (SUN, M. & HOWARD, R. (2004) Understanding IT in Construction, London, Spon Press.).

COMPUTER AIDED COLLABORATION FOR MANAGING CONSTRUCTION

Nine Case Studies on Technology Implementation and Value Analysis

CASE STUDY 1. INDIANAPOLIS PUBLIC SCHOOLS

1. INTRODUCTION

This case study focuses on identification and measurement of the value of online collaboration and project management (OCPM) technology from a public owner perspective. The case covers tangible and intangible benefits/values at both the project and the organizational level. The following subsections give a brief description of the program and outline the need, selection, cost, and implementation of an OCPM tool in a capital improvement program. A project of Indianapolis Public Schools (Riverside Elementary School) is selected as a model for OCPM tool value calculations.

1.1. Capital Improvement Program

Indianapolis Public Schools (IPS) is the largest school district in the state of Indiana, with 79 schools serving more than 39,000 students. In accordance with a strategic plan developed in 1999, IPS conducted a facility study in 2001 which showed that many of its facilities should either be upgraded or replaced to meet educational and physical requirements. Following the findings of this study, IPS initiated a 10-year capital improvements program (CIP) in 2001 with a total cost of US$832 million to bring aging IPS school buildings up to current standards. Schmidt Associates (Schmidt) was selected as the CIP manager and IPS' representative at the beginning of the program. Schmidt is a full-service facility design firm that leads the design and construction process for owners. The firm offers various professional services including construction administration, engineering, architecture, owner's representation, and site and interior design.

The program covers 78 schools and includes renovations, expansions, and a number of new schools. The work has been divided into three phases. Phase 1, which is currently under way, was initiated with a US$250 million bond issue in 2001. The first phase covers: (1) renovation of science labs in 23 locations (these are small projects roughly US$300,000 each) and (2) 12 large projects (6 high school renovation projects and 6 new elementary schools). The school board went through a bond initiative at the end of 2004 to obtain US$200 million for the second phase. As of April 2005, project teams are in the beginning of the planning and design work of Phase 2, which consists of renovations of several middle and high schools as well as three elementary schools.

1.2. The Need for an OCPM Solution

IPS was aware of the magnitude of the CIP and the financial commitment it entailed from their community. For IPS, cost overruns or other problems that would hinder the benefits to the community weren't acceptable. IPS' priority was executing the CIP in a way that set definite budgets and developed the projects in a manner consistent with these budgets. This was a critical issue in order for the CIP to be continuous; in other words, the first phase's success was essential for continuing to the second phase. In addition, IPS (the owner) and Schmidt (program manager) knew

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Figure 1. New elementary school

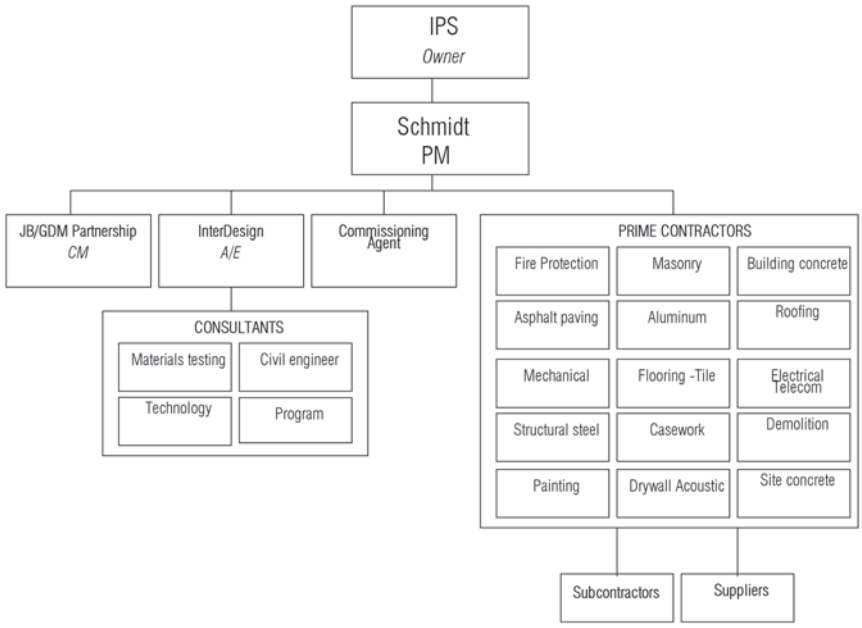


Figure 2. Project team organizational diagram and number of members that have access to the OCPM solution

that coordinating the work of thirteen architecture/engineering (A/E) firms, nine construction managers (CM), and scores of contractors and consultants across dozens of schools would be a major challenge. For these reasons, IPS and Schmidt have decided that an OCPM solution was vital for centrally coordinating the program and accurately managing the projects.

1.3. OCPM Technology Selection

Schmidt started searching for a completely web-based tool with the best usability and flexibility. IPS wanted a web-based tool because they wanted all functions to be accessible through a browser from any type of computer with any type of Internet connection. In addition to the tool's features and capabilities, the technology provider's stability in the market was another decisive factor, as IPS would rely on the tool for the duration of the program. The team formulated a list of assessment criteria and prioritized them. Schmidt prepared and sent a request for qualification (RFQ)

to six technology providers. Among the six vendors, only three were considered because one vendor sent answers to a "similar" RFQ, one vendor sent "decline to respond," and the other didn't respond to the RFQ at all. Schmidt's information systems analysts reviewed the responses, conducted further industry research on selected vendors, and explored systems with demo accounts. Schmidt also sought recommendations from the State of Indiana and from other AEC firms. After the first assessment, the list was refined to two vendors, one of which was Constructware. Schmidt asked for a web-based conference with each vendor to clarify RFQ information, to ask additional questions, and to walk through specific features. Constructware was awarded the contract based on its demonstrated features: document and process management features (built-in viewers, auditing, and processes/documents supported, reporting), user interface (external e-mail notification, client system/bandwidth requirements, intuitive "out of the box," content customizability on the personal level), system administration (security, level of customization, the ability to browse external archives, broadcast messaging), vendor stability (responsiveness, company stability, system integrity, training availability), and its cost structure. IPS started implementing the OCPM solution in 2001.

1.4. The Cost

IPS is paying for the OCPM tool and providing it to all project participants. By providing the tool and mandating its use, IPS believes it will be able to realize problems early in the process and will be able to monitor the overall program in a more efficient way. IPS has purchased a 5-year enterprise license which allows the district to add number of users. The total cost was US$175,000 for the license excluding training, implementation, and additional costs. As the system is web-based there were no additional support costs and infrastructure costs such as servers, backup systems, etc. The ratio of total OCPM budget (including implementation consulting, training, license, and project close-out) to overall project cost is 0.07%.

1.5. Implementation

Training hundreds of entities and getting them to "buy in" to the system, has been crucial to gaining financial and process benefits. An early tactical step was to contractually mandate the use of the OCPM solution for all parties. They also mandated the training requirement. The training was extensive but not lengthy. The first step was training the administrators and IPS/Schmidt trainers so they could carry on the training sessions in the following phases of the program. For Phase I projects, IPS/Schmidt brought in the trainers to give on-site training with flexible schedules that accommodated trainees' schedules. Private one-to-one sessions were also offered by the IPS/Schmidt OCPM tool administrators for users with little or no exposure to an online application. For better buy-in, IPS purchased the rights to use the software and make it available to the contractors and also provided training sessions for them. As a result, at least one primary staff member at each contractor has been able to utilize the OCPM solution. Weekly continuing education sessions are also available to the users via a free online meeting service provided by the solution vendor. There are currently 23 IPS projects in the system. Most of them have two more years to completion. The projects are divided into 8-12 prime contracts as most of the buildings are occupied during construction. IPS' goal has been to involve as many different companies as possible throughout the community. However, they were limited by the number of responding companies who fit their qualifications. IPS and Schmidt have taken a proactive approach by (1) factoring the OCPM solution into the overall program plan early on, (2) developing business processes around the OCPM solution's capabilities, and (3) making proactive arrangements for training the users and companies that would be executing the work. IPS provided free training to all project participants joining the team.

1.6. Riverside Elementary School

Built in 1908, this two-story red brick school expanded to meet a growing student population in the 1920s, 30s, and 60s. The IPS facility study showed that the building had poor physical conditions and educational suitability; the building didn't meet new space requirements for elementary schools. So IPS decided that a new elementary school should be built on or near the existing site. The construction of this US$11 million project started in March 2003 and was completed at the end of 2004. The new elementary school was dedicated January 16, 2005. The project is scheduled to be completed in June 2005 with the demolition of the old facility and completion of the grounds. InterDesign was selected as A/E firm. J. Beard Management/Geupel DeMars Hagerman, Partnership provided CM services. Fifteen prime contractors (primes) provided service to the Riverside Elementary School project.

1.7. The Use of the OCPM Solution in the Riverside Elementary School Project

The team had several meetings before the project started to establish the rules for project communication and execution. Issues such as: the process of getting paid, the order of giving decisions, and how the OCPM solution would be utilized were discussed and agreed on in these meetings. In early team meetings, Schmidt made it very clear that if a document is not in the OCPM solution, it is not official and it doesn't exist. There are 108 team members among the users of the solution in the Riverside Elementary School project. The A/E, CM, IPS, and Schmidt have been continuous users of the system, each with many participants, whereas each prime contractor has generally had one project manager who did invoicing and used the RFQ and pay application modules. The goal is for all users to be able to see the information pertinent to them. For instance, all team members can view anything in the documents module. In some cases IPS/Schmidt worked with the vendor to make this possible. Contractors can "view" all contractors' RFIs but "edit" only the ones from their company. Contractors can't see or monitor the others' work progress. Subcontractors didn't have access to the OCPM. Some suppliers had access, but have rarely used it. However subcontractors and suppliers are listed as "contacts" which allows OCPM tool users to send information from the OCPM tool to their external e-mails. Primes could only let others know about an item if they select their names from the menu when sending the message.

The Riverside Elementary School project utilized most of the modules of the OCPM, including:

- Document management: attachments, ASIs, daily reports, documents, drawing log, meetings, RFIs, submittals, transmittals
- Cost management: budget, cost events, cost items, RFQs, contracts, contractor change orders, contractor change requests
- Project information: project calendar, project details, project team

2. BENEFIT/VALUE ANALYSIS

In order to measure benefits, we need to understand the business of the investors and what they are seeking from their investment. There are three main questions: (1) Who are the investors and what values would they like to get out of their OCPM technology investments *(potential benefits)*? (2) What did they get from their investment in terms of benefits/values *(realized benefits)*? (3) What would they lose if they didn't implement these systems *(lost opportunities)*? When considering the implementation of a new system it is essential to understand whether you seek efficiency *(tangible)*, effectiveness *(quasi-tangible)*, or overall business performance *(intangible)* benefits, or which combination of these.

For our purposes the benefit/value analysis is based on three factors: effectiveness, efficiency, and performance. In the scope of this case study only effectiveness and efficiency will be discussed, as no performance areas are discovered. *Effectiveness (quasi-tangible benefits)* is the ratio of achieved outputs to planned outputs (doing the right things): the ability of a program, project, or work task to produce a specific desired effect or result that can be measured. It is performing the right tasks correctly, consistent with organizational mission, vision, values, and in support of the organization's goals and objectives. *Efficiency (tangible benefits)*, in this context, is defined as the rate at which inputs are converted to outputs (doing things right). Efficiency is financially measurable and is represented by money. We will discuss and quantify the benefits in the efficiency area in the following session in the light of the Riverside Elementary School example. *Performance (intangible benefits)* is not directly measurable in quantifiable terms but is judged qualitatively on the basis of the impact of a successful implementation in influencing long-term business performance and market share.

-Effectiveness-

2.1. Potential Benefits

IPS plays a vital role in the Indianapolis community. Along with educating more than 39,000 students, IPS employs more than 5,000 people in jobs ranging from teachers to bus drivers. Their mission is to provide—within a safe, secure learning environment—a standards-based system of curriculum, instruction, and educational support services. The main goal of IPS is to be widely recognized as a model urban school system that is guided by high

expectations and standards of excellence. As a responsible public entity, IPS seeks to use taxpayers' funds in the best possible way to achieve its goals. To date, the IPS CIP projects are on time and within budget.

IPS wanted to invest in the OCPM solution because district leaders believed this comprehensive system would (1) give them the ability to track all events that occur in the project, (2) develop some standard processes by which each project would be managed even though different people are involved in the projects, (3) ensure that the district has tracked and captured all the data for each project and that this data will be available to refer to as an archive/historical record and that the data can be easily retrieved when it is needed to deal with disputes or similar issues. IPS realized that the OCPM solution was the only feasible way to fulfill its needs given the hundreds of people who would be involved in the execution and management of the CIP projects.

IPS evaluated the system's benefits in several forms, not just in monetary terms. Standard monetary analyses that apply to private owners do not pertain to public entities. The return on investment (profitability) a private entity might enjoy is not a valid measure for public owners. Similarly, in the private sector it is advantageous to delay borrowing construction money, as you will have less construction loan interest to pay back. By controlling the project well, a private entity can delay borrowing money until it is needed. IPS as a public owner is required to borrow money before it is needed by issuing bonds, for some or all of the money. The district earns interest on the capital until it is paid out. Even though typical monetary benefit analysis methods do not apply, IPS still values saving money on the projects through intelligent project management. IPS felt that there were significant benefits beyond just monetary gains. Steve Young, the IPS Facilities Director, says, *"Being able to control the program, and the efficiency the OCPM solution brought to the execution and control of the program have justified the costs."*

2.2. Realized Benefits

2.2.1. Maintaining the standards *(Effectiveness):*

The major issue for IPS is providing equity across the district by maintaining the same standards in all buildings. For this reason, as a part of the initial study the district developed educational standards that indicate what type of space and how much space needs to be provided in each building depending on the district's enrollment. For example, programmed spaces in all Phase 1 elementary buildings are the same size, and all are required to have a certain number of art rooms, music rooms, support space, and classrooms. Although they have customized designs to blend in with their neighborhoods, established standards ensured equity for each region of the district. The OCPM solution allows IPS and Schmidt to monitor and guarantee the consistency. Consistency and equity are tracked in terms of design reviews. Issues brought up by the craftsmen and foremen are addressed and discussed during the design and construction with use of the OCPM solution communication. This guarantees that everyone is aware of the issues, is informed about a proposed correction and agrees that it is acceptable.

2.2.2. Better project monitoring and control *(Effectiveness):*

Another important issue is the type and quality of the materials used in the projects, such as mechanical and electrical components. IPS never allows any of its heating/cooling ductwork to have insulation inside the duct, because the district has found that this is not good for long-term indoor air quality. However, there have been several instances where it was determined in the submittal process that the prime was planning to install a solution other than the required one. Knowing this in a timely manner and being able to respond quickly prevents primes from making mistakes. To provide better project control IPS can create a cost report to see a cost in the job. Every time there is a cost item, someone attaches a value to it, so IPS can immediately see what the costs are in a job.

2.2.3. Timely and efficient communications *(Effectiveness):*

In addition to better project control, IPS and Schmidt are able to manage this complex program with a small number of staff. They have also managed to be very effective, as all of the external parties report through one system. Steve Young, the IPS Facilities Director, says, *"The tool has had a very positive impact on our ability to manage the IPS construction program. We are experiencing more timely and efficient communications between the parties involved in the program, and that translates into lowered administrative costs, reduced risks, and improved accountability."*

2.2.4. Better public relations *(Effectiveness):*
Another positive outcome is gaining and maintaining public confidence in the program. IPS and Schmidt are able to provide detailed progress reports on individual projects through public website functionality provided by the system. Public access to a portion of the system gives information about project status and provides pictures and additional documentation. IPS receives requests from the local media to publish various reports on each project's status, budget, etc. The OCPM solution allows IPS to pull all data very easily and efficiently.

2.3. In the Absence of the OCPM Solution
Steve Young indicates that if IPS wasn't implementing the OCPM solution, IPS would (1) lose much of the control it has over the program, (2) have much less information to make valid decisions, (3) be at a disadvantage in resolving disputes without records of the timing and sequence of things happening and who was involved, and (4) have less efficient communication and coordination.

(1) Control: Having knowledge of the primes' progress helps IPS and Schmidt to control the projects better, especially when there are so many projects and primes. Knowing what your status is day by day is critical to ensuring that your projects are on track and under budget. Debra Kunce of Schmidt says, *"It is a central point of information. From the owner's perspective, you can look across projects and compare very quickly. You can check how many RFIs and submittals you have and hopefully stop/divert issues before it happens."*

(2) Valid decisions: Similarly to most construction projects, IPS and Schmidt run into situations where there are disputes among the professionals and contractors. They are responsible for the damages to other primes such as delays. Having an OCPM solution in place provides all the data to evaluate the situations and to give the right decisions.
(3) Audit trail: With the system, IPS and Schmidt know whether or not a document was submitted. They have a record of all kinds of issues, helping them track and control the project.

(4) Coordination and communication: The system ensures that when a participant runs into a problem, at least one person from that company will see that issue the same day it occurs and responds to it immediately. The other team members are able to notice that information within a couple of hours. This is very critical for keeping construction projects on time.

Steve Young says, *"Frankly it keeps people honest, and that is difficult to quantify. I cannot say what my cost would be if I didn't have the OCPM solution, but the savings would be sufficient for me to make the investment."* Debra Kunce of Schmidt, program manager, says: *"How did we decide? At some point we knew it would get overwhelming for communication among numerous parties, and we wouldn't be able to handle it. At that point these systems are priceless."*

2.4. Quasi-tangible Benefits' Ranking
Besides interviews, an electronic survey of quasi-tangible benefits was designed and distributed via email to all interviewees to measure the improvement in a more consistent and less subjective way. The aim of the survey was to uncover as much information as possible and to quantify quasi-tangible benefits of OCPM technology investments. Each respondent received the identical set of benefits, phrased in exactly the same way in order to reduce errors resulting from the recording of responses, and the respondents were free to rank the benefits according to their relevance at responder's own pace. The survey covered several benefits that were stated during the interviews. The responders were asked to rank the benefits 1 through 5 (where 5 is *'very high'*, 4 is *'high'*, 3 is *'neutral'*, 2 is *'low'* and 1 is *'very low'*). Benefits and values ranked by IPS case interviewees can be seen in the table below.

Benefits/Values	**A***	**B***	**C***	**D***	**E***	**Ave.**	**StDev**
- Enabled faster reporting/ feedback	4	5	4	5	5	4.6	0.5
- Improved info. management	4	5	5	5	4	4.6	0.5
- Enabled better project control	4	5	5	5	4	4.6	0.5
- Improved data availability	3	5	5	5	5	4.6	0.9
- Improved timely capture of design/construction decisions	3	5	4	5	4	4.2	0.8
- Enabled quicker response to project status and budget	4	5	4	5	3	4.2	0.8
- Provided accurate and timely information to give valid decisions	4	5	4	5	3	4.2	0.8
- Improved process automation (RFIs/COs, automatic updated master budget,)	4	5	5	5	2	4.2	1.3
- Improved project relationships with strategic partners	3	4	5	5	4	4.2	0.8
- Enabled having complete audit trail	4	5	5	5	1	4.0	1.7
- Enabled fewer information bottlenecks	5	5	4	5	1	4.0	1.7
- Improved quality of the output	3	5	4	4	4	4.0	0.7
- Reduced rework/data reentry	3	5	5	4	2	3.8	1.3
- Enabled better resource allocation; more effective assembly of project teams	3	5	4	5	2	3.8	1.3
- Improved idea sharing among team members/within organization	4	4	4	4	2	3.6	0.9
- Enhanced working within virtual teams	2	5	4	4	2	3.4	1.3
- Enabled better forecasting and control	3	5	4	4	1	3.4	1.5
- Reduced personnel costs due to improved efficiency	3	5	4	4	1	3.4	1.5
- Minimized project/business risks	2	4	4	4	2	3.2	1.1
- Reduced errors & omissions	2	3	4	4	1	2.8	1.3
- Enabled faster launch to market due to faster delivery	3	3	X	3	3		
- Improved public relations	2	4	5	5	X		
- Enabled more effective identification and assessment of new suppliers	3	4	X	4	1		
- Improved information version control	4	X	5	4	2		
- Enabled advance purchase of materials	2	2	X	3	X		
- Reduced delivery lead times	3	5	X	X	X		
- Enabled better inventory management	2	3	X	X	X		

Table 1. Ranking of various benefits/values by IPS case interviewees, (*The names of the respondents are hidden for confidentiality reasons. However, the respondents are managers of IPS, Schmidt and the users of the OCPM solution in Riverside Elementary School. "X" stands for when the question is not relevant or the responder doesn't know the answer.)

-Efficiency-

2.5. Request for Information (RFI)

The RFI module is one of the most-used modules of the OCPM solution in the Riverside Elementary School project. The system has been set up in such a way that every RFI goes through the CM, though other parties can be copied. The reasons for having the CM at the center of communication were as follows: (1) the CM reviews both questions and answers; (2) the CM becomes aware of the issues; (3) the CM knows the issues that involve more than one prime, so he/she makes sure everyone affected is in the loop; (4) the CM always has the power to add, copy, or

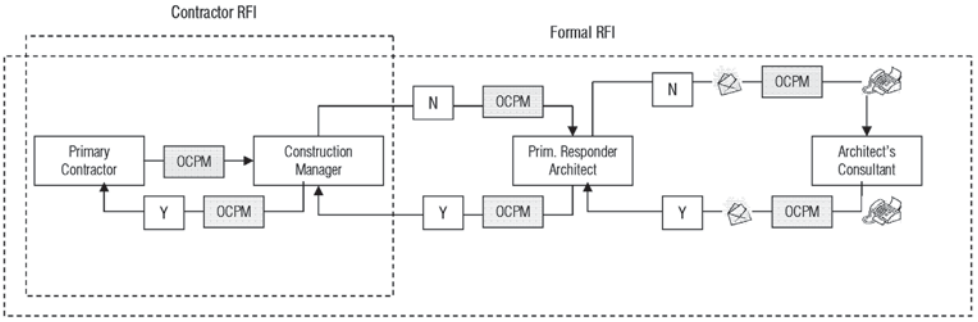


Figure 3. RFI process in IPS projects

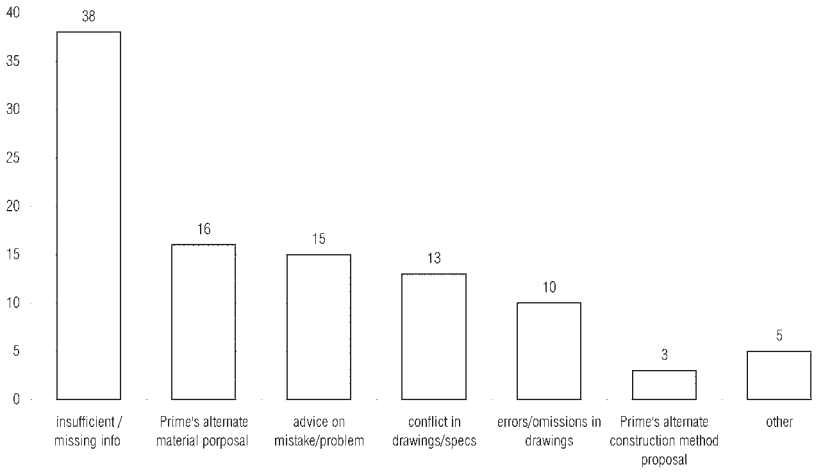


Figure 4. Reasons for RFIs in Riverside Elementary School project

phrase answers in such a way that the primes will understand. The CM might be able to answer the question depending on the nature of the RFI. In this case he would answer and forward a copy to the A/E. If the CM doesn't know the answer, he makes the contractor RFI into a formal RFI and forwards it to the A/E. The same path is followed for the answer. This method has been used for all IPS projects.

When the primary responder (a designated person to answer the RFI) in the A/E firm receives the RFI, he usually prints a copy and then takes or e-mails it to the appropriate person. If the appropriate person has access to the OCPM, he forwards the question through the system. However, only the primary responder can respond, because the answers must come from the primary responder's account. The procedure was set up this way because the primary responder's company is contracted to IPS, i.e. their consultants do not hold contracts with IPS.

There were 130 RFIs in this project, all of them answered. The subject matter of RFIs can be classified into three areas: (1) insufficient information [61%] (insufficient and/or missing information in the drawings; conflict between architectural drawings, specifications, and structural drawings; errors and omissions in the drawings); (2) alternate proposal [19%] (prime's alternate model/size and alternate construction execution method proposal); (3) guidance [15%] (advice asked regarding a mistake made or a problem that has occurred on the construction site).

2.5.1. Realized benefits of electronic RFIs:

Reduction of turnaround time:

The average RFI turnaround time is approximately 5 days in Riverside Elementary School project (Figure 5). The tool brought speed to issuing and answering questions, as the process is very well automated. The tool enabled team members to type in the question in an electronic form and to send it to the relevant parties by just pressing a button rather than faxing, e-mailing, or mailing documents back and forth. 85 out of 130 RFIs in the Riverside Elementary

School project were answered in less than 5 days. (Figure 6).

It is difficult to predict the impact of reduced RFI turnaround time on the overall schedule and budget. In our analysis of project RFIs, we came across RFI #116 where an immediate response was required from one of the primes. The question was about a connection detail showing how to anchor roof ladders into the hollow block. The question was asked on 10/28/2004 and the answer was required by 10/29/2004. The RFI was answered the same day it was asked, which prevented any delay in the construction sequence. The OCPM solution prevented any mail delay or risk of an RFI not being realized on time, thanks to its real-time communication features and automated notifications.

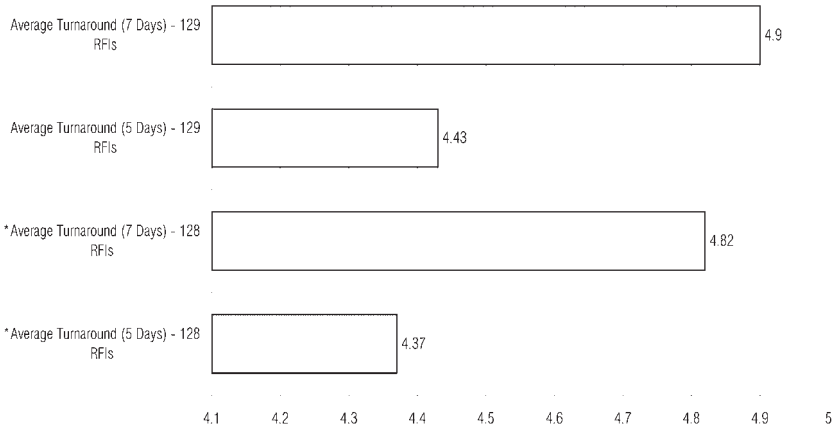


Figure 5. Average RFI turnaround times (* one RFI is omitted)

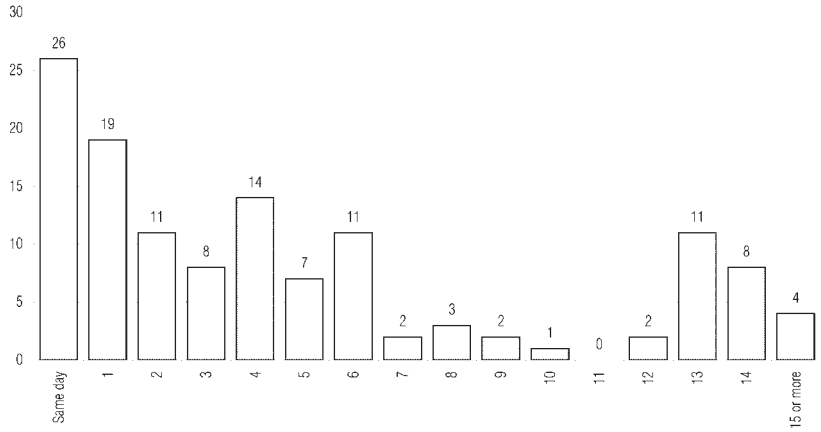


Figure 6. Number of RFIs and turnaround times *More than 20 days are omitted

Decrease in time spent on issuing an RFI:

Team members interviewed agreed that answering electronic RFIs is easier because all project information is at a central location, stored in a structured way. There is no faxing, no illegible handwriting; one doesn't have to create a spreadsheet to list RFIs, do binders, and send them. One can just pull the information from one's computer, view it, issue it, and send it almost within minutes. Construction administrators usually don't have to leave their desks and search folders for information, because all information is at a central location. One of the construction administrators interviewed indicated that working on electronic RFIs would take him 5 minutes instead of 45 minutes. This may reduce the number of administrative staff in the office, and/or the staff can spend more time on other issues due to efficiency gained by using electronic RFIs. While these staff savings do not directly impact IPS (the owner) on this project, one hopes that they will impact future projects, i.e. the CM will be willing to negotiate a lower contract price because they know they will need to spend less time.

We can estimate the savings with a basic calculation:
Number of RFIs = 130
Average salary of construction administrator = $40,000/year ($25/hour)
Time spent to process an RFI = 45 minutes (3/4 of an hour) with traditional method
¾ X 130 X 25 = $2437
45minutes vs. 5minutes
SAVINGS: [2437/9] X 8 = $2166 per project
Assume there are 10 projects in the office
2166 X 10 = **$21,660** per year

Reduction in numbers:
There is no evidence that the OCPM solution in this project reduces the number of RFIs. However, it has been mentioned several times that it is easier for the primes to access and review the entire list of questions. In addition, the system clears up the question early in the process in a speedier manner. This avoids mistakes and solves problems early in the process.

2.6. Change Orders in the Riverside Elementary School Project

There are several reasons for issuing a change order. Typically the contractor requests additional funds because they think they have done work out of and/or additional to their scope. In addition, change orders might result from unforeseen site conditions, or they might be issued by the owners. If there is a change order, it has to be approved by the architect, owner, and CM.

2.6.1. Change order process in IPS projects

If a prime thinks he is owed money, he fills in a contractor change request (CCR) form in the system. This CCR automatically goes to the CM. If the CM agrees this is a valid change, he generates a cost event. Once cost events have been approved by the AE and the CM, they are processed by Schmidt, the program manager, as a valid contract change order (CCO). The CCO can be processed in various ways. Schmidt can create an allowance for each process, which would be the work that is beyond the Prime's scope of work. Change orders must be approved by the IPS Board. To avoid having to take the 45 days to get Board approval for every change, an allowance is built into the Prime's contract. Unused allowance amount is "returned" to IPS at the end of the project. CCO module is used to track both types of change (both change orders and allowance). Schmidt has the authority to make "allowance authorizations." There is external paperwork (with "wet" signatures) that must take place for legal reasons. Creating a formal CCO or an allowance mostly depends on the magnitude of the event; if it is a major event with a significant effect a CCO is created.

Allowances are construction dollars that are included in the original contract and used for unforeseen conditions and/or changes. CCO's would require changes to the original contract amount and would require Board approval. If a

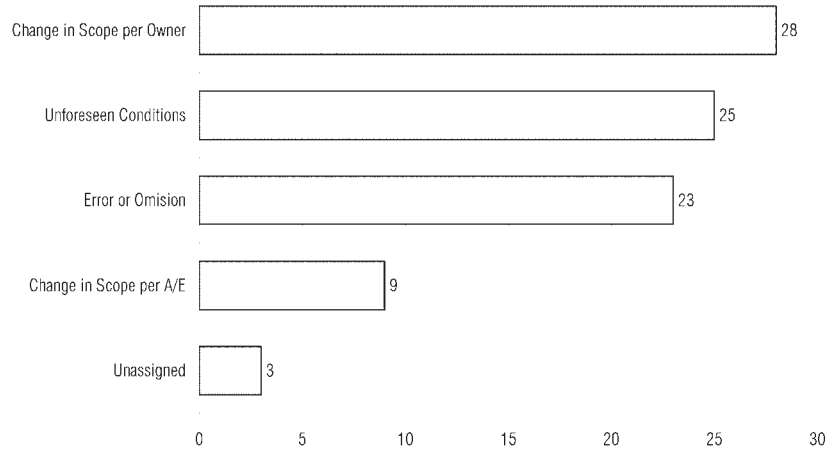


Figure 7. Reasons for change orders in Riverside Elementary School

CCO is created, Schmidt issues a separate piece of paper that must be signed by four parties: CM, A/E, prime, and IPS. This process is paper-based, because it is a legal document with signatures required. Schmidt signs and sends it to the CM; the CM signs and sends it to the A/E; the A/E sends it back to Schmidt via the CM; and finally Schmidt sends it to IPS for approval. The IPS Board gives the final decision. Schmidt scans and uploads the final document on the OCPM solution for a record even though the process is not accomplished through the system. There have been 88 changes in Riverside Elementary School project; 5 are contract change orders and 83 are allowance changes.

Change orders can decrease the productivity or delay the schedule. To avoid these problems, the management team issued a construction change directive (CCD) that enabled the prime to proceed with the work. (There is no guarantee that a CCD will result in a change in dollars. Sometimes it is a change in time or a contractual mechanism to keep the contractor to proceed with his work when an area of scope is in dispute.) The figure below shows the total cost of changes categorized by the causes of changes. However CCDs are very rare as they are used only in emergency situations. There are no CCDs listed on the Riverside Elementary School project.

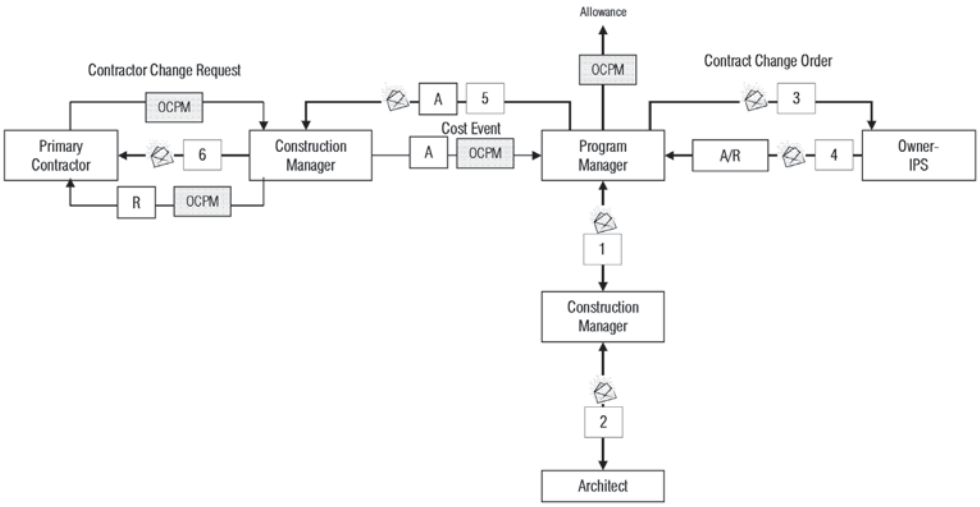


Figure 8. Change order process in IPS projects

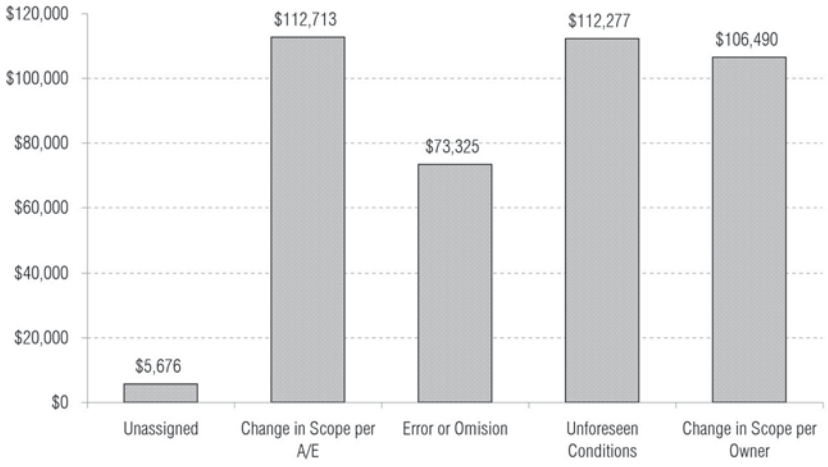


Figure 9. The cost of change orders categorized according to the type of change orders

2.7. Other Utilized Modules

The RFI and change order modules are only two of the several modules utilized in the Riverside Elementary School project. In addition, document and cost management functionalities are utilized extensively. Documents stored and their quantities are listed in the figure below. Almost all communication and document transfer has been electronic in this project unless a document is: (1) a legal document requiring signatures, (2) a physical submittal—in which case the submittal form is created and stored in the system, (3) a shop drawing. Marvin Baker, the construction manager of Riverside Elementary School project, comments that shop drawings are not transmitted through the system because reviewing electronic full-size drawings is very difficult and there is no equipment to print/scan them on site.

2.7.1. Paper reduction:

Estimating the reduction in printing and copying is a challenge, because most of the parties print the documents (1) to have a record or back-up for internal systems, (2) to review drawings, (3) to transfer them to unconnected parties or construction site, or (4) for legal reasons. We can assume from the data gathered through the interviews that 50% of the documents are printed for the reasons above. It is interesting to note that sending electronic documents passes the printing cost on to the recipient. Traditionally, that cost is with the sender - one might infer that the sender may be more willing to share information now since they do not need to assume the cost. Cost savings (whether to print or not) is then under the recipient's control.

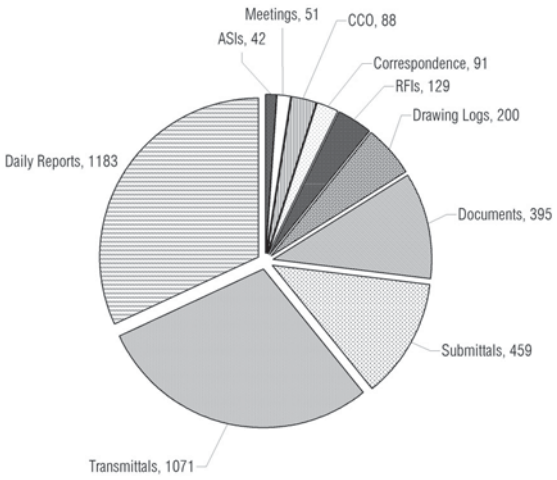


Figure 10. Stored documents in the system

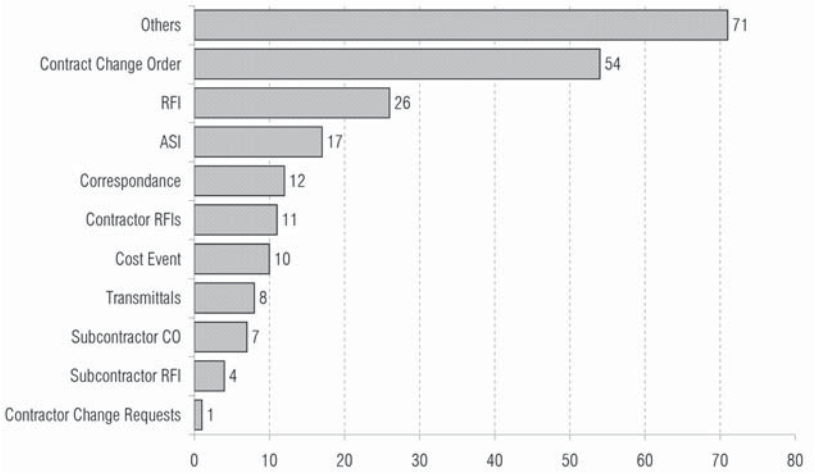


Figure 11. Number of documents with attachments

In all, we know there are 3709 documents (1 page) + 221 documents with attachments (2 pages).
Total number of pages = 3709 + (221 x 2) = 4150

Assume 50% of documents do not need to be printed
4150 x 50% =2075 pages

Assume at least 3 parties would print if the system wasn't implemented
2075 x 3=6225 pages of document

Assume printing cost $0.1 per page
$0.1 x 6225= $623 per project

Assume 3/4 of the documents don't need to be mailed due to efficient electronic transfer and mailing cost $1 per envelope in average
$1 x ¾ X 4150 = $3113 per project

TOTAL SAVINGS:
3113 + 623 + 2166 (RFIs) = **$5902** per project ~ **$59,000** for 10 projects (Assume IPS conducts annually 10 projects similar to Riverside Elementary School project.)

3. FUTURE OPPORTUNITIES

Upon the completion of the CIP, IPS is planning to import some of the information from the OCPM to their facility management program. IPS is hoping to use this information as a basis for the facility management system to attach intelligent data as equipment changes in the building. IPS also wants to use the information as a reference for facility management. IPS has approximately 150 people involved in the maintenance of its facilities. Having electronic data and electronic access to it will make their jobs easier.

4. BENEFIT/VALUE SUMMARY

Tangible, quasi-tangible and intangible benefits of the IPS case are summarized in the table below. Savings from the electronic document exchange and electronic RFIs are the base for the tangible benefits. The Riverside Elementary School project is used as an example and the results are projected to 10 IPS projects although the OCPM investment is used for more than 10 IPS projects. The electronic survey is used to quantify the effectiveness benefits by ranking. No performance (intangible) benefits are observed in this OCPM implementation. The cost of the system is around $175,000 for 5 years, not including implementation costs.

Types of Benefits	**Measured Benefits**
Tangible	**$59,000** annual (for 10 projects)
Quasi-tangible	Survey: **3.9/5** (20 benefits identified out of 27)
Intangible	Not identified
Cost of the system	**$175,000** for 5 years ($35,000/year)

INTERVIEWEES

- Brenda Havens, OCPM solution Administrator, Schmidt Associates, 01/14/2005
- Debra Kunce, the CIP Manager, Schmidt Associates, 12/03/2004, 01/11/2005
- Jack Metcalf, Riverside Elementary School PM, Schmidt Associates, 01/17/2005
- Joseph Uhlenhake, Riverside Elementary School RFI Primary Responder, InterDesign, 01/19/2005
- Marvin Baker, Riverside Elementary School CM, J. Beard Management/Geupel DeMars Hagerman Partnership, 01/19/2005
- Steve Spangler, Construction Administrator, Schmidt Associates, 01/11/2005
- Steve Young, the CIP Director, IPS, 12/03/2004, 02/15/2005

CASE STUDY 2. INSCAPE CORPORATION

1. INTRODUCTION

This case study focuses on identification and measurement of the value of online project collaboration and project management (OCPM) technology from the perspective of a manufacturing organization. The case explains a very innovative use of the technology to gain competitive advantage and build and strengthen customer relationships. It covers intangible business benefits and values, at the organizational level only. The following subsections give a brief description of the organization and outline the need, selection, cost, implementation, and use of an OCPM tool as an important part of the organization's marketing strategy.

1.1. Inscape Corporation

Inscape Corporation (Inscape), in business since 1888 (as Office Specialty until 1997 and Inscape since then), is a leading designer and manufacturer of high-performance workplace solutions for today's changing world of work. Headquartered in Holland Landing, Canada, they serve their clients through a network of their own sales personnel, dealers, independent representatives and showrooms across North America. Inscape offers a wide array of product solutions for modern office interiors, including movable walls, post-and-beam architectural products, office systems, storage products, seating and ergonomic work tools. The company engineers its products for longevity, non-obsolescence, aesthetics and technology handling capabilities. The majority of Inscape's customers are located in the United States.

The company is under its current controlling shareholder since the early 80s. Inscape started as a filing solutions provider and grew dramatically through the 1990s. In the early 90s, Inscape became a $30 million company. Inscape introduced "systems furniture" in the mid 90s and reached $70 million in systems sales by 2000. Most small steel cabinet manufacturers went out of business in Canada during the 90s due to increased inventory and inefficiencies in their production lines. Inscape implemented a "lean manufacturing[1]" philosophy in 1985, which aims to eliminate the bottlenecks in its manufacturing plants and to increase the volume of their production. Inscape was well positioned to grow by picking up others' sales and by implementation of the lean manufacturing philosophy. The company went public in 1997.

Unfortunately the entire office furniture industry experienced a massive 40% decline in North America from 2001 to 2003. For this industry, business is driven by two factors: corporate profits and increase in white collar workers. There was a reversal in both of those areas in these years, and as a result the $13 billion office furniture industry shrank to an $8 billion industry. Inscape lost money for the first time in the 4th quarter of their 2004/5 fiscal year and first three quarters of their 2005/6 fiscal year. The competition was tight, and Inscape, a $100 million company, was the smallest company in the field - the next biggest competitor was a billion dollar company. Moreover, their competitors pressured some of the dealers working with Inscape to make a choice between them and Inscape, which resulted in a loss of Inscape's distribution channels. Since they were being squeezed out of distribution, Inscape decided that they needed to reinvent their marketing strategy.

1.1.1. Inscape's traditional marketing strategy

Inscape had adopted a very traditional marketing approach for years, based on a set of sequential activities. Inscape worked with a network of dealers – around 900 in the US – and independent representatives who would identify the opportunities for potential orders around the country. When a dealer approached Inscape with a potential order, Inscape would offer a quotation, which the dealer would then take back to the customer. The customer might ask other manufacturers for a similar quotation, and depending upon various factors, such as price and quality, Inscape might or might not get the order. This model has a success rate of 5% to 10%; and moreover, Inscape had no visibility of the orders nor had the power to communicate directly with the end-users.

1.2. The Need for an OCPM Solution

The need for an OCPM solution was quite different from a traditional implementation and usage of such systems. Being the smallest player in the market took away the advantages a big player might enjoy such as a large sales force or competitive pricing. In order to gain market access with a niche product, Inscape decided to use an OCPM tool to (1) gain market share, (2) build new relationships with end users, and (3) bring visibility to their sales. Atul Bali, a marketing strategist by training and Vise President of Inscape, leading its front –end charge used the following logic, explained in his words: *"Contract furniture is required when there is a project, and the biggest challenge faced by customers, as Inscape found out in a detailed buying behavior study it conducted in 2003, was efficient project management – so why not create a strategy centered around offering on line collaboration for project management and hence get a foot in the door very early in the process and convert that to competitive advantage."*

1.3. OCPM Technology Selection

Atul Bali's team explored five different OCPM tools available in the Canadian and the US markets. After the market research and technology vendors' demonstrations, Inscape decided to go with eBuild.ca's Collaborative Business Platform because it was (1) easy to use and learn, (2) easy to customize and (3) provided the white-labeling option. Also (4) the tool had excellent functionalities to facilitate design collaboration, proven through vendor's own client base largely in the Canadian construction marketplace. Furthermore, Inscape was able to leverage the vendor's experience in developing an understanding of Collaborative Technologies and the tool needed no additional hardware investment as it is purely web-base and the vendor hosts the solution.

1.4. The Cost

Inscape has an exclusive business partnership agreement with the vendor in their market space, fundamentally a license resell agreement. The cost of a license is $70US per user, per month. This provides users with unlimited storage space and an unlimited number of projects. In most cases, Inscape passes on this cost to the users of the solution.

1.5. The New OCPM-Enabled Business Strategy

The fundamental reason for Inscape to go ahead with a different marketing approach and out-innovate the competition was the need to increase Inscape's sales. The company had never done two things: (1) marketed to end users directly -they had always depended on channel partners for marketing as well or (2) tried to learn the needs of their clients directly. As a result, they had a poor understanding of the market realities. Subsequently, they conducted a buyer behavior exercise to understand why clients buy furniture. Inscape executives asked, *"When is the furniture required?"* The answer was *"Whenever there is a project."* Therefore, they tried to figure out a way of *"getting wind of projects" before their competitors. The second question asked was "Who are the decision makers and who are the decision influencers?"* As a result of this initial study, they decided that their target should be the real estate brokers, building owners, and project managers, as these parties are the ones who know about a project well before anybody else does and they are at the top of the list of decision makers/influencers.

Inscape started to think about the common difficulties these people faced, and quickly identified project management and communication as a common challenging task, and one that isn't the core competency of most owners or brokers. Therefore, Inscape determined to become a very customer-centric company where customer needs and challenges are the priorities. The question they asked now was *"Can we call an offer through a collaboration tool which we can offer as a service to the community that will enable us to know of any given project earlier than our competitors?"* There is where the whole idea of market collaboration was born.

Inscape would offer the OCPM technology to real estate brokers and project management communities as a new way of managing owners' projects while potentially helping them save time and money. Consequently Inscape white-labeled the OCPM tool and named it ourinscape.com. Inscape and the vendor also extended the white-label service offering to other organizations in Inscape's value chain. The vendor provides a direct link between these sites. Inscape started setting up projects and giving access to team members very inexpensively for the project team's internal communication long before the team started to think about furniture.

Later, as part of the launch of this go-to-market strategy, Inscape also offered up to four "test-for-fit" services facilitated through the OCPM solution. In this case, the potential customer of Inscape uploads their base-building drawings to the system, normally through their design house or brokerage house of choice. Inscape works on the fit-ins and sends the drawings back through the OCPM tool to the designer or the brokerage house as the case may be, for the end-user to review. The end users can mark up and discuss the drawings electronically and send them back to Inscape through the OCPM solution. The fact that most end users are not CAD users is never a problem – the vendor provides eReview – an online review and markup tool that works with over 330 file types. While the tool provides a practical way to facilitate this exercise, Inscape learns about the project ahead of time. Also the tool offers a complete and comprehensive audit trail of any information exchange, including online meetings, which are recorded and can be replayed later.

Inscape's only requirement is to be given an equal chance of being a party to the project with the other furniture manufacturers. If Inscape is not awarded the furniture contract for some reason, they still allow the owner to use the tool for the project. In this case, Inscape creates guest licenses and allows their competitors to work only in that particular project without being able to invite others. Fortunately, Inscape hasn't had the experience of losing a project to a competitor yet. And the prices they have been able to get the projects at have resulted in better margins to the company, as there is a premium associated with this value-added service. With the industry growing and their innovative use of the OCPM technology, Inscape is again well positioned. Its sales are growing steadily, as they now have a new approach to market and each collaboration partner has their own relationships they bring to the table.

1.6. Implementation and Use of the OCPM System

Inscape started using the OCPM system in April 2004 as a part of their marketing strategy and also internally for collaboration management of their own projects. Through much of the early implementation, the vendor was instrumental in developing Inscape's expertise in the area of collaboration - particularly in the areas of performing product demonstrations for their end-users, mapping process flow – the vendor created a "broker to punch list" series of flowcharts for Inscape - and developing their training curriculum and personnel. As of May 2005, they hold 100 active licenses; half are internally owned by Inscape for their operations, the other half by Inscape's potential customers. Inscape provides implementation and training services for the customers. The condensed 3 hour training course has been a key selling feature. Although Inscape is planning to charge for implementation in the future, they haven't charged their clients yet because the total scale and scope of the projects have not been particularly big nor have the projects lasted for a very long time. As of May 2005, roughly half of Inscape's top dealers are using the tool to approach potential customers. The reason Inscape didn't roll the idea out to all of their dealers was to test the idea and make sure that they can fully support the orders. However, Inscape plans to expand use in the future to its entire dealers list. There are more than 200 Inscape projects stored in the tool as of May 2005. Inscape uses the tool internally for 3 purposes:

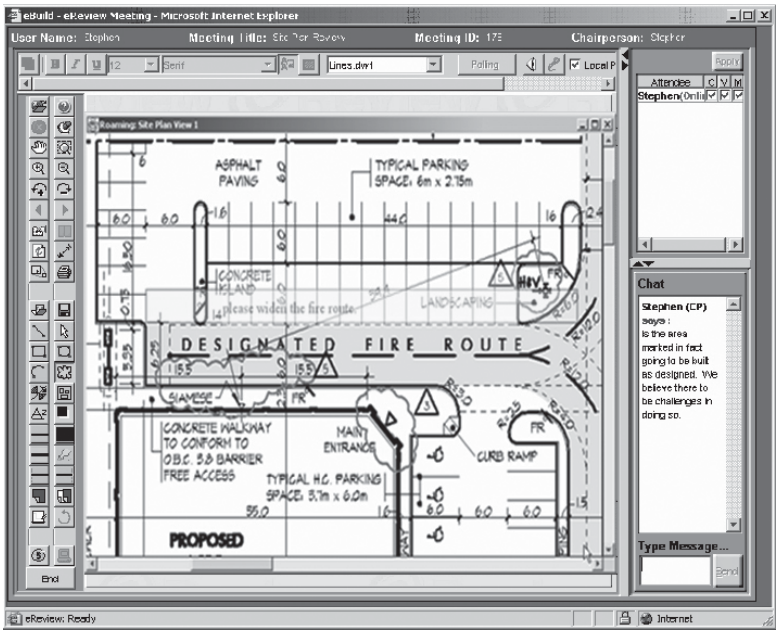
1. Communicating with dealers and Inscape's sales team: They have been using the tool as a general tab for the request for qualification (RFQ) approval process. Every time a dealer sends a request, the tool records the communication so that they have a very strong audit trail. In addition, Inscape's staff uploads every response, drawing, or document to the specific folders for the sales team to access and view wherever they are located. Inscape keeps a strong tab of what jobs have been lost and won. This gives them an opportunity to capture their sales tunnel as well as the reasons for winning and losing. They also use the tool for order management and for change management tracking, given its robust audit trail.

2. Project-specific use: There are project-specific areas where Inscape designers and other users in a project communicate.

3. Form and templates repository: Inscape has created questionnaires and forms, and they all reside in the OCPM solution. The Template feature allows them to formalize their best practices and quickly replicate these for future projects.

A good majority of Inscape's projects are still managed by traditional methods. The larger a project is, the more likely the OPCM tool will be used. The tool has been adopted easily by the internal Inscape team. The design department, customer service, sales representatives in the field, dealers, and owners are among the frequent users of the tool. Once a project is completed, it is archived and removed from users' screens.

10 Figure 1. Welcoming page of ourinscape.com



11 Figure 2. eReview to meet in real time over the Internet

2. BENEFIT/VALUE ANALYSIS

When considering the implementation of a new system, it is essential to understand whether you seek benefits in efficiency (tangible), effectiveness (quasi-tangible), overall business performance (intangible), or a particular combination of these. This case study focuses on organizational-level benefits rather than individual project-level benefits. The reason for this is that Inscape uses the tool to enable their marketing strategy, to gain market access and to build and/or strengthen their relationships with customers. Performing the right tasks correctly, staying consistent with the organization's strategy and values, and supporting its goals and objectives have been among Inscape's most important goals in deciding to implement this technology.

Therefore this case study will look at two areas: performance and effectiveness. *Performance (intangible benefits)* is the level of new outputs enabled (doing better things). The nature of modern business is such that, increasingly, senior managers are required to think beyond the direct tactical issues of efficiency and effectiveness, toward more strategic issues. Business performance, in its broadest terms, is a major strategic issue and one that OCPM technology has much to contribute to. A major argument of this case is that OCPM technology's benefits in construction extend beyond the tactical and into strategic business performance improvement. *Effectiveness (quasi-tangible benefits)* is the rate of actual compared to planned outputs (doing the right things) – the ability of a program, project, or work task to produce a specific desired effect or result that can be measured.

There are three main questions for us to ask in order to understand the business of the investors and what they are seeking from their investment: (1) Who are the investors and what values would they like to get out of their OCPM technology investments (potential benefits)? (2) What did they get from their investment in terms of benefits/values (realized benefits)? (3) What would they lose if they didn't implement these systems (lost opportunities)?

-Performance and Effectiveness-

2.1. Potential Benefits

Inscape wanted to use the tool to differentiate itself in the market by approaching clients to understand their needs and challenges in a construction project and provide them an OCPM tool as a solution to manage the project. For itself, Inscape's main goal was to increase sales by gaining market access. They also wanted to build relationships with potential customers and to bring the customers' projects to Inscape's attention. The contract furniture industry is a relationship business (as in fact are most businesses). Most buyers make a decision to buy furniture once every seven to ten years, and it is a major investment. They need to buy from people they can trust. The OCPM tool lends itself to creating strong relationships through the creation of project hierarchy/folder structure with in depth discussions. In addition, Inscape's potential benefits in its own operations would bring efficiency to its internal sales and design development. Everybody in their field was trying to communicate the value, while Inscape wanted to provide a way to create a value.

2.2. Realized Benefits

2.2.1. Increased market access; increased sales *(Performance):*

The real benefit of the OCPM tool for Inscape has been increased market access. Inscape has used the tool as a sales enabling tool. There were far too many competitors all trying to sell their product value. However, Inscape decided to talk a "services story" first – responding to real needs of the customer in a project management challenge – and then pull in their products. Since they have used this marketing strategy, they have tripled their presence in Toronto alone. Their past sales level of $800,000 a year has reached $3 million, with a possibility of more. In Toronto they have quoted seven jobs with this tool, so far losing one and winning three. (In the one they lost, the customer used existing furniture from another office.) In the USA and Canada together, they have been exposed to $13.2 million of work and have successfully closed $2.6 million. In the US, they have quoted about 50-55 projects, losing none and winning 11. The rest are still in the process of evaluating furniture; Inscape enters in the picture long before the furniture is normally decided.

2.2.2. Enhanced customer relationships *(Performance):*

Besides the increased market access, this tool substantially helped Inscape in building long-lasting relationships with their customers. The furniture purchase order usually comes into the picture in the 7th month of a 9-month project; however, Inscape invests 6 months prior to the order to understand its customers' challenges. For example, the project manager for Schawk, Canada (from CBRE, Canada) says, *"We moved Schawk from five offices into one corporate center at 1620 Tech Avenue two weeks ahead of schedule and under budget. Thank you, Inscape for your collaborative effort and for creating a new culture at Schawk with your low panels."*

As construction projects require the collaboration of numerous parties, the OCPM tool is exposed to more projects and so is Inscape, building more relations with owners, subcontracting trades, contractors, etc. Atul Bali explains, *"For example, next week I have been invited by a company who is starting a pretty significant project. They have heard about this tool through their dealer there. I will fly there and meet with thirteen people, each one a stakeholder in the project, who will be part of the project, including the architect, construction manager and contractor. The relationships we build are far bigger than we could think about in the absence of ourinscape.com."*

2.2.3. Better negotiation power *(Performance):*
As the OCPM tool brings several benefits to project teams from the project management standpoint, Inscape's negotiations for its product have become much easier. Inscape has noticed that the customers don't usually bargain for a price reduction on the furniture when they are enjoying efficient processes, shorter project cycles, and reduced costs. Again Atul Bali comments, *"The clients sometimes pay $25,000 rent for a 50,000 sq ft office and are often given incentives for early move-ins. They are not going to bargain for a couple of thousands of reduction on the furniture when they are able to finish their office earlier and save from their rent because of an early move-in."*

2.2.4. Exposure to the market, access to potential clients *(Performance):*
By offering this service to the project team, Inscape has gained access to the players down in the supply chain such as real estate brokers, designers, end users and dealers. The tool and the service proposition enable Inscape to meet project stakeholders that they usually have no access to. This is another way to get in front of the people who will buy furniture in the future: they might not require Inscape's products at the present time, but are potential candidates for the service proposition. It is a big advantage for Inscape to introduce themselves and their products and improve access to potential clients.

2.2.5. Effective communication *(Effectiveness):*
Besides business-related benefits, Inscape's in-house team also realized benefits in their operations. The team was able to give quicker responses to revisions in a customer's project. The tool also enabled all project collaborators to be on the same page. The use of the OCPM system brought accountability to Inscape's operations and enhanced the trust between collaborators. Usually their AutoCAD files are too large to send by email. So before the implementation of the OCPM tool, they were sending hard copies by FedEx. With the use of the system, the team has become more efficient, with online meetings, discussions, and electronic file transfer. Now, they don't have to worry about delivery of the packages or time zones. In addition the audit trail brought accountability to the team communication. Now all files are in a centralized location where all parties can go and update the data and find accurate information and the latest versions. Sean Mathurin, team leader of Design and Specification Support at Inscape, says, *"I can see who has done what in the project. So if someone says he has never received the drawing or the specification package from us, I can pull it out and prove that he had a look at it yesterday."*

2.2.6. Effective sales team *(Effectiveness):*
Inscape didn't reduce the number of its sales force but it made them more effective. Their product allows them to get a certain success ratio based upon the needs of their customers. For example, if we assume the success ratio is 10% (they would be considered for ten projects and get one), what happens with this marketing strategy is that now Inscape has access to a hundred projects and gets ten of them with the same success ratio because their product has not changed. According to Inscape, the OCPM tool makes the effort much more useful in the field.

2.3. In the Absence of the OCPM Solution
If Inscape didn't have the system they would lose an opportunity to increase their sales and enhance their relations with their customers. Dan Kennedy, sales analyst at Inscape, says, *"Getting involved in the project sooner, this is one way that we can spark up in the conversation sooner. This is extremely important for our sales."* Internally, if they hadn't implemented the system they would have lost responsiveness to customer needs and requests, the speed and accountability of information transfer as well as the audit trail. Jacquie Spencer, project coordinator, says, *"If we don't have the tool we would go back to extended response times because we will be dealing with overnights and time zones. It can slow down our process seriously."*

2.4. Quasi-tangible Benefits' Ranking

Besides interviews, an electronic survey of quasi-tangible benefits was designed and distributed via email to all interviewees to measure the improvement in a more consistent and less subjective way. The aim of the survey was to uncover as much information as possible and to quantify quasi-tangible benefits of OCPM technology investments. Each respondent received the identical set of benefits, phrased in exactly the same way in order to reduce errors resulting from the recording of responses, and the respondents were free to rank the benefits according to their relevance at responder's own pace. The survey covered several benefits that were stated during the interviews. The responders were asked to rank the benefits 1 through 5 (where 5 is *'very high'*, 4 is *'high'*, 3 is *'neutral'*, 2 is *'low'* and 1 is *'very low'*). Benefits and values ranked by Inscape case interviewees can be seen in the table below..

Benefits/Values	**A***	**B***	**C***	**D***	**E***	**Ave.**	**StnDev**
- Enabled having complete audit trail	5	5	5	5	5	5	0.0
- Improved data availability	5	5	4	4	5	4.6	0.5
- Improved information version control	4	5	4	4	4	4.2	0.4
- Provided accurate and timely information to give valid/accurate decisions	4	4	3	3	5	3.8	0.8
- Improved project relationships with strategic partners	2	4	4	4	4	3.6	0.9
- Improved information management	4	5	3	3	3	3.6	0.9
- Enabled better project/program control	4	4	2	2	5	3.4	1.3
- Enhanced working within virtual teams	5	5	1	1	4	3.2	2.0
- Improved process automation (RFIs/COs, automatic updating of master budget, etc.)	3	4	2	2	3	2.8	0.8
- Enabled fewer information bottlenecks	4	5	1	1	3	2.8	1.8
- Reduced personnel costs due to improved efficiency	3	4	1	1	4	2.6	1.5
- Improved idea sharing among team members/within organization	3	3	1	1	3	2.2	1.1
- Enabled quicker response to project status and budget	4	X	3	3	4		
- Enabled faster reporting and feedback	5	X	3	3	4		
- Enabled better forecasting and control	4	X	X	X	3		
- Improved quality of the output	4	X	X	X	3		
- Reduced errors and omissions	4	X	1	1	4		
- Minimized project/business risks	2	X	X	X	3		
- Enabled advance purchase of materials	X	X	X	X	3		
- Reduced rework/data reentry	X	X	1	1	4		
- Reduced delivery lead times	X	X	X	X	3		
- Enabled better inventory management	X	X	X	X	3		
- Enabled more effective identification and assessment of new suppliers	X	X	X	X	3		
- Enabled faster launch to market due to faster delivery	X	X	X	X	3		
- Improved public relations	X	X	X	X	3		
- Enabled better resource allocation; more effective assembly of project teams	2	X	1	1	4		
- Improved timely capture of design /construction decisions	X	3	1	1	4		

Table 1. Ranking of various benefits/values by Inscape case interviewees (*The names of the respondents are hidden for confidentiality reasons. However, the respondents are managers of Inscape and users of the OCPM solution in Inscape projects. "X" stands for when the question is not relevant or the responder doesn't know the answer.)

3. FUTURE OPPORTUNITIES

Inscape is introducing and promoting the OCPM tool to its representatives and sales force across the USA. Inscape strongly believes in the benefits of this tool in their business.

4. BENEFIT/VALUE SUMMARY

Tangible, quasi-tangible and intangible benefits of the Inscape case are summarized in the table below. Tangible benefits were not considered in this case as the investor's main goal was to gain quasi-tangible and intangible benefits through their OCPM investment. The electronic survey is used to quantify the quasi-tangible benefits (improvements) by ranking. Four performance (intangible) benefits are observed in this OCPM implementation: increased market access – increased sales, enhanced customer relationships, better negotiation power, exposure to the market - access to potential clients The total cost of the system is $84,000/year based on $70US fee per license.

Types of Benefits	**Measured Benefits**
Tangible	Not considered
Quasi-tangible	Survey: **3.5/5** (12 benefits identified out of 27)
Intangible	**Four identified**: Increased market access – increased sales, enhanced customer relation-
ships, better	negotiation power, exposure to the market - access to potential clients
Cost of the system	**$84,000/year** ($70US per license. Inscape holds around 100 licenses. In most cases,
Inscape passes on	this cost to the users of the solution)

INTERVIEWEES

- Atul Bali, Executive Vice President, Channel Management, Inscape Corporation, and Officer of the Company, 04/19/2005, 05/19/2005, 06/08/2005
- Dan Kennedy, Sales Analyst, Specification Coordinator, 04/22/2005
- Dennis Dyke, Vice President of Human Resources, Inscape Corporation, 04/22/2005
- Jacquie Spencer, Major Project Coordinator, Inscape Corporation, 04/22/2005
- Kerry Newton, Junior Design Specification Coordinator, Intern Arido, 04/22/2005
- Sean Mathurin, Design Specification, Team Leader, Inscape Corporation, 04/22/2005

CASE STUDY 3. ITG GROUP

1. INTRODUCTION

This case study focuses on identification and measurement of the value of online collaboration and project management (OCPM) technology from a private owner's perspective. The case covers intangible benefits and values at the organizational level. It describes an innovative use of OCPM technology to accomplish a massive rebranding program within an ambitious time frame. The following subsections give a brief description of the program and outline the need, selection, cost, implementation, and use of an OCPM tool in a bank's rebranding program.

1.1. The Hawton Rebranding Program

ITG Group (ITG) is one of Europe's leading financial services groups. It has more than 30 million UK personal customers and over 2,600 UK branches. The Property Services Division (PSD) of ITG manages a portfolio of around 6,500 properties in the UK. A large proportion of these properties require refurbishment following mergers and rebranding exercises.

In June 2000, the ITG completed the acquisition of National Hawton Bank (Hawton). Following the acquisition, ITG made the decision to renew the image of Hawton branches. The first and fastest element of the process would be an external branding (ATM machine, logos, signs, etc.) which was to be rolled out to 1,750 branches in a 14-week period of on-site work commencing in April 2003. This £90 million external rebranding program required that a significant volume of preparation work be completed for each branch to ensure that the final site work would be effectively completed within the short period of time. The challenges were (1) the number of branches and parties involved, (2) the tight schedule of design (12 months) and actual on-site implementation (14 weeks), and (3) the implementation process in branches that remained open for business while the rebranding was going on.

1.2. The Need for an OCPM Solution

To execute the program, ITG assembled a team that consisted of two signage contractors, project managers, a planning consultant, designers, electrical and building contractors, and estates surveyors based throughout the UK. Although the ITG management team had developed a work process to apply at each branch, they realized that such an ambitious program of works would require adoption of an innovative approach facilitated by OCPM technology. Such a system was required (1) to act as an information hub that would link all the individual businesses within the project supply chain, (2) to provide a structured way of managing the projects' information, (3) to help ITG to meet the program's ambitious schedule while maintaining the required quality. In addition to the use of OCPM technology in this specific program, ITG determined that employing this technology would probably assist in management of the many planned annual branch upgrade projects, including external refurbishments as well as significant internal renovations such as new customer counters, updated banking equipment, and back office refurbishments.

1.3. OCPM Technology Selection

Following the decision to manage the program by an OCPM solution, ITG undertook the technology selection process in the summer of 2001 by carrying out a review of available solutions. ITG wanted to have a system that could be tai-

lored, as they believed that the system needed to be closely linked to the overall business strategy of an organization, whereas most suppliers offered a standardized solution. Some alternate solution providers were very expensive over the five-year program duration without offering the option for use on other projects. Several systems' functionalities were compared against the bank's multi-project requirements. Tendering documents were sent to a total of five selected system providers. Two were short-listed and given a proof-of-concept challenge.

ITG selected the system of Atkins Management Consultants (Atkins) based upon Business Collaborator's web collaboration technology. The choice was based on (1) their delivery of the requirements, (2) their economic pricing (in both purchase and operation) in the management of multi-site projects, and (3) their flexibility in dealing with a rebranding program. Atkins was appointed by ITG in August 2001 to develop a solution that would act as a data management system not only for the external rebranding but also for the forthcoming internal branch refurbishment programs and other similar roll-out projects. Atkins is responsible for providing system support to the overall program and management of the OCPM for four years, which will end at the end of 2006. The tool was owned by the bank, developed and customized by Atkins and hosted by a private hosting service provider.

1.4. The Cost

The direct cost of development and use of the OCPM tool in the Hawton rebranding program is confidential and also difficult to estimate because the tool is being used in other ITG projects. Marek Suchocki, research and innovation manager at Atkins, says, *"A good estimation for this investment's cost would be less than 0.1% of the total expenditure."* ITG has a four-year agreement for an unlimited number of projects and 500 users.

1.5. Hawton Rebranding Program Team

While Atkins was providing consulting services for implementation and development of the OCPM technology, another branch of the same company, Atkins Faithful & Gould, was providing project and cost management consultancy. Procuring external resources for projects is a method that ITG uses in order to allow the ITG staff numbers to remain constant. Following that method, Houstian Ltd. was awarded the design contract. The office had a team of designers working in Edinburgh and Prague offices. Two signage contractors, Vander Co. and Curtin Lin Ltd., with their entire procurement, manufacturing, and installation teams, were located in the UK. Vander Co. carried out about 65% of the signage manufacture and installation work, while Curtin Lin Ltd. carried out the rest. The program also had around six maintenance contractors to make the necessary preparations in the branches around the country. ITG also had in-house design and project management teams. In addition to the core team, the project had several national and international signage consultants.

1.6. Implementation

Atkins's responsibility was to configure the OCPM system to match the rebranding process rather than attempting to modify the process to suit the technology. The focus was rapid identification by a number of different criteria e.g.

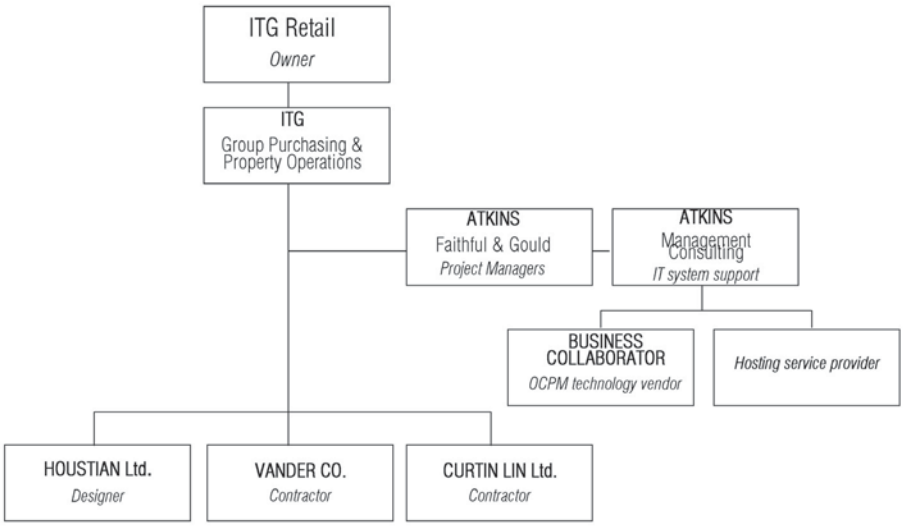


Figure 1. Hawton branding program organizational diagram

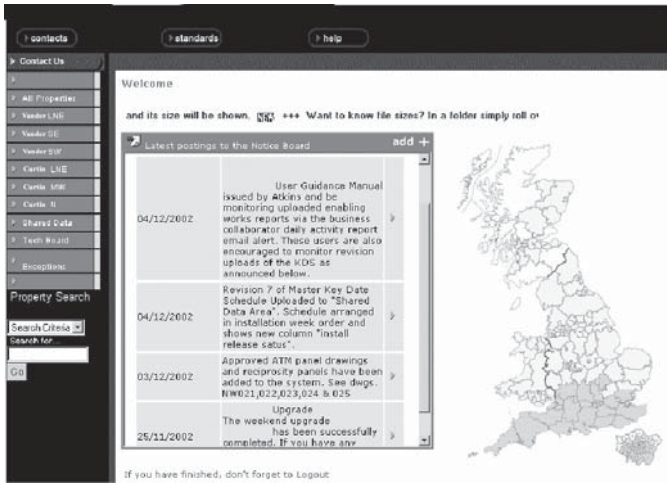


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Figure 2. The ITG Hawton rebranding program home page

branch name, id, region, and project manager; either to view the individual branch or project program details (Atkins, 2002). An initial system was quickly configured using the available program information. The first users were invited in late September 2001 to test and refine the system. Analysis and evaluation were given a key focus, and this continued throughout the system implementation as the working processes themselves changed by the introduction of the technology. Early users and those who attended evaluation workshops significantly influenced the system functions (Suchocki, 2002). Atkins carried out three workshops in total for design process analysis and for establishing the procedures, the templates, and the types of data to work with. In some cases Atkins actually created the processes, because the bank was not working under a process model.

The involvement of the users helped encourage the adoption of the system. Essentially cultural difficulties were overcome by engaging the key users in the development process and by providing them a more efficient working method. The team started using the OCPM tool extensively in late 2002 for the design process. Everybody from the core team was given access to the system. Two main contractors, which were responsible for execution of the main work, had access to the system but could, only, see the projects they were responsible for. There were no subcontractors in the system other than the ones directed by the main subcontractors. ITG removed the access rights of the users once their involvement was over.

1.7. The Use of the OCPM Solution in the Hawton Rebranding Program

About 200 users from around 25 organizations have been invited to use the system. Users have uploaded live information on 1,750 different branch-specific upgrades. The system has mainly been used for storing and sharing each branch's information and for the design approval process. The OCPM system allowed the montages to be produced, various amendments to be made and archived, the montages to be approved, the statutory and landlord approvals to be sought, and various amendments to be made per local authority/landlord edicts, as the local council needs to receive a formal application and should approve any change to the external image of a building. With the use of the system, the signage contractors were informed about ITG's final requirements, and they used it as an instruction to manufacture the product. The tool also enabled the contractor to have power supplies in place prior to installation for the signage installation team to fit the signage and the project manager to check that the signage was installed per the design. The information about a particular branch was available to all project participants at any time.

1.7.1. Automatically created folder structure

One of the efficiencies the OCPM tool brought to the program was automatically created folders for each branch based on a template that mirrored the project process. The folders were created automatically by an XML-driven "add" function that interrogated the relational databases and built folders from the correct template in the appropriate parent folder hierarchy (Suchocki, 2002) (Figure 3). The parent folders determined if the data would be shared or restricted, and the folders were identified either by the year in which the work would be executed or by the contractor doing the work.

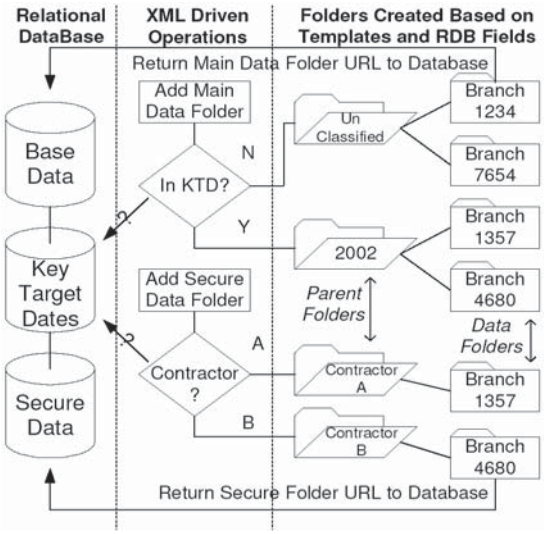

Figure 3. Shared and secure folder creation process (after Suchocki)

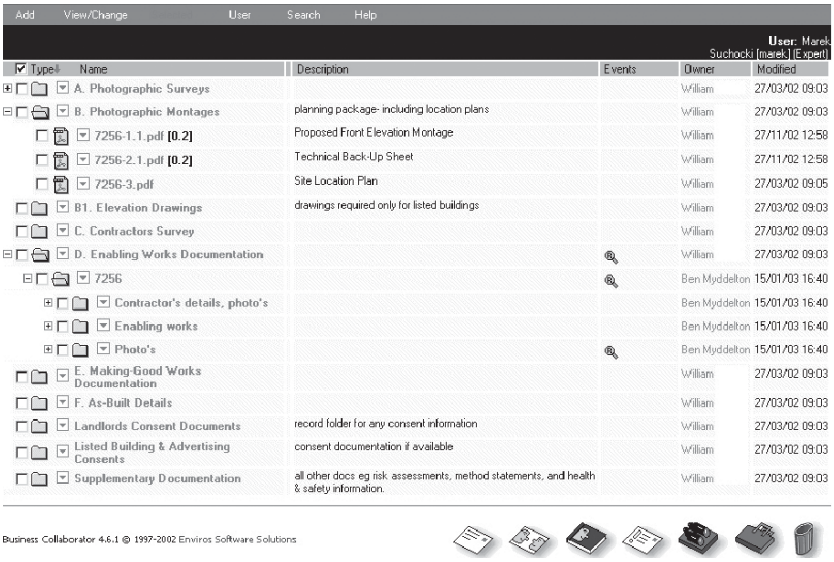

Figure 4. Template-driven project folders

This innovative approach exploited the two main data components of the system: *shared relational databases* and *object-level folders and files*. All objects created in the OCPM tool were assigned a URL, and the "add" function returned the URL for a newly created folder tree to the database record for each branch. Thus the database automatically linked to branch folders and could act as the main navigation tool, rather than users having to remember where in a hierarchy each folder exists. Branch folders are created from standard templates (Figure 4) structured according to a project chronology, starting with survey information and followed by client briefing information, design proposals, local authority approvals, construction information, signoff documentation, and finally handover to the bank's technical library (Suchocki, 2002). The system provided a user-friendly system readily available to all parties and helped in facilitating the design process, development of standards and protocols, project contract details, creation of photomontages for each site, management of planning and landlords' approvals, costs and program coordination, site-specific survey details, recording of key target dates, etc.

1.7.2. The design approval process

Another critical work flow embedded into the OCPM tool was the design approval process, which was essential for keeping up with the accelerated schedule. Traditionally complex aspects such as design approval could be carried out with "one click" system functions, at the same time as the management of any amendments to rejected designs was supported by a developed exceptions database. The team worked with photographs and PDF documents instead of traditional architectural drawings, and the whole process was facilitated by the OCPM tool. A person was assigned to travel and take pictures of 1,750 branches all around the country. The designers worked on the photographs, and when they finished the design, they uploaded the proposal to the system as PDF documents. Each of the photomontages was supported with detailed design sheets, which included all changes to be made to the branch as part of the refurbishment. The only thing the photomontage offered was visual support, which satisfied UK planning authorities. A notification which included all iterations/revisions of the design proposal was simultaneously sent to the ITG project manager and the Atkins PM. If the ITG project manager approved the design proposal, the system would send a notification back to the designer; otherwise the project manager would fill an exceptions log with the reasons for the rejection and the recommendations. A notification would be sent to the designer informing him that the proposal was rejected, with the reasons for the rejection. The next step would be the designer's corrections to the original proposal. The same uploading, notification, and project manager's approval or rejection would take place until the design was approved by the ITG project manager.

Similarly all users could be notified of new documents, approvals, rejections, and changes to any branch that they were involved in. Each document was stored in its native format, with the system providing full version control as well as a definitive audit trail to guarantee effective project control. Many phases of the project required contributions from multiple team members to ensure that deadlines would be met. For example, the preparation of a photographic montage for each of the 1,750 sites required the designers to work exceedingly long hours. When extra resources

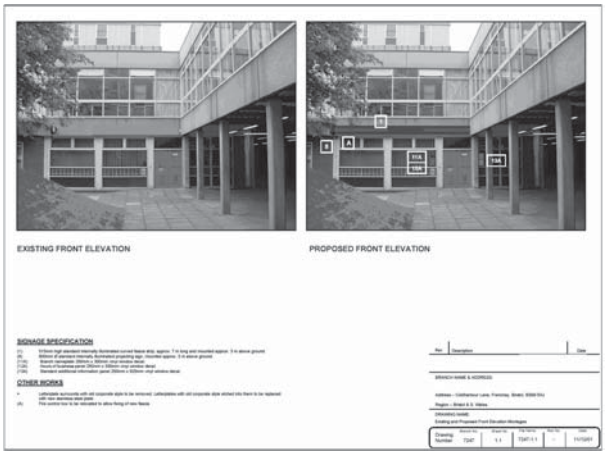

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Figure 5. A "photomontage" design proposal

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Figure 6. An exception's log

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Figure 7. Design approval page

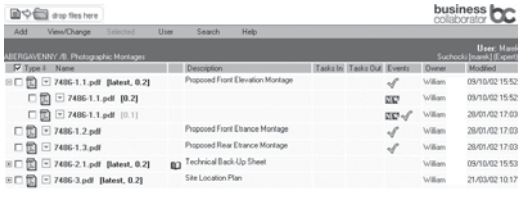

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Figure 8. Exceptions menu

were required, another team based in Prague was commissioned. This very simple process enabled the ITG project manager to work from his home on the south coast of the UK and hastened the project schedule. Marek Suchocki, research and innovation manager at Atkins, says, *"This technology does certain things when you do the traditional process, but when you are looking at hundreds and thousands of projects in a small span of time, then one has to look at the technology and say 'how can we redo the old process?"*

2. BENEFIT/VALUE ANALYSIS

When considering the implementation of a new system, it is essential to understand whether you seek benefits in efficiency (tangible), effectiveness (quasi-tangible), or overall business performance (intangible), or some combination of these. This case study focuses on one program and tries to identify the value of the OCPM tool to the organization in the context of this specific program. The questions we are going to try to answer are: Would the program have been finished within the same time scale if no OCPM technology had been in place? And would it have been possible to achieve the same goals without the tool? If it would not have been possible to finish the program within the same time scale, how would you measure the damage to the organization's reputation? Or how would you measure the effect of any delay to the project if the deadlines are crucial because the organization is announcing its opening in the stock exchange?

We will look at two areas in this case study: performance (intangible benefits) and effectiveness (quasi tangible benefits). *Performance* is not directly measurable in quantifiable terms but is judged qualitatively on the basis of the impact of a successful implementation on long-term business performance and market share. It is the level of new outputs enabled (doing better things). The nature of modern business is such that, increasingly, senior managers are required to think beyond the direct tactical issues, toward more strategic issues. Business performance, in its broadest terms, is a major strategic issue and the one that OCPM technology has much to contribute to. A major argument of this case is that OCPM technology's benefits in construction extend beyond the tactical into strategic business performance improvement. *Effectiveness* is the ratio of achieved outputs to planned outputs (doing the right things): the ability of a program, project, or work task to produce a specific desired effect or result that can be measured. It is performing the right tasks correctly, consistent with organizational mission, vision, values, and in support of the organization's goals and objectives.

There are three main questions for us to ask in order to understand the business of the investors and what they are seeking from their investment: (1) Who are the investors and what values would they like to get out of their OCPM technology investments? (Potential benefits); (2) What did they get from their investment in terms of benefits/values? (Realized benefits); (3) What would they lose if they didn't implement these systems? (Lost opportunities)

-Intangible and Quasi-tangible Benefits-

2.1. Potential Benefits

ITG decided that it was crucial to use an OCPM solution in the Hawton rebranding program because of the sheer number of branches needing to be refurbished within a very speedy schedule with a team of several parties located all over the UK and Europe. ITG believed that their potential benefits would be (1) a more standardized way of working, (2) a better overall control over the program by enabling transparent reporting, audit trail, and information availability, (3) improved customer perception; the property services division's internal clients, contractors, design team, and (4) improved teamwork and professionalism. However, the most important goal of ITG was (5) being able to finish the project on time and on budget with the desired level of quality.

2.2. Realized Benefits

2.2.1. What if it would not have been possible without an OCPM solution? *(Performance):*

Finishing the project as fast as possible was crucial for ITG because the bank had advertisements in the media presenting the bank's new image and announcing the acquisition of Hawton. Furthermore the bank wanted to publicize the acquisition in the stock exchange as soon as possible. The image and reputation of the bank were the big concerns, as any delays in the program would injure the bank's reputation and customer perception. The OCPM tool gave the bank a way to leverage their business processes. All of the team members think that the program might possibly have been completed even if no OCPM tool had been used, but that it would have been impossible to finish the project within the proposed cost structure and the given time frame of 12 months of design and 14 weeks of on-site implementation. The team could have added more resources, but this would have increased organizational and approval complexity and raised the cost of the program. Ben Myddelton, Atkins project coordinator, says, *"The*

project would be possible but not with this schedule. It was a very speedy program." William Landman, the chief designer, agrees: *"It would be possible, but it would take a lot longer and it would be a lot more expensive."* Marek Suchocki at Atkins searches and finds a project with a cost of £15,000. He says, *"What can you get for that money in a traditional project? You cannot actually get a consultant for that amount of money. That needs a lot of thinking."*

2.2.2. Discovery and formalization of extended business processes *(Performance):*
The team carried out workshops in order to establish the procedures, the templates, and to determine which types of data to work with. In some cases they actually created processes because the bank was not working under a process model. The project standards have been set so that the OCPM system can easily be deployed on a variety of future projects. Marek Suchocki says, *"Although the work was considered well understood, adoption of the OCPM tool provided an appreciation of the wider business process."*

2.2.3. Central and one-place-for-all program information *(Effectiveness):*
The tool enabled the users to reach and search the project information globally. It also made it possible to grant access to some users or restrict them to particular project areas. The user actions were simplified to allow the reading or creation of data with the minimum of difficulty. The focus of the OCPM system has always been on the process. Adrian Wilson, the ITG project manager, comments, *"The tool is superb, we are still using it. It is very useful because all branch information is at one place and we don't have to create folders from scratch every time. Everything is in the library. If you sent information regarding a certain branch, all the footnotes go to the library; that itself is a fantastic benefit. No matter where you are you can look at the project. The rest of the world sees it at the same time. I can right now go and use the information. If we were to send all of that information via email, we would lose track."*

Ongoing availability of information when questions arise about a particular branch has also been important to the team members. Marek Suchocki asks, *"If you have a dozen people working on the project, how can you be sure that all of them have the most up-to-date and relevant information? You cannot if you are doing it via emails or if you are mailing it and the drawings are sitting on the desk of somebody. With the tool, we are making sure that we are getting the correct information and we can see the previous history."*

2.2.4. More effective management *(Effectiveness):*
More effective management has been achieved with easy overall project management and control. The overall control of a program of this nature would have been extremely difficult, if not impossible, with the branches spread over a huge geographic area and contractors/designers also diversely located. The ability to review multiple projects provided a more effective management, wrapping up many projects into one site visit and avoiding the need to revisit for each separate project. The team also believes the implementation of online approvals and comments in real time helped avoid the need for meetings and travel in many cases. Marek Suchocki agrees: *"Being able to monitor multiple projects at the same time reduces the administration staff and provides better construction management."* In addition, an improvement in teamwork and professionalism was experienced through a positive attitude to using the OCPM tool from the entire team.

2.2.5. Reduction in errors and wastage *(Effectiveness):*
Duplication of effort and wastage are key concerns on construction projects. The OCPM system gave all users certainty of information. The benefit isn't just having the correct version and having access to it but also having the ability to track the previous versions back and seeing who else has accessed or modified the information. Technology wastage has been addressed with a reduction in email and storage on personal computers.

2.2.6. Extensive file management system *(Effectiveness):*
The tool provided an extensive file management system with access restrictions to the folders. The users had the ability to imply the rules on folder naming, folder structures, and folder length. They could find the asset documents from the database easily, and notification rules provided them with certainty of the activity.

2.3. In the Absence of the OCPM Solution
ITG believes that the system proved to be an excellent collaborative tool, supporting many gigabytes of data, readily accessible worldwide via Internet connection. This solution proved to be invaluable to the delivery of the program, and provided complete value since its investment cost was less than 0.1% of the total expenditure. All team members agreed that it would be difficult to imagine how this rebranding program could have been delivered without it. They

also agree that the people involved in this project were very good, the program was very well done, and internal politics were well established. Still, they are confident that if they hadn't had the system in place, it would have been impossible to deliver a program of this size with the same amount of resources: 1,750 properties amended in 14 weeks of bulk work (12 months for peripheral work) and 12 months of design. The team considers the completion of this program a real success in challenging the business process.

In sum, if ITG hadn't implemented and used the OCPM solution in the Hawton rebranding program, they would (1) not have been able to complete the project on time and on budget, (2) not have had the same speed of communication between the parties involved, (3) have had more errors and less effective management, and (4) have lost individuals' time by using less fluent and more cumbersome ways of communication.

2.4. Quasi-tangible Benefits' Ranking

Besides interviews, an electronic survey of quasi-tangible benefits was designed and distributed via email to all interviewees to measure the improvement in a more consistent and less subjective way. The aim of the survey was to uncover as much information as possible and to quantify quasi-tangible benefits of OCPM technology investments. Each respondent received the identical set of benefits, phrased in exactly the same way in order to reduce errors resulting from the recording of responses, and the respondents were free to rank the benefits according to their relevance at responder's own pace. The survey covered several benefits that were stated during the interviews. The responders were asked to rank the benefits 1 through 5 (where 5 is *'very high'*, 4 is *'high'*, 3 is *'neutral'*, 2 is *'low'* and 1 is *'very low'*). Benefits and values ranked by ITG Group case interviewees can be seen in the table below.

Benefits/Values	**A***	**B***	**C***	**D***	**Ave.**	**StnDev**
- Improved data availability	5	5	5	5	5	0.0
- Improved information version control	5	5	4	5	4.75	0.5
- Enabled faster reporting and feedback	5	4	5	5	4.75	0.5
- Enhanced working within virtual teams	5	4	5	5	4.75	0.5
- Enabled fewer information bottlenecks	5	5	4	4	4.5	0.6
- Provided accurate and timely information to give valid/accurate decisions	5	5	5	3	4.5	1.0
- Improved information management	5	4	4	5	4.5	0.6
- Enabled having complete audit trail	3	5	5	5	4.5	1.0
- Improved process automation (RFIs/COs automatic updated master budget, etc.)	5	5	3	4	4.25	1.0
- Improved timely capture of design/ construction decisions	5	4	4	4	4.25	0.5
- Reduced errors and omissions	5	4	4	4	4.25	0.5
- Enabled better project/program control	5	4	4	4	4.25	0.5
- Enabled faster launch to market due to faster delivery	5	3	4	3	3.75	1.0
- Reduced personnel costs due to improved efficiency	5	4	4	2	3.75	1.3
- Enabled better resource allocation; more effective assembly of project teams	5	4	3	3	3.75	1.0
- Improved idea sharing among team members/within organization	5	3	2	4	3.5	1.3
- Minimized project/business risks	3	4	3	4	3.5	0.6
- Improved project relationships with strategic partners	3	4	3	3	3.25	0.5
- Enabled quicker response to project status and budget	3	4	2	3	3	0.8
- Improved quality of the output	3	4	3	2	3	0.8
- Reduced rework/data reentry	3	3	4	2	3	0.8
- Enabled better forecasting and control	3	4	2	X		
- Enabled advance purchase of materials	3	2	X	3		
- Reduced delivery lead times	3	3	4	X		

- Enabled better inventory management	3	4	3	X
- Enabled more effective identification and assessment of new suppliers	3	3	X	X
- Improved public relations	3	3	3	X

Table 1. Ranking of various benefits/values by Inscape case interviewees (*The names of the respondents are hidden for confidentiality reasons. However, the respondents are managers of Inscape and users of the OCPM solution in Inscape projects. "X" stands for when the question is not relevant or the responder doesn't know the answer.)

3. FUTURE OPPORTUNITIES

ITG has purchased a proven technology designed for collaboration and adapted it to suit its business needs. The bank can easily reuse and reconfigure the tool for its future projects. The success of the system has led the bank to add two multi-million-pound new-build office projects to the OCPM tool. With the exception of configuration, any new projects can be added without incurring additional cost. ITG is using it at the moment for property management: tracking rent reviews, lease renewals, rates, etc. And they want to use it more significantly in internal and capital projects.

Other than the reusability on future projects, the implemented solution will also provide long-term benefits to the bank from a knowledge management perspective. The ITG users will be able to revisit data on past projects, essentially using the OCPM tool as a universally accessible reference library. This feature has already identified shortcomings in the way the bank currently maintains its technical records – in particular the reliability of stored information. Although this tool is still being used for several ITG refurbishment projects, this is not the only OCPM tool ITG uses in its projects. At the completion of this program all information is still in the system and it all belongs to the client. Essentially once the project is over and the service is no longer paid for, the files get archived and much of the useful information such as user activity is lost.

4. BENEFIT/ VALUE SUMMARY

Tangible, quasi-tangible and intangible benefits of the ITG Group case are summarized in the table below. Tangible benefits were not considered in this case as the investor's main goal was to gain quasi-tangible and intangible benefits through their OCPM investment. The electronic survey is used to quantify the effectiveness benefits (quasi-tangible improvements) by ranking. Two performance (intangible) benefits are observed in this OCPM implementation; one is the discovery and formalization of extended business process; and the second one is realization of the project in a very ambitious time scale. Upon the OCPM investor's request, the cost of the system is preferred to be presented as a percentage of the total expenditure.

Types of Benefits	**Measured Benefits**
Tangible	Not considered
Quasi-tangible	Survey: **4/5** (21 benefits identified out of 27)
Intangible	**2 identified**: Discovery and formalization of extended business process; and realization of the project in a very ambitious time scale
Cost of the system	**0.1%** of the total expenditure

INTERVIEWEES

- Adrian Wilson, Project Manager, ITG Purchasing and Property Operations, 04/29/2005
- Ben Myddelton, Project Manager, Atkins, 04/07/2005
- Ivan Fait, Client Project Manager, ITG Purchasing and Property Operations, 03/30/2005
- Marek Suchocki, Research and Innovation Manager, Atkins, 12/01/2004, 01/24/2005, 05/19/2005, 05/24/2005
- William Landman, Designer, Houstian Ltd., 03/16/2005

REFERENCES

Suchocki, Marek (2002), *"Delivering Collaborative Programme Management,"* 13th international Conference on Database and Expert Systems Applications, 13th International Workshop on Collaboration, Aix-en-Provence, France, September 2002 , 326-332

Atkins Management Consultants (2002), Information Technology Submission to the Contract Journal Construction Industry Awards, *"There is Another Way"*

CASE STUDY 4. KITCHELL CONTRACTORS

1. INTRODUCTION

This case study focuses on identification and measurement of the value of online collaboration and project management (OCPM) technology from a general contractor's perspective. The case covers tangible and intangible benefits/values at both the project and the organizational level. The following subsections give a brief description of the company and outline the need, selection, cost, and implementation of the OCPM tool. A project of Kitchell Contractors, St. Joseph's Barrow Neurological Institute Tower, has been selected as a model for the OCPM tool value calculations.

1.1. Kitchell Contractors

Kitchell Corporation, a $600 million privately held firm headquartered in Phoenix, Arizona, provides a wide range of services from general contracting to construction management and development. Kitchell Contractors (Kitchell) is the corporation's largest branch; it is a construction management and general contracting company serving the private sector. Kitchell has specialty divisions such as health care, custom homes, Native American, and master-planned communities in Arizona and Nevada. The company also has a subsidiary offering of medical equipment and occupancy planning.

1.2. Catholic Healthcare West and St. Joseph's Barrow Neurological Institute Tower Project

Catholic Healthcare West (CHW) is one of Kitchell's clients. CHW, headquartered in San Francisco, is a system of 40 hospitals and medical centers in California, Arizona, and Nevada. Founded in 1986, CHW is the eighth largest hospital system in the nation and the largest not-for-profit hospital provider in California. St. Joseph's Hospital and Medical Center (St. Joseph's) is one of CHW's hospitals in Phoenix, Arizona, with 535 beds, serving the community since 1895. St. Joseph's new Barrow Neurological Institute (BNI) Tower is one of three new ongoing construction projects of CHW.

Construction on the BNI Tower, a $91 million expansion project, started in January 2004. Kitchell was awarded the construction management and general contracting guaranteed maximum price (GMP) contract. Perkins & Will's Los Angeles office is responsible for the design services. All parties are contracted by the owner and subcontractors are contracted by Kitchell. With Kitchell and the architect, CHW used corporate agreement forms to utilize an OCPM tool. As of May 2005, the project was under construction and completion expected by February 2006. Although the BNI Tower is one project from a capital funding perspective, the project is divided into four contracts: BNI Tower proper, pharmacy, lobby remodel, and medical mall. CHW is managing the project in multiple phases, with individual owner/contractor agreements for each contract, and different subcontractors on each phase. The new 7-story tower is mostly for neurological patients including operating, surgery, and magnetic resonance imaging rooms as well as patient rooms. The construction of the lobby will start shortly and the pharmacy is under construction as of April 2005.

1.3. The Need for an OCPM Solution

To manage its construction operations, Kitchell standardized on OCPM solutions from Meridian Systems, utilizing

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Figure 1. Rendering of St. Joseph's BNI Tower

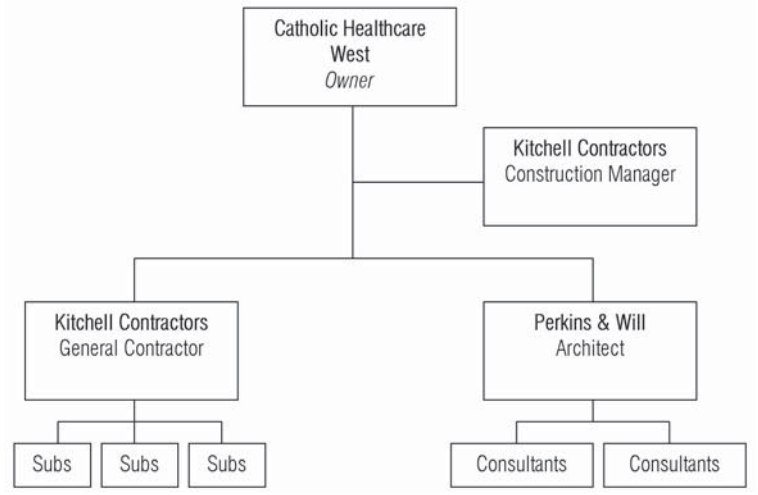

Figure 2. Project organizational diagram

both the client/server-based Prolog for the past 5 years and web-based ProjectTalk for the past 4 years. The ultimate goal was to facilitate and improve the communication between team members in all of Kitchell's large-scale projects. Kitchell wanted to have all project documentation in one central place to: (1) help projects move smoothly without miscommunications or delays; and (2) enforce the teamwork among the participants.

1.3. The Need for an OCPM Solution

To manage its construction operations, Kitchell standardized on OCPM solutions from Meridian Systems, utilizing both the client/server-based Prolog for the past 5 years and web-based ProjectTalk for the past 4 years. The ultimate goal was to facilitate and improve the communication between team members in all of Kitchell's large-scale projects. Kitchell wanted to have all project documentation in one central place to: (1) help projects move smoothly without miscommunications or delays; and (2) enforce the teamwork among the participants.

1.4. OCPM Technology Selection

Kitchell evaluated several products before investing in an OCPM system. The company selected its OCPM tool based on the solution features and flexibility; cost wasn't the main driver in the selection process. The tool gave Kitchell an opportunity to create reports easily and customize them according to owners' needs. CHW's Corporate Real Estate (CRE) office is the design and construction corporate division that oversees all CHW projects greater than $5M. Based on feedback from Kitchell and other contractors, CHW standardized on the same OCPM application for all major projects, and required its use in the St. Joseph's BNI Tower project. CHW selected this OCPM system because

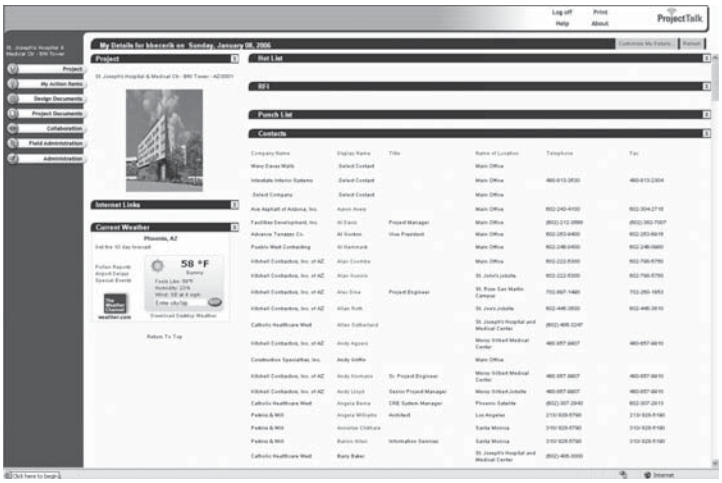

Figure 3. BNI Tower welcome page

of Meridian's long history in the market, as well as the flexibility the tool provides to customize reports and forms. CHW has decided to utilize the web-based solution because they didn't want to invest in the hardware and/or the personnel to host it themselves.

1.5. The Cost

Pricing for the OCPM solution is based on memberships. Organizations can choose to subscribe on a monthly basis or prepay for an annual agreement. When Kitchell decided to use the product, they didn't set up any kind of corporate-wide agreement with the vendor. Kitchell utilizes the actual amount memberships needed per year based on the actual amount of work secured. This gives them flexibility based on work volume, or when they do not dictate the project management method used on a particular project.

For the hosted OCPM solution, four membership levels are available: 1) project management, 2) scheduling, 3) collaboration, and 4) basic. The project management membership level includes all the collaboration membership services plus financial control, purchasing, project setup, and administrative features. Collaboration-level membership includes the ability to create and manage your own project portfolio, use of the personal action item manager, and collaboration, document control, reports, and field administration features. The memberships Kitchell holds and their cost are shown below.

40 web-based OCPM memberships:
- 31 are at the project management level: 4 are monthly memberships and 27 are annual memberships
- 2 are at the collaboration level: both are annual memberships
- 7 are sponsored (non-Kitchell employees) at the collaboration level: 1 is a monthly membership and 6 are annual memberships

Kitchell also has 48 basic (free) users registered on the web-based OCPM solution.

The list price for Collaboration memberships is $60/month, or $576/year (which includes a 20% prepaid discount). The list price for project management memberships is $160/month and $1,536/year (which includes a 20% prepaid discount). Kitchell also obtained 60 user licenses of the client/server-based OCPM tool at a price of $2,500 each; these licenses are used internally. The 40 licenses of the web-based solution are paid for by Kitchell clients (e.g., CHW covers the cost of the OCPM solution for the St. Joseph's BNI Tower).

1.6. Implementation

All Kitchell projects over a certain dollar value threshold – about $100,000 – use either web-based or client/server-based OCPM solutions. The decision of which type to use depends on the client, as they have to pay for the system if they choose to use the web-based system. If the client agrees to use the collaboration tool, Kitchell and the rest of the team utilize the web-based solution; otherwise, the client server-based solution is used for project management functionalities. One-third of Kitchell's projects using the tool are managed by the web-based system, the rest on the client/server-based solution.

The intention is eventually to utilize the tool for all Kitchell projects. The St. Joseph's BNI Tower project was one of the first projects to utilize the tool around 4 years ago. Kitchell trains its own staff and also provides training to project teams upon request. Kitchell charges for training depending on how much it requires; e.g., if it requires traveling and involves a large group like 30-40 people, then Kitchell charges for the training. The users' access levels are determined by the client (in this case CHW). Kitchell has access to all project information as they are the OCPM tool leader. Architect and design consultants, project and program managers, project sponsor, inspector of record, and CRE personnel have limited access determined by CHW. Subcontractors and suppliers don't have access to the tool. If they have a question they pass it to Kitchell and Kitchell enters the question into the system. Access levels are indicated below.

- General contractor: all aspects
- Architect and design consultants: meeting notes, RFI response, submittals, drawing logs
- Project and program managers: change management and meeting notes
- Project sponsor: report viewing
- Inspector of record: creation of inspection reports, review status of RFIs, submittals, drawings
- CRE personnel: review of project status and database administration

1.7. The Use of the OCPM Solution in the St. Joseph's BNI Tower

Kitchell has around 100 active and 25 closed projects in their databases. There are a total of 450 internal and external users in both OCPM solutions. The frequently used modules are cost modules for creating owner contracts, potential change orders, change order requests, owner change orders, RFIs, meeting minutes, issues, drawings and specifications, submittals, transmittal and correspondence log, field administration for recording work journal entries, daily details, events, notices to comply and safety notices, testing and inspection reports for general and detailed inspection information, scheduling required tests, and creating quality assurance checklists.

Different projects use different modules; overall, however, the most-used modules are the RFI and meeting minutes modules. Kitchell leaves the level of use to the project managers and team members. Their long-term goal is utilizing all the modules in every project and mandating the use of the tool by making it a requirement in the contract. One challenge Kitchell faces is resistance to using the system as many parties also have their own systems and see it as a duplication of work. At the end of a project, Kitchell usually archives all project information and gives a copy to the owner.

Although the OCPM tool was not utilized during the design phase of St. Joseph's BNI Tower project, Kitchell believes it is important to do so at the beginning of projects. Ed Costanza, applications administrator at Kitchell, comments, *"It's advantageous to use the software in the design phase, and we try to accomplish this on our projects."*

For the St. Joseph's project, the primary users of the OCPM software were the architecture/engineering firm and the general contractor. The architect's team mostly uses it for RFIs, drawings, and specifications. Kitchell as the general contractor uses almost all modules except purchasing. In addition, the owner receives hard-copy reports generated through the application. Nicholas Dalba, the hospital's director of facilities development, uses the meeting minutes. He says, *"If there is a question, I receive it via email. But I can also go to the OCPM site and check what is posted on it for curiosity. It is a great tool for the owner to monitor the overall project."*

2. BENEFIT/VALUE ANALYSIS

In order to measure benefits, we need to understand the business of the investors and what they are seeking from their investment. There are three main questions: (1) Who are the investors and what values would they like to get out of their OCPM technology investments (potential benefits)? (2) What did they actually get from their investment in terms of benefits/values (realized benefits)? (3) What would they lose if they didn't implement these systems (lost opportunities)?

For our purposes the benefit/value analysis is based on three factors: effectiveness, efficiency, and performance. When considering the implementation of a new system it is essential to understand whether you seek efficiency, effectiveness, or overall business performance benefits, or some combination of these factors. *Effectiveness (quasi-tangible benefits)* is the ratio of achieved outputs to planned outputs (doing the right things). This is the ability of a program, project, or work task to produce a specific desired effect or result that can be measured. Effectiveness is

performing the right tasks correctly, consistent with organizational values, goals and objectives. *Efficiency (tangible benefits)* is defined as the rate at which inputs are converted to outputs (doing things right). Efficiency is financially measurable and is represented by money. We will discuss and quantify the benefits in the efficiency area in the following section in the light of the DIA Center addition project. *Performance (intangible benefits)* is not directly measurable in quantifiable terms but is judged qualitatively on the impact of a successful implementation in influencing long-term business performance and market share. The scope and context of the Kitchell case study focused on effectiveness and efficiency in light of CHW's St. Joseph's BNI Tower project example.

-Effectiveness-

2.1. Potential Benefits

CHW expected to benefit from the OCPM tool early on in the project based on their ability to check project status in real time. If user concerns arose, they could be addressed immediately and questions answered quickly using the RFI module. For Kitchell, using the OCPM tool would allow them to address their biggest concern on the St. Joseph's BNI project of maintaining the schedule. Because this project was a GMP contract, it involved liquidated damages of $5,000 per day. Therefore, key expectations were (1) to keep the project schedule under control, (2) enable smooth and effective project communication, and (3) address problems and/or issues in a timely manner.

2.2. Realized Benefits

2.2.1. Central place for project information *(Effectiveness):*

When using an OCPM tool on a construction project, all project participants can manage their own information. However, this information becomes more valuable because it resides in a single database. The OCPM tool eliminates the disconnected silos of project data, enabling all team members to see the latest versions of the files and fostering better teamwork. The tool also provides the flexibility to execute a project globally when users are in different locations and time zones. Karl Zook, senior project engineer of Kitchell, comments, *"There is no question about who owns what, and once everybody is on the same page there are no surprises."* Mark Bittner, one of the area directors of CHW, adds, *"It is beneficial for all parties to have access to the same documentation via the logs for submittal processing, RFI processing, change management processing, and meeting minutes."*

2.2.2. Increased project speed *(Effectiveness):*

It is important for the owner to have the building completed on time as the hospital will generate revenue as soon as it opens. The project team agrees that with the utilization of the OCPM tool there is less paper to handle and they spend less time executing construction work processes such as RFIs or change orders. One can print out different logs or submittal packages and organize this information in many different ways. The team believes that they gain efficiencies; these may or may not be reflected in the schedule directly. Ed Costanza explains the effect of the OCPM tool on the overall project schedule this way, *"It definitely enables our people to perform other tasks due to increased efficiency."*

2.2.3. Better monitoring and control *(Effectiveness):*

The tool automatically tracks everything related to the project. The single database model allows team members to create reports and easily search to find the documents they need. In addition, the tool increases team member awareness through instant notifications and provides easy access to information for consultants. There are no claims so far in the BNI Tower project, but if any were to develop, Kitchell has all the documentation available to substantiate their position. This level of audit ability is very important on a project like the BNI Tower, which has $5,000 liquidated damages per day. Ed Costanza says, *"We definitely have more documentation electronically than hard copies. We can build a catalog of documents in short order to argue a claim if needed."* The tool also gives power to the owner. Karl Zook comments, *"The owner can look at the system and can tell if somebody is underperforming. It enables open communication and it is very beneficial to all parties."*

2.3. In the Absence of the OCPM Solution

Those interviewed commented that without an OCPM system, (1) there would be an increased level of frustration, (2) productivity would decrease, (3) both team work and collaboration would suffer, and (4) the turnaround time for RFIs, submittals, or change orders would be a lot longer. Julie Ernzen, project engineer of BNI tower project, comments, *"If I didn't have the system in place, I would have 10 times more paperwork. I would spend more time sending documents back and forth. The tool gives us an opportunity to work in a more structured way."* Ed Costanza answers the question from the Kitchell point of view: *"If we didn't have a system like this, we would be less efficient and efficiency*

is critical when you're dealing with liquidated damages contracts. For us, this is the best system."

2.4. Quasi-tangible Benefits' Ranking

Besides interviews, an electronic survey of quasi-tangible benefits was designed and distributed via email to all interviewees to measure the improvement in a more consistent and less subjective way. The aim of the survey was to uncover as much information as possible and to quantify quasi-tangible benefits of OCPM technology investments. Each respondent received the identical set of benefits, phrased in exactly the same way in order to reduce errors resulting from the recording of responses, and the respondents were free to rank the benefits according to their relevance at responder's own pace. The survey covered several benefits that were stated during the interviews. The responders were asked to rank the benefits 1 through 5 (where 5 is *'very high'*, 4 is *'high'*, 3 is *'neutral'*, 2 is *'low'* and 1 is *'very low'*). Benefits and values ranked by Kitchell case interviewees can be seen in the table below.

Benefits/Values	A*	B*	C*	D*	Ave.	StnDev
- Enabled having complete audit trail	5	3	5	5	4.5	1.0
- Enabled faster reporting and feedback	5	4	4	4	4.3	0.5
- Improved data availability	5	4	4	3	4.0	0.8
- Improved information management	5	3	4	4	4.0	0.8
- Improved process automation (RFIs/COs, automatic updating of master budget, etc.)	4	3	4	4	3.8	0.5
- Improved quality of the output	5	4	3	3	3.8	1.0
- Provided accurate and timely information to give valid/accurate decisions	4	3	4	4	3.8	0.5
- Enabled better project/program control	5	3	4	3	3.8	1.0
- Enhanced working within virtual teams	5	4	2	3	3.5	1.3
- Reduced rework/data reentry	5	4	1	3	3.3	1.7
- Enabled better resource allocation; more effective assembly of project teams	4	3	3	3	3.3	0.5
- Enabled fewer information bottlenecks	4	2	3	3	3.0	0.8
- Reduced errors and omissions	5	1	2	2	2.5	1.7
- Reduced personnel costs due to improved efficiency	3	2	2	3	2.5	0.6
- Improved idea sharing among team members/within organization	1	1	3	3	2.0	1.2
- Reduced delivery lead times	3	3	2	X		
- Enabled better forecasting and control	5	4	X	X		
- Enabled advance purchase of materials	X	2	2	X		
- Improved project relationships with strategic partners	2	2	X	X		
- Enabled quicker response to project status and budget	3	2	4	X		
- Minimized project/business risks	3	3	2	X		
- Improved timely capture of design/ construction decisions	5	3	2	X		
- Improved information version control	X	X	3	4		
- Enabled better inventory management	X	X	2	X		
- Enabled more effective identification and assessment of new suppliers	X	3	X	X		
- Enabled faster launch to market due to faster delivery	3	3	2	X		
- Improved public relations	3	X	X	4		

Table 1. Ranking of various benefits/values by Kitchell case interviewees (*The names of the respondents are hidden for confidentiality reasons. However, the respondents are managers of Kitchell and CHW and the users of the OCPM solution in the St. Joseph's BNI Tower project. "X" stands for when the question is not relevant or the responder doesn't know the answer.)

2.5. Request for Information (RFI)

An RFI is one of many documents generated during the construction period. It occurs when a contractor, subcontractor, or supplier finds an unclear element or dimension in construction drawings, a conflict between specifications and drawings, or any question regarding anything on the construction site. The handling of RFIs has a very big impact on the project schedule because RFIs that haven't been answered on time might cause delays in construction work.

Questions asked have traditionally been sent by fax or in paper form to the construction/project manager or architect, depending on the procurement method. These questions are then passed to the responding parties. The party issuing the RFI - usually the general contractor or a subcontractor - has to wait for the answer, which might take a long time depending on the responding party. After receiving the answer, the construction manager or architect passes to the inquiring party the question file and attached answer information, with the name of the answering party, time, and date they have received it. Usually RFI documents are bound in three-ring binders, which also occupy space. The responsible party has to look at all documents (specifications, drawings, etc.) and answer the question. While some of the questions might be simple to answer, others might take longer. In response to an RFI, the drawing or specification could be changed, modified, or cause a change order, which needs the owner's approval.

In the St. Joseph's BNI Tower project, when subcontractors have a question regarding the construction site, it is referred to Kitchell in order to generate an RFI using the OCPM tool. When the description is entered and the date is created, the tool calculates the date required based on the duration set for RFI review. The author company and author of the RFI are automatically filled in with the user information. The tool automatically posts the RFI in the database, and the person from the architect's office to whom the RFI is referred immediately receives a notification

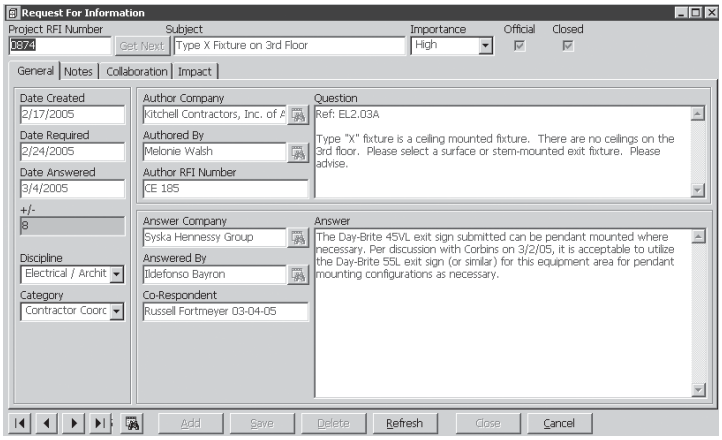

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Figure 4. RFI log

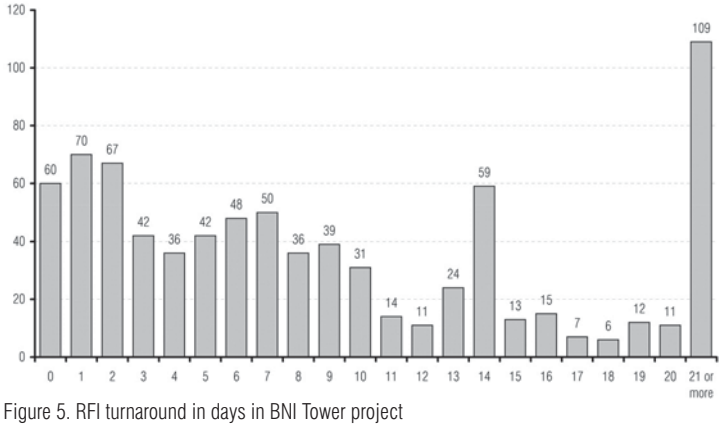

Figure 5. RFI turnaround in days in BNI Tower project

regarding this RFI. This RFI form can be used to track contract document changes including drawings, and any cost and schedule impacts associated with each request for information.

By using this electronic RFI module, specific RFIs can be pulled up on screen without using the search button. Individual drawings listed in the drawing and specification logs can be linked to the RFI using the function in the notes tab. Comments can also be entered in the RFI under the notes tab. Each RFI has the option to show the cost, schedule, and drawing impact under the impact tab. In this project, the team asks for answers within a period of time; if it is critical, they mark it as such and set it up for rapid turnaround such as 2 days. The architect returns the RFI with an answer through the OCPM tool using the same methods. As of May 2005, there have been 983 RFIs asked in the project, of which 181 are still open.

2.5.1. Realized benefits of electronic RFIs:

The BNI Tower project team agrees that the RFI module is a great advantage because the RFIs can electronically transferred and stored in a shared database. In a paper-based process, RFIs need to be transmitted by fax, eventually ending up on somebody's desk or mailbox. With the OCPM tool, all team members receive RFI much more rapidly and can be made aware of the issue simultaneously. In addition, there is always a record of whether the corresponding person has received it and opened it. Russell Triplett of Perkins+Will, BNI tower project the designer, comments, *"When the contractor sends a question, we get an email saying there is a new RFI. I can direct it to other people if necessary or I can copy the email to them. It is a great tool for tracking everything."*

Reduction in turnaround time:

The RFI turnaround time on the BNI Tower project can be seen in figure 5. Out of 802 closed RFIs, 415 were answered within a week. The average turnaround time of RFIs based on a 7-day work week is 9.2 days. A total of 397 RFIs were answered before their due dates, as determined by the party who asked the question.

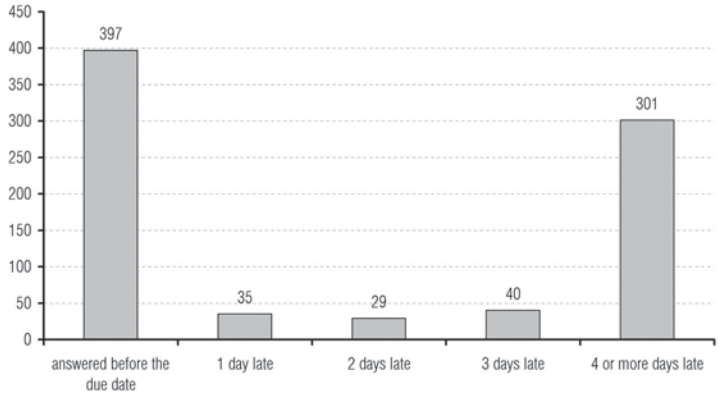

Figure 6. RFI overdue in BNI Tower project

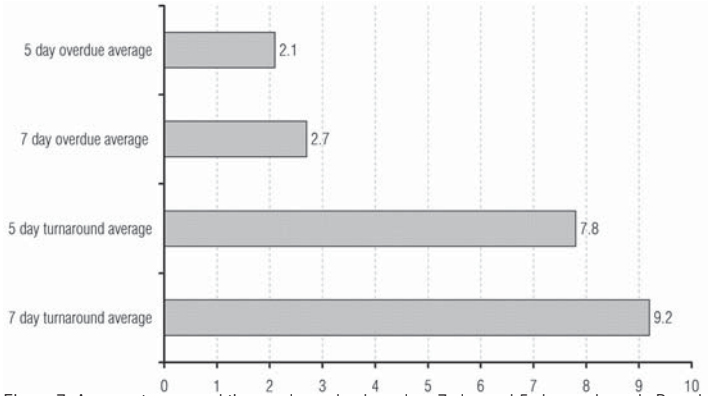

Figure 7. Average turnaround time and overdue based on 7-day and 5-day work week. Based on 781 RFIs; RFIs not answered (181) and those with over 39 days turnaround time (only 21) are eliminated.

Decrease in time spent on issuing an RFI:
According to the team, the tool definitely decreases the time spent on issuing an RFI. Depending on the issue, the designers agree that they can send the answer back to the contractor literally in a minute.

Reduction in numbers:
The team agrees that there is no reduction in the number of RFIs in this project. Although the number of RFIs might seem high, Russell Triplett, the designer, thinks that for a $100 million hospital project this is a normal number. Complex structures like hospitals usually have more RFIs.

2.6. Change Orders in the BNI Tower Project
A change order is the formal document that is used to modify the original contractual agreement and becomes part of the project's documents. Changes in a construction project can have numerous causes: design changes, design errors and omissions, etc. Change orders are responsible for a series of impacts as they disrupt work schedules and can create cost overruns. Changes can be initiated by all parties in the construction process. All changes, however, must be approved by the owner before being implemented. As of May 2005 there have been 465 potential change orders on the BNI Tower project. When they are approved they will be turned into actual change orders. 164 of these potential change orders refer to an RFI in the project. Change orders are not so important for the cost of this project because of the GMP contract.

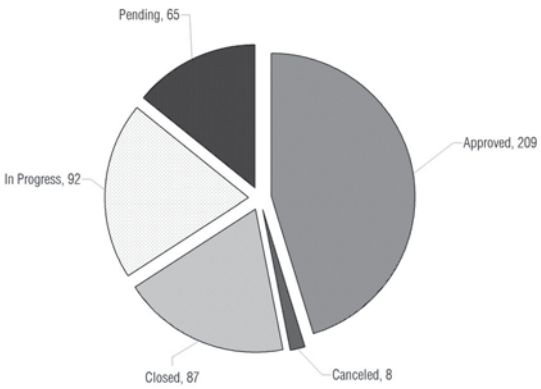

Figure 8. Status of potential Change Orders

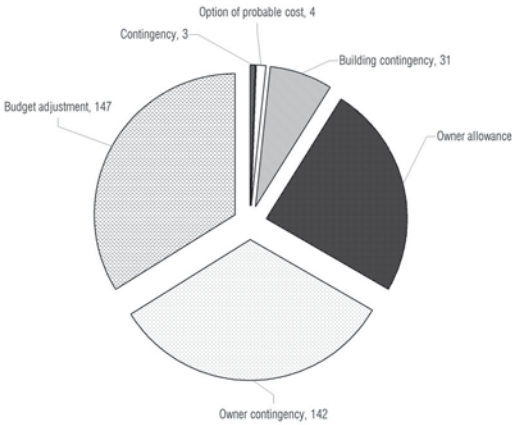

Figure 9. Funding of potential Change Orders

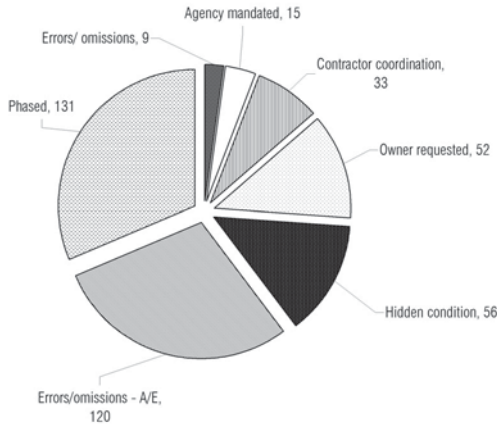

Figure 10. Reasons for potential Change Orders

2.7. Other Utilized Modules

Document and cost control modules are being used very extensively in this project. Ease of transferring documents, drawings, and specifications was definitely among the most important benefits of the OCPM tool, as the architects were located in Los Angeles and the construction team was in Phoenix. Drawings are not sent in their original format due to liability issues. Architects are worried that they have their electronic stamp on the drawings and they don't want anybody to copy it and use that stamp inappropriately. In addition, they don't want subcontractors to work on architectural drawings to prepare their specifications. The reason is that, if the vendor doesn't do the field measurements and utilize the appropriate installation, there might be claims for inappropriate fabrication. Instead, the team posts drawings as PDF documents.

In all, we know there are 4,284 documents (we assume half are 1 page, the other half 2 pages) Total number of pages = 2,142 + (2,142 x 2) = 6,426
Assume 50% of the documents do not need to be printed
6,426 x 50% = 3,213 pages
Assume at least 3 parties would print the same document if the OCPM tool wasn't implemented
3,213 x 3 = 9,639 pages of document
Assume cost of printing is $0.1 per page
$0.1 x 9,639 = $964 per project
Assume 3/4 of the documents don't need to be mailed due to efficient electronic transfer and mailing costs of $1 per document
$1 x ¾ X 4284 = $3213 per project

TOTAL SAVINGS:
3,213 + 964 = **$4,177** per project ~ **$42,000** for 10 projects

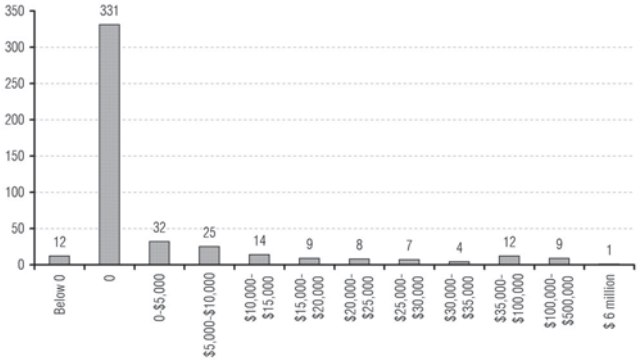

Figure 11. Estimated cost impact of potential Change Orders

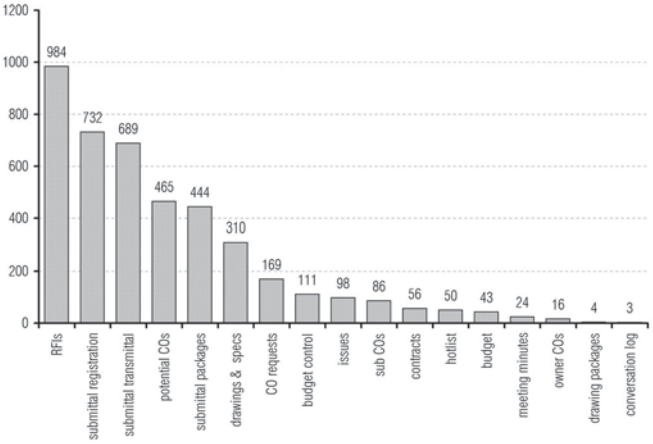

Figure 12. Number and type of BNI Tower project documents stored in the OCPM tool

3. FUTURE OPPORTUNITIES

Kitchell cannot imagine giving up its OCPM tool as it is now a critical part of their business operations and work culture. Ed Costanza says, *"If we were to stop using the tool for whatever reason, we would have to use another tool. Speed is critical and with the type and size of our projects there is no other way."* In the future, the company is aiming to integrate its OCPM tool with its accounting system and also engage more users. Another plan of Kitchell is having portable devices on their site to address the issues directly.

4. BENEFIT/ VALUE SUMMARY

Tangible, quasi-tangible and intangible benefits of the Kitchell case are summarized in the table below. Savings from the electronic document exchange are the base for the tangible benefits. The BNI Tower project is used as an example and the results are projected to 10 Kitchell projects. The electronic survey is used to quantify the quasi-tangible benefits (improvements) by ranking. No performance (intangible) benefits are observed in this OCPM implementation. The cost of the system is around $45,500 annually for the web-based system; however the cost is passed to the owner frequently.

Types of Benefits	**Measured Benefits**
Tangible	**$42,000** annually (for 10 projects)
Quasi-tangible	Survey: **3.5/5** (average of 15 benefits identified out of 27)
Intangible	Not identified
Cost of the system	**$45,500** annually (web-based system; however the cost is passed to the owner frequently)

INTERVIEWEES

- Ed Costanza, Applications Administrator, Kitchell Corporation, 02/25/2005, 02/28/2005, 05/23/2005
- Julie Ernzen, Project Engineer, Kitchell Contractors Healthcare Division, 03/30/2005
- Karl F. Zook, Senior Project Engineer, Kitchell Healthcare Division, 03/29/2005
- Melonie Walsh, Senior Project Engineer, Kitchell Contractors Healthcare Division, 04/01/2005
- Nicholas J. Dalba, Director of Facilities Development, St. Joseph's Hospital and Medical Center, 04/18/2005
- Russell Triplett, Senior Associate, Perkins+Will, 04/01/2005

CASE STUDY 5. LOS ANGELES UNIFIED SCHOOL DISTRICT

1. INTRODUCTION

This case study focuses on identification and measurement of the value of online collaboration and project management (OCPM) technology from a public owner's perspective. The case covers intangible business benefits and values, at the organizational level only. The following subsections give a brief description of the organization (Los Angeles Unified School District) and its new construction program, and outline the need, selection, cost, and implementation of the OCPM tool. The paper presents the value of OCPM technology especially in the areas of *"claims mitigation and management"* and *"forecasting"* in a large capital construction program.

1.1. Los Angeles Unified School District

The Los Angeles Unified School District (LAUSD) is the largest public school system (in terms of number of students) in California and the second-largest in the United States. As of 2005, it serves over 746,800 students in eight districts. To serve the students there are more than 41,000 certificated employees, including teachers. They are assisted by a non-teaching staff of about 36,000 part- and full-time employees in fields ranging from environmental planning to medical to real estate and beyond.

The LAUSD is the largest property owner in Los Angeles. LAUSD's Facilities Services Division (FSD) is responsible for building new schools and making existing school facilities better and safer for the district while preserving the public's trust. FSD has two divisions: New Construction and Existing Facilities and Modernization. The New Construction division is responsible for construction projects that will build new classroom seats throughout the district. Achieving this goal allows LAUSD to reduce class sizes to agreed-upon limits at all grade levels, provide special education facilities as mandated, provide pre-kindergarten facilities, and reduce the reliance on portable classrooms. The Existing Facilities and Modernization division is responsible for the maintenance and operation of all existing schools as well as the completion of all modernization projects designed to upgrade the schools.

1.2. The New Construction Program

The New Construction program is a multi-phased, multibillion-dollar program to deliver new school facilities with the aim of relieving critical student overcrowding throughout LAUSD. This overcrowding has resulted from (1) increased student enrollment, (2) state-mandated class-size reduction, and (3) lack of funding to expand capacity in the years prior to this effort. This program requires LAUSD to identify target areas of need, acquire necessary sites, design and develop plans, and construct schools as quickly as possible. Over the next six years, LAUSD will complete the construction of 139 new construction projects to accommodate explosive growth in the student population. The New Facilities Master Plan identifies the need for 79 new schools, 60 on-site building additions, and 20 playground expansion projects. The 139 building projects will comprise 3,222 new classrooms and will accommodate a total of 76,871 students on a 2-semester basis. New schools and site expansions will require the acquisition of over 450 acres of land, some of which LAUSD has already acquired.

The current new school construction project is divided into two distinct but overlapping phases. Phase 1 is valued at approximately US$3.625 billion dollars and began in June of 1998. The scope of the Phase 1 effort is to build 78,000 classroom seats by mid-2008. Phase 2 has estimated funding of US$1.643 billion and began in November 2002. The scope of the Phase 2 effort is to construct 35,000 new classroom seats by 2010. The effort also includes new or expanded seats for early childhood development and the expansion of charter schools. Additional to the new construction, LAUSD has about 22,000 project needs to be taken care of such as replacing air conditioning units and remodeling classrooms.

Funding for the new school construction program is primarily provided through tax revenues. Three finance mechanisms generate funding to meet the needs of LAUSD's new construction program: (1) bonds, which are issued by government agencies for the purpose of raising money, (2) direct revenue generated from tax receipts and interest, and (3) grants, which are gifts of money for a specified purpose from various sources.

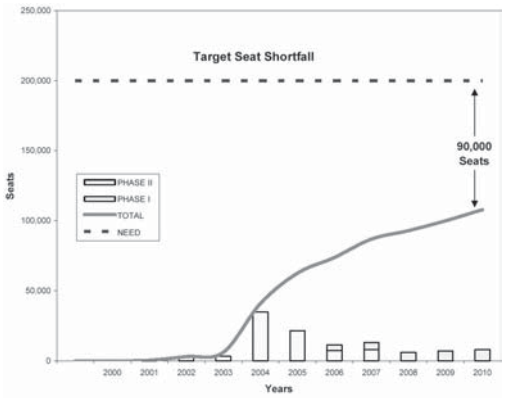

Figure 1. The progress that the new construction program will make toward the established target of an additional seats (courtesy of LAUSD New Construction Strategic Execution Plan)

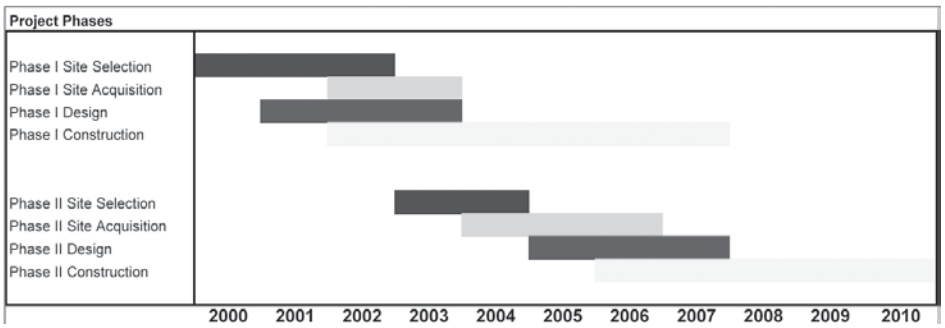

Figure 2. The schedule of Phase 1 and Phase 2 (courtesy of LAUSD New Construction Strategic Execution Plan)

1.3. Project Organization

For each LAUSD project, a regional director is responsible and accountable for monitoring the project's progress and providing additional support to ensure success (including staff changes and augmentation) and also for providing well-defined project controls to meet LAUSD requirements. Every project has an on-site owner's authorized representative (OAR) who is responsible and accountable for construction contracts administration, completing final design with Division of the State Architect (DSA) approval, timely resolution of construction issues, monitoring site construction, and leading the integrated project team including the contractor and architectural/engineering services. To provide the pool of necessary resources to staff the organization, LAUSD has selected fifteen construction management firms. Although LAUSD has in-house architects, they contract out the architectural work with an RFP process based on LAUSD criteria. There is always a program management firm that oversees every project. Contractors are contracted directly by LAUSD based on competitive bid and are managed by one of the pre-selected construction management firms.

1.4. The Need for an OCPM Solution

The biggest reason for LAUSD to invest in an OCPM solution was the need for information consolidation. With the size of the program and the number of projects LAUSD is carrying on, the (1) standardization, (2) audit trail, and (3) timely access to projects' information became crucial for the management team. If each project had its own satellites of software, LAUSD would take a huge risk of data being lost and would face greater complexity in managing the information. The intention was to record all activities happening on the sites and to be able to monitor the projects from the main office. LAUSD wanted to ensure they (4) maintain and control the information for every project in a timely manner.

1.5. OCPM Technology Selection

Primavera's OCPM solution has been used by LAUSD in non-construction areas since 1998. Nevertheless, all construction management firms were required to use the solution in construction operations. In 2002, LAUSD decided to standardize the tool on all LAUSD operations, including the New Construction program. LAUSD went through an evaluation and considered various OCPM solutions. They decided on Primavera's solution based on the solution's long-term and maintenance costs, its capabilities and features, as well as the vendor's long history in the market. LAUSD specially wanted a solution that would work on the client-server side because being able to maintain data was crucial for them.

1.6. The Cost

LAUSD usually gets licenses for one-third of the in-house project members; if they realize there is a need, they increase the number of licenses. As of August 2005, LAUSD has around 71 copies of Primavera's OCPM solution in the New Construction division. The cost is $900 per license and US$30,000 per year for maintenance. LAUSD also utilizes 50 copies of Primavera's scheduling solution.

1.7. Implementation

In 2002, LAUSD started implementation of the OCPM tool in the New Construction division's operations. Training is provided by LAUSD's in-house certified trainers. LAUSD offers 3 classes every month, each for 4 hours. Whoever requests a user name and a password to access the tool is required to take the training classes. Usually one-time training is mandatory; however, LAUSD's Facilities Information Systems (FIS) division monitors use and provides additional assistance if needed. LAUSD school board, executives, division managers, and OARs have access to the tool, whereas, architects, contractors, and other project collaborators don't have access. The reason for this is primarily the security and the cost of licenses and training.

1.8. The Use of the OCPM Solution

The New Construction division utilizes the tool extensively. LAUSD has decided to use the OCPM solution as a management tool during construction and as a forecasting tool during preconstruction rather than as a collaborative tool throughout the project. Therefore, only LAUSD managers and OARs have access to the tool. The projects are executed in a traditional way; the tool is mostly used by LAUSD management to track the performance of their projects in terms of costs, schedule, and quality. The decision was made based on the size of the program and the number of the projects in the program. The use of the system is enforced by LAUSD. LAUSD uses a thin client solution for remote access to its software. LAUSD also specifies the modules that should be used; communication, contract information, and logs are being used as an information/document repository for the program. The most used modules are as follows.

ANTICIPATED COST REPORT (ACR)

PHASE	Cost Code	BUDGET				COMMITMENTS					OVER / (UNDER)
		Current Budget (C)	Pending Revisions (D)	Estimated + Adjustments (E + F)	PROJECTED C + D + E + F (G)	Original Commitment (H)	Approved Revisions (I)	Pending Revisions (K)	Estimate to Complete (L + M)	ANTICIPATED H + I + K + L + M (N)	Anticipated Costs vs. Projected Budget (N - G)
2 ENVIRONMENTAL											
2.E.1-71	DTSC (DEPT TOXIC SUBSTANCES CONTROL)										
2.E.1-72	PEA (PRELIM ENVIRONMENTAL ASSESSMENT)										
2.E.1-73	RAW (REMOVAL ACTION WORK PLANS)										
2.E.1-74	RAP (REMEDIAL ACTION PLAN)										
2.E.1-75	CEQA (CALIF. ENVIRONMENT QUALITY ACT)										
2.E.1-76	AIR TOXICS										
2.E.1-77	EHS OTHER										
2.E.1-7A	SITE - EHS OVERSIGHT-PRECONSTRUCTION										
2.E.1-7B	SITE - EHS OVERSIGHT-CONSTRUCTION										
2.E.1-7C	EHS LEGAL FEES										
2.E.1-7G	SITE - EHS CONSTRUCTION SUPPORT										
2.E.2-41	PHASE I ENVIRONMENTAL SITE ASSESSMENT										
2.E.2-42	FOCUSED SITE INVESTIGATION										
2.E.3-32	ASBESTOS/LEAD REMOVAL (CONSTRUCTION)										

Figure 3. Example of one category and some of its subcategories from OCPM solution of LAUSD (Courtesy of Charlie Anderson)

- Communication: transmittals, requests for clarification, notices, noncompliance notices, letters, correspondence sent and received, meeting minutes, notepads, and telephone records;
- Contract information: cost, contracts, purchase orders, payments, change management, proposals, and change orders;
- Logs: drawing sets, drawings, submittal packages, submittals, materials, daily reports, insurance, and punch lists

Since they are a public entity, reporting and accuracy of the information is critical for LAUSD. Therefore, in the pre-construction phase, LAUSD managers are using the tool for two primary purposes: (1) forecasting the cost and (2) storing meeting minutes and correspondence. Adding forecasting features required some degree of customization. LAUSD brought in experts to set up the entire set of budget constraints and a layer that shows all the potential costs. This allowed managers to check the budget of each project as well as the master budget for the overall program. LAUSD used the OCPM tool to create a series of cost codes and tied the costs to LAUSD's accounting system. LAUSD built nine phases of construction into the tool. These phases are actually a crosswalk definitions table that ensures consistency between the LAUSD's accounting system and the OCPM solution. Since LAUSD's accounting system is set up primarily for operating a school district (with teachers' salaries, etc.), they have attached the capital construction program on top of this system using only selected cost codes for proper coding. The phases refer to the work areas that occur throughout the entire life of a project, including the site, environmental, plans (architectural, structural, etc.), construction (contracts, utilities, demolition, design and construction costs, etc.), management (real estate, design, project management, construction management), tests (soil, structure, other) , inspection (construction, technology), furniture and equipment, and community outreach. LAUSD is planning an Oracle-based automatic upload from the accounting database to the OCPM system to include project contract commitments, expenditures, and encumbrances. The LAUSD managers use the tool as a way to predict future costs.

The tool has categories for budget (current, pending, estimated + adjustments, projected) and commitments (original, approved revisions, pending revisions, estimate to complete, anticipated). By comparing anticipated costs vs. projected budget, LAUSD managers have good track of what funds are available for each project and what has been spent to date in any given region.

2. BENEFIT/VALUE ANALYSIS

When considering the implementation of a new system, it is essential to understand whether you seek benefits in efficiency (tangible), effectiveness (quasi-tangible), overall business performance (intangible), or a particular combination of these. This case study focuses on organizational-level benefits rather than individual project-level benefits. The reason for this is that risk mitigation and management rather than small cost savings (such as mailing/printing/faxing costs) have been more important for the organization. Performing the right tasks correctly, staying consistent with the organization's mission, vision, and values, and supporting its goals and objectives – as well as providing an ability to mitigate and measure risks related to cost – have been among LAUSD's most important goals in deciding to implement this technology.

Therefore we will look at two areas in this case study: performance and effectiveness. *Performance (intangible benefits)* is the level of new outputs enabled (doing better things). The nature of modern business is such that, increasingly, senior managers are required to think beyond the direct tactical issues of efficiency and effectiveness, toward more strategic issues. Business performance, in its broadest terms, is a major strategic issue and one that OCPM technology has much to contribute to. A major argument of this case is that OCPM technology's benefits in construction extend beyond the tactical into strategic business performance improvement. *Effectiveness (quasi-tangible benefits)* is the rate of actual outputs compared to planned (doing the right things) – the ability of a program, project, or work task to produce a specific desired effect or result that can be measured.

There are three main questions for us to ask in order to understand the business of the investors and what they are seeking from their investment: (1) Who are the investors and what values would they like to get out of their OCPM technology investments (potential benefits)? (2) What did they get from their investment in terms of benefits/values (realized benefits)? (3) What would they lose if they didn't implement these systems (lost opportunities)?

2.1. Potential Benefits

LAUSD's main goal in implementing an OCPM solution was to (1) forecast and (2) control the costs for the overall program, (3) to have complete audit trail in order to mitigate and/or manage construction disputes and claims, and (4) to centralize the information in a database where LAUSD managers can access from everywhere and the information never gets lost for any reason.

2.2. Realized Benefits

2.2.1. Forecasting *(Performance):*

There are two factors that affect 95% of the project costs. The first factor is the acquisition of the land and the second is the design of the project. In LAUSD, the decision regarding the land is in the first six months of the project and the design is determined two months after the land acquisition. In other words, in the first six to eight months, LAUSD certifies and makes its budget commitments. Therefore, accurate forecasting the costs of a project is extremely important and for that reason LAUSD utilizes the OCPM solution for forecasting the costs during the preconstruction phase. LAUSD sets the tool in such a way that the managers can control the budget activity in an easier and more precise way. Charlie Anderson, LAUSD Program Manager, says *"The single biggest benefit is that we can see where the trends are going and we have the power to do something before it is too late."*

2.2.2. Claims mitigation and management *(Performance):*

- Claim mitigation:

The team believes that the use of the OCPM tool helps them to prevent potential claims. In LAUSD projects, all documents that are part of the contract and any information that is specified by the contractors are being tracked as they are registered by OARs on the construction sites. Rodger Hughes, OAR of the Alabama Elementary School project, says, *"You don't have to go and dig into a file cabinet. This is a great legal tool. Any backups the contractor has – sketches, letters, documents – are always in the system."* Charles Wren, OAR of the Commonwealth Addition, adds, *"We don't have any formal claims in the project yet, but we have several construction disagreements. I think the records will help us in case they turn into claims. All parties know we register everything to the system. The best way to stop a claim is to stop before it happens."*

- Claims management:

The problems with claims management are most profound in the areas of (1) claims justification, (2) quantification, and (3) retrieval of supporting information and adequacy of information. If one considers that, on a major construction project, the owner or owner's representative has to be able to assimilate paper-based documentation from, say, a dozen subcontractors as well as the design team and manage subsequent changes, it is no surprise that vital evidence required to substantiate or invalidate claims takes long hours to identify, retrieve, and assemble. If implemented well, an OCPM tool can remove a major obstacle to the preparation, quantification, and validation of claims to be disputed. Absence of necessary information is particularly the case with information that establishes a casual link between the amounts claimed and the events giving rise to the claim. This absence forces contractors to use questionable approaches to the quantification of claims.

With the use of the OCPM solution, LAUSD reduces to a minimum the risk of losing data. Considering the number of projects and the size of the program, it has been very important for LAUSD that the information is centralized, recorded, and never lost. LAUSD required the project managers and OARs to upload every project-related document or piece of information to the OCPM tool to have a record in case of claims. David Page, OCPM tool implementation leader at the FIS, explains with his own experience: *"I was involved with a project in which we had everything in the tool. There was the first series of heavy storms. The contractor had started the excavation but they actually lost part of their job site because of flooding. The question came up about who is responsible for the erosion control. It was the time when most files were displaced and some were destroyed due to flooding. What we found out is during the pre-bid process, there was a significant RFI that came in from one of the contractors asking if erosion control is supposed to be in the earthwork contract. The response came back from the owner that it was. [Until then,] we didn't know that the same contractor who filed the claim had written a letter stating that they wanted to verify that the erosion control would in fact be included in their contract even though it wasn't stated in the bid documents. It was signed by the same gentleman who was filing the claim. The overall claim was about $300,000. The district paid $35,000 because we considered it as a natural disaster.* ***That one claim itself paid for the entire system.****"*

2.2.4. Effective project control and management *(Effectiveness):*
The basic management functions recognized in most construction contracting organizations are (1) planning: the process of choosing methods and the sequence of works to be used on the project from all the methods and sequences possible; (2) estimating: the process of collecting and calculating cost data, selecting resource and output rates, and combining cost and resource use to determine the likely cost of works; (3) cash flow forecasting: the assessment of the anticipated cost of work in progress at periods or stages for which reimbursement is expected; (4) valuation: the process of determining the amount of payment for work done day to day; and (5) control and monitoring: reconciliation of projected cost of works with actual cost and accounting – the process of identifying, measuring, recording, and communicating the transactions of the organization. Each of these functions depends on information generated by the others.

Having all project information stored in one centralized space helps the project managers to control the budget and the schedule more effectively. For example, project managers can easily analyze the effects of delays on the contract completion date. This involves hypothetically imposing the delaying event and carrying out a critical analysis to determine the new completion date. By performing a number of "what if" analyses and storing the results, the manager can prove the effect of delaying events. David Page comments, *"It is the small things that you don't see where the cost savings come in. For example, project managers don't have to go through everything; they just go to generate function. A meeting minute can take you half an hour to an hour. With this process, you just simply modify the items that are basically going on. The punch list, daily reports, meeting minutes. You are starting to save 30 minutes here and there, in total you are saving 2-3 hours a day, 2,000 hours of savings over the course of a year. If you have hundreds of projects, this is a substantial saving."*

2.2.4. Increased project visibility *(Effectiveness):*
The tool provides visibility and generates specific reports showing the cost of the overall program and the cost of particular districts, regions, and/or individual schools. Based on these reports, LAUSD managers can identify which regions and/or projects are actually having a problem. The tool helps them to recognize the projects experiencing difficulties before they actually become major. The higher management, who actually see the summary of the projects rather than the details, have the ability to bring the program back on track. Luis Hernandez, the Acting Director of Facilities Information Systems, comments, *"There is a variety of benefits, but the greatest is organized construction information, therefore project visibility. This allows the division to effectively mediate issues of construction concern that could potentially lead to costs, legal costs, and impact."*

2.3. In the Absence of the OCPM Solution
According to the LAUSD managers, if they didn't have the system they would lose the overall control over several projects and they would also lose track of the budget. Other potential down sides would be fragmented information, lack of information standards, and lack of information. They believe the visibility of the projects brings them better control and management of the overall program. Also if there were no OCPM system, the lost of information would increase and there would be more claims due to the lack of communication. David Page comments, *"The lack of communication in the project will create confutation, and if you have confutation, you will have separation. If you have any of these three then you have a problem in the project. Separation creates the lack of communication so you get into the cycle. What you want to do is to break that cycle and make sure that everybody is getting the information they need."* And he adds, *"I would pay whatever the price is to use the system again because I believe it will save me in the long run. I have seen cases where one claim can save the entire thing's costs. And I don't have any headaches. As a matter of fact, if they don't want to do that I might pay for the application out of my pocket."*

2.4. Quasi-tangible Benefits' Ranking
Besides interviews, an electronic survey of quasi-tangible benefits was designed and distributed via email to all interviewees to measure the improvement in a more consistent and less subjective way. The aim of the survey was to uncover as much information as possible and to quantify quasi-tangible benefits of OCPM technology investments. Each respondent received the identical set of benefits, phrased in exactly the same way in order to reduce errors resulting from the recording of responses, and the respondents were free to rank the benefits according to their relevance at responder's own pace. The survey covered several benefits that were stated during the interviews. The responders were asked to rank the benefits 1 through 5 (where 5 is *'very high'*, 4 is *'high'*, 3 is *'neutral'*, 2 is *'low'* and 1 is *'very low'*). Benefits and values ranked by LAUSD case interviewees can be seen in the table below.

Benefits/Values	A*	B*	C*	Ave.	StnDev.
- Improved data availability	5	5	5	5.0	0.0
- Improved process automation (RFIs/COs, automatic updated master budget, etc)	5	4	5	4.7	0.6
- Improved timely capture of design/ construction decisions	4	5	5	4.7	0.6
- Enabled quicker response to project status and budget	5	4	5	4.7	0.6
- Enabled better project/program control	5	3	5	4.3	1.2
- Reduced personnel costs due to improved efficiency	5	3	5	4.3	1.2
- Provided accurate and timely information to give valid/accurate decisions	5	3	5	4.3	1.2
- Enabled better resource allocation; more effective assembly of project teams	5	3	5	4.3	1.2
- Improved quality of the output	4	4	5	4.3	0.6
- Reduced rework/data reentry	5	4	4	4.3	0.6
- Enabled having complete audit trail	5	3	5	4.3	1.2
- Improved information version control	4	3	5	4.0	1.0
- Enabled better forecasting and control	5	2	5	4.0	1.7
- Enhanced working within virtual teams	4	2	5	3.7	1.5
- Minimized project/business risks	5	2	4	3.7	1.5
- Improved information management	X	5	5		
- Reduced delivery lead times	4	1	X		
- Improved project relationships with strategic partners	4	3	X		
- Enabled more effective identification and assessment of new suppliers	X	1	X		
- Improved idea sharing among team members/within organization	X	2	5		
- Reduced errors and omissions	4	1	X		
- Improved public relations	X	1	3		
- Enabled fewer information bottlenecks	X	4	5		
- Enabled advance purchase of materials	4	2	X		
- Enabled faster reporting and feedback	X	5	5		
- Enabled faster launch to market due to faster delivery	X	1	X		
- Enabled better inventory management	X	1	X		

Table 1. Ranking of various benefits/values by LAUSD case interviewees (*The names of the respondents are hidden for confidentiality reasons. However, the respondents are managers of LAUSD managers and OARs. "X" stands for when the question is not relevant or the responder doesn't know the answer.)

3. FUTURE OPPORTUNITIES

LAUSD will keep using the OCPM solution in the new construction division to forecast and capture costs, and to do their construction analysis both on impact, risks, and costs. LAUSD's long-term plan is to extend the use of the OCPM tool and use it as a collaboration tool. Right now, the reasons for not using it as a collaboration tool are the cost, training, and the sensitivity of the information. In addition, LAUSD is planning to integrate the OCPM solution into their asset management software and to their enterprise content management solution; FileNet, which all will be tied to their SAP. The software will talk together and pull everything together under one database.

4. BENEFIT/VALUE SUMMARY

Tangible, quasi-tangible and intangible benefits of the LAUSD case are summarized in the table below. Tangible benefits were not considered in this case as the investor's main goal was to gain quasi-tangible and intangible benefits through their OCPM investment. The electronic survey is used to quantify the quasi-tangible benefits (improvements) by ranking. Two performance (intangible) benefits are observed in this OCPM implementation. The OCPM solution

is used for forecasting, and claims mitigation and management. The total cost of the system is $153,000 for 4 years including one year of license cost and three years of maintenance costs.

Types of Benefits	**Measured Benefits**
Tangible	Not measured
Quasi-tangible	Survey: **4.3/5** (15 benefits identified out of 27)
Intangible	**2 identified**; forecasting, and claims mitigation and management
Cost of the system	**$153,000** for 4 years (1 year of licenses + 3 years of maintenance)

INTERVIEWEES

- Charlie Anderson, Director of LAUSD New Construction Program Management, 06/09/2005
- Luis Hernandez, Acting Director of Facilities Information Systems, LAUSD, 08/19/2005
- David H. Page III, Facilities Information Systems, Primavera Implementation Leader, 03/17/2005, 05/17/2005, 08/22/2005
- Charles Wren, Owner's Authorized Representative, Commonwealth Addition, LAUSD, 05/06/2005
- Rodger Hughes, Owner's Authorized Representative, Alabama Elementary School Project, LAUSD, 05/06/2005

REFERENCES

Vidogah, W., Ndekugri, I., (1998), "A review of the role of information technology in construction claims management," Computers in Industry, no. 35, pp. 77-85.

CASE STUDY 6. MANHATTAN CONSTRUCTION COMPANY

1. INTRODUCTION

This case study focuses on identification and measurement of the value of online collaboration and project management (OCPM) technology from a general contractor's perspective. The case covers tangible and intangible benefits/values at both the project and the organizational level. The following subsections give a brief description of the company and outline the need, selection, cost, and implementation of the OCPM tool. A project of Manhattan Construction Company, the Defense Intelligence Analysis Center addition, is selected as a model for the OCPM tool value calculations.

1.1. Manhattan Construction Company

Manhattan Construction Company (Manhattan), one of the four companies of Rooney Holdings, Inc., is among the 20 largest commercial general contractors in the US. The company has offered general contracting and construction management services since 1896. Today, Manhattan operates from its offices in Atlanta, Dallas, Houston, Tulsa, Oklahoma City, Washington, DC, and Mexico City. The company's building portfolio includes corporate headquarters, institutional, health care, office, hospitality and leisure, sports, entertainment, aviation, retail, and judicial facilities.

1.2. Defense Intelligence Agency Center Addition

The Defense Intelligence Agency (DIA) is a member of the national intelligence community and a Department of Defense combat support agency. DIA provides military and military-related intelligence to war fighters, defense policymakers, and planners to support military operations, planning, and weapons system acquisition. DIA is responsible for providing all-source intelligence analysis and collection management support to the Secretary of Defense and the Chairman of the Joint Chiefs of Staff and serves as an advisor on military intelligence issues.

To consolidate administrative, analytical, and support functions, DIA decided to invest in a 430,000-square-foot addition to its headquarters, the DIA Center. Designed by SmithGroup Inc., the new addition was contracted to Manhattan through "best value" approach, based on the company's references, capabilities, and competitive pricing. Naval Facilities Engineering Command (NAVFAC) provides project management services as owner's representatives for the DIA Center project. The DIA Center addition is the agency's first project to apply the General Services Administration's Construction Excellence Peer Program, under which a panel of three private-sector experts reviewed construction documents at the 15 percent and 70 percent stages to evaluate both constructability and conformance to design and budget goals.

The concrete structure includes highly secure environments, non-secure office space, and controlled access at varying levels in accordance with security requirements. Located near Washington, DC at Bolling Air Force Base on a 48-acre site adjacent to the existing center, the $100 million addition to the DIA Center started construction in April 2003. The six-story addition will contain a full array of office, conference, and classroom spaces. The structural concrete frame is surrounded by a 150,000-square-foot glass and aluminum curtain wall with a centerpiece four-story

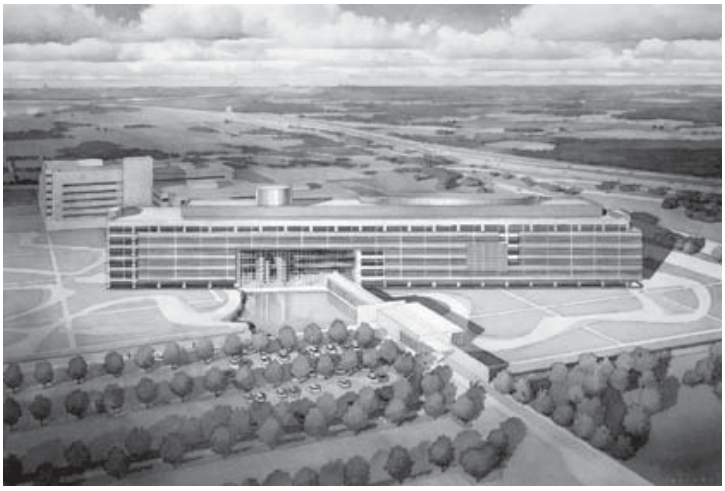

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Figure 1. Rendering of DIA Center addition

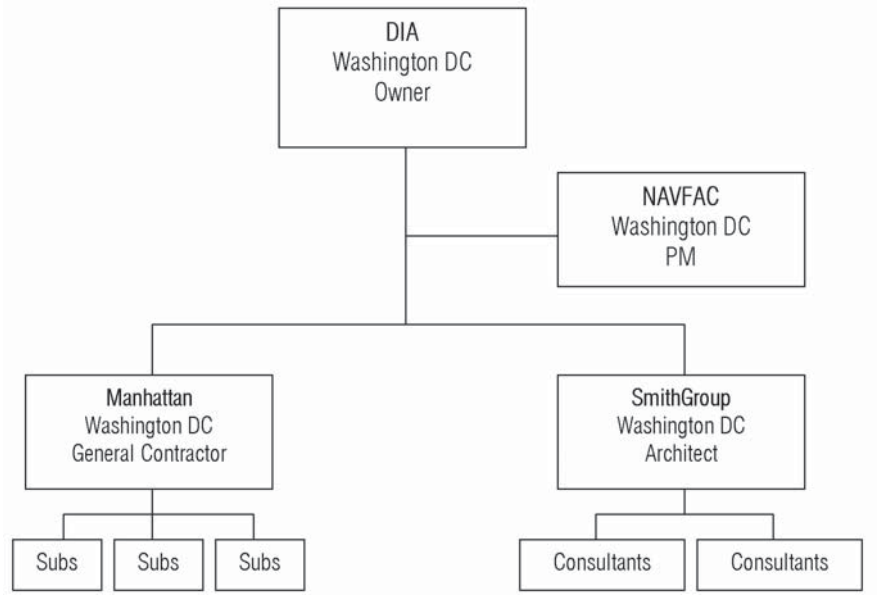

Figure 2. DIA Center addition project's organizational diagram

transparent atrium serving as a portal to visually link the lobbies of the new and existing buildings. On schedule for completion in October 2005, the DIA Center addition will provide a secure, technologically flexible work environment that also enhances worker comfort and productivity.

1.3. The Need for an OCPM Solution

The use of a web-based project management solution was a NAVFAC requirement in Manhattan's contract. Therefore, Manhattan introduced its company-wide OCPM solution to the project. Manhattan has been using OCPM systems regularly on projects for almost ten years. Prior to standardizing on Meridian System's solution six years ago, Manhattan projects used several software packages and different data formats, which made it difficult for participants to access project information and to collaborate. As part of a leadership decision, Manhattan standardized on Meridian's technology in order to: (1) unify all project teams on the use of the OCPM tool; (2) gain efficiencies; 3) increase visibility and collaboration capacity to project participants; and (4) to standardize and centralize all project information.

1.4. OCPM Technology Selection

The decision to use Meridian technology was made by Manhattan's IT department selection committee after considering several solutions. As part of the selection process, Manhattan referred to comprehensive market research, tried different solutions, and consulted Manhattan OCPM tool users. A special focus was place on multi-project management and control as well as the tool's collaboration capabilities. Manhattan originally started using vendor's client/server solution, but eventually implemented the web-based solution as the vendor started offering it in 2001. Since that time, most of Manhattan's government clients and some of its private clients became increasingly interested in the advantages of online collaboration and project management. Keeping all information in one place without any data duplication efforts was also very attractive for project participants. The DIA Center addition is Manhattan's first project using the technology vendor's web-based OCPM solution.

1.5. The Cost

Manhattan is using an off-the-shelf solution, but they have created custom reports and integrated the tool into their databases. The company doesn't have a corporate agreement with the vendor; they pay for the licenses annually and renew their agreement every year. As of June 2005, Manhattan has 138 project management membership licenses and 16 collaboration membership licenses. While Manhattan does not publicly disclose its pricing, Meridian's list price for project management membership is $160 per month, and $60 per month for collaboration membership. For the DIA Center project, NAVFAC partially contributes to the license fees. For this project, Manhattan holds five licenses, and NAVFAC and SmithGroup hold one each. Manhattan, so far, has only paid about $5,000 for implementation and has spent around $25,000 in the last four years on training.

1.6. Implementation

At the beginning of the implementation, the team had some problems due to NAVFAC's and DIA's strict firewalls. However, this problem was solved by NAVFAC's and Manhattan's IT departments working with the vendor. Manhattan used a third-party provider recommended by the OCPM vendor for training the team members, which was very useful and helped all team members to be on the same page. The users' level of participation depended on their contribution to the project as well as their level of sophistication with the tool. However, most of Manhattan's users were already experienced with the tool as they had been using different versions for almost six years. The team started using the tool in July 2003, a few months after DIA project construction started.

1.7. The Use of the OCPM Solution in the DIA Center Addition Project

As of August 2005, there are 18 active users: 13 from Manhattan, 4 from US Navy Engineering Field Activity Chesapeake (EFA-CHES), and 1 from SmithGroup. None of the subcontractors are using the OCPM system. The most-used features are RFIs, submittals, meeting minutes, and punch list. The project uses the tool limitedly for cost information; occasionally for tracking issues and prices. Manhattan has their own accounting software for cost-related information such as budget and invoices. However, they use change order requests, potential change orders, and prime contract change orders internally for tracking. Drawings and specifications are not transferred via the tool except for some sketches attached to RFIs. Manhattan uses the drawings log for tracking; the drawings and specifications are sent via email and/or FedEx by the architect.

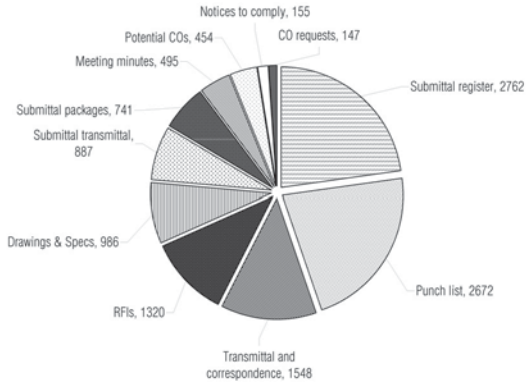

Figure 3. Document types and numbers posted on the OCPM tool

Manhattan Construction Company

Eighty percent of Manhattan's projects are currently managed in its web-based OCPM solution. Its Washington, DC division uses the tool more consistently than other divisions, with all projects (3 government and 1 private) on the system. Generally Manhattan's projects are large-scale (50 to 150 million dollar range) and last from 1.5 to 3 years. They have a total of 136 users in the system, and 150 projects just in the Atlanta region.

2. BENEFIT/VALUE ANALYSIS

In order to measure benefits, we need to understand the business of the investors and what they are seeking from their investment. There are three main questions: (1) Who are the investors and what values would they like to get out of their OCPM technology investments (potential benefits)? (2) What did they actually get from their investment in terms of benefits/values (realized benefits)? (3) What would they lose if they didn't implement these systems (lost opportunities)?

For our purposes the benefit/value analysis is based on three factors: effectiveness, efficiency, and performance. When considering the implementation of a new system it is essential to understand whether you seek efficiency, effectiveness, or overall business performance benefits, or some combination of these factors.

Effectiveness (quasi-tangible benefits) is the ratio of achieved outputs to planned outputs (doing the right things). This is the ability of a program, project, or work task to produce a specific desired effect or result that can be measured. Effectiveness is performing the right tasks correctly, consistent with organizational values, goals and objectives. *Efficiency (tangible benefits)* is defined as the rate at which inputs are converted to outputs (doing things right). Efficiency is financially measurable and is represented by money. We will discuss and quantify the benefits in the efficiency area in the following section in the light of the DIA Center addition project. *Performance (intangible benefits)* is not directly measurable in quantifiable terms but is judged qualitatively on the impact of a successful implementation in influencing long-term business performance and market share. The scope and context of the Manhattan case study focused on effectiveness and efficiency.

-Effectiveness-

2.1. Potential Benefits

The initial reasons for Manhattan to invest in an OCPM solution were: (1) centralizing project data, (2) standardizing the information, (3) bringing visibility to projects located across several locations, and (4) having an electronic history of project information. Scott Grissom, Project Management Systems Coordinator at Rooney Holdings, says, *"With our OCPM solution, you have centralization of the information. People can access it from a browser. The database system just makes it very easy to keep all the information together. It makes it easier to create and process information. In the past, all of our projects were using Excel spreadsheets and Word documents, which made it very hard for others to access and use them. We wanted information to be more visible to our offices as well as our collaborators."*

2.2. Realized Benefits

2.2.1. Standardization and ease of reporting *(Effectiveness):*

The team members agree that the tool provides a more standardized way of working, which saves time and brings consistency to their operations. Brian Killion, Senior Project Manager at Manhattan, says, *"The tool is saving time because everything is standardized. Take the meeting I was holding on Wednesday as an example. Before, I needed a certain amount of time on Tuesday and Wednesday to prepare for it. Now if I want, I can pull out some reports and understand where we stand."* Scott Grissom adds, *"Team members go from project to project and everything looks alike. They will be using the same system for each project they work on. They don't have to learn things over again... in the old days every project manager had their own ways; project to project, things were changing."*

2.2.2. Complete audit trail *(Effectiveness):*

Tracking the history of the documents posted (such as RFIs and submittals) is identified by the team as very valuable. As Michael Imbergamo, Project Architect, indicates, the tool informs everyone about active development. He adds, *"Anyone can go and take a look at the archive; what is open or active. They can find old but relevant information. It becomes a resource tool for all project members."* And he adds, "*With the tool, it became easier to find the history in case of any claims or disputes."*

2.2.3. Information/document availability *(Effectiveness):*
In the DIA Center addition project, the schedule was always tight even in the design stage. The users believe that the OCPM tool helped them to keep up with the schedule by having all information available at one place. Michael Imbergamo confirms, *"The tool really helped us with the schedule. For example, there have been critical issues. We don't have to follow the normal way of processing the information. We are not tied to the individuals as we used to be in the past. The information is readily available with a couple of clicks."* He adds, *"It brought efficiency to our processes. We only had weekly meetings and there were no surprises. Information was available to everyone."*

2.2.4. Increased Automation *(Effectiveness):*
Manhattan users value the automation the OCPM tool brings to their processes. Scott Grissom comments that he hears a lot of feedback that once the database is up and running and all of the contacts are in the database, it is very easy to issue or answer an RFI or write meeting minutes. Users can link their RFIs to other documents; or with a couple of clicks the system can create the letter template for you. He adds, *"The increased automation and having all information in one place are what the users like the most."* Mike Parkinson, Project Manager, also adds, *"Web-based is great because we didn't need to catch up with the owner's computer system. We have consistency in the document appearance and format."*

2.2.5. Competitive advantage *(Effectiveness):*
Manhattan believes that the use of the OCPM solution gives them a competitive advantage among other general contractors. Mike Parkinson indicates that in the Washington, DC region, they use the tool on an increasing number of projects due to contract requirements. He adds that there is more interest in its use from their clients, and how quickly they can go live with the tool is very important, especially on large projects.

2.3. In the Absence of the OCPM Solution
According to the team, if they didn't have the system in place they would lose time in (1) processing construction work flows such as RFIs and (2) having timely access to project-related information. The project would use hard copies and multiple technologies, which would result in (3) reduction of efficiency. (4) People would be less responsive because they would be less aware of the issues. As Anthony Teritehau, US Navy Project Manager, adds, (5) they wouldn't have the history, tracking, RFIs, and submittal logs.

2.4. Quasi-tangible Benefits' Ranking
Besides interviews, an electronic survey of quasi-tangible benefits was designed and distributed via email to all interviewees to measure the improvement in a more consistent and less subjective way. The aim of the survey was to uncover as much information as possible and to quantify quasi-tangible benefits of OCPM technology investments. Each respondent received the identical set of benefits, phrased in exactly the same way in order to reduce errors resulting from the recording of responses, and the respondents were free to rank the benefits according to their relevance at responder's own pace. The survey covered several benefits that were stated during the interviews. The responders were asked to rank the benefits 1 through 5 (where 5 is *'very high'*, 4 is *'high'*, 3 is *'neutral'*, 2 is *'low'* and 1 is *'very low'*). Benefits and values ranked by Manhattan case interviewees can be seen in the table below.

Benefits/Values	A*	B*	C*	D*	Ave.	StnDev
- Improved process automation (RFIs/COs, automatic updated master budget, etc.)	5	4	5	4	4.5	0.6
- Improved data availability	5	4	4	5	4.5	0.6
- Enabled faster reporting and feedback	4	4	4	4	4.0	0.0
- Improved information management	4	4	4	4	4.0	0.0
- Enabled having complete audit trail	4	4	3	5	4.0	0.8
- Enabled better project/program control	3	4	5	4	4.0	0.8
- Provided accurate and timely information to give valid/accurate decisions	4	3	4	3	3.5	0.6
- Enhanced working within virtual teams	3	4	4	3	3.5	0.6
- Enabled fewer information bottlenecks	3	3	4	3	3.3	0.5
- Improved timely capture of design/ construction decisions	3	3	3	4	3.3	0.5
- Enabled quicker response to project						

status and budget	2	4	4	3	3.3	1.0
- Enabled better forecasting and control	2	3	4	4	3.3	1.0
- Improved project relationships with strategic partners	3	3	3	3	3.0	0.0
- Minimized project/business risks	2	3	3	3	2.8	0.5
- Improved information version control	4	X	4	3		
- Improved idea sharing among team members/within organization	3	4	4	X		
- Improved quality of the output	3	3	4	X		
- Enabled advance purchase of materials	2	2	3	X		
- Reduced rework/data reentry	5	3	3	X		
- Reduced delivery lead times	2	1	3	X		
- Reduced errors omissions	1	3	4	X		
- Enabled better inventory management	X	2	3	X		
- Enabled more effective identification and assessment of new suppliers	X	1	3	X		
- Enabled faster launch to market due to faster delivery	X	1	3	X		
- Improved public relations	4	1	4	X		
- Reduced personnel costs due to improved efficiency	2	2	3	X		
- Enabled better resource allocation; more effective assembly of project teams	2	2	4	X		

Table 1. Ranking of various benefits/values by Manhattan case interviewees (*The names of the respondents are hidden for confidentiality reasons. However, the respondents are managers of Manhattan, the US Navy, and the users of the OCPM solution in the DIA Center addition project. "X" stands for when the question is not relevant or the responder doesn't know the answer.)

-Efficiency-

2.5. Electronic RFIs (e-RFIs)

With the use of OCPM tools, the lengthy and linear RFI process could be shortened dramatically. These tools bring efficiency to the process by providing *automation* as soon as the sub/general contractor (originator) starts filling in the electronic RFI form. For example, areas such as the RFI number, the date the RFI is created, author company's information, and author person's information are automatically filled in by the tool with the originator's log-in information. This provides a complete *audit trail*. Contact information for all collaborators is built into the tool in advance so that the person who issues the RFI can select the "corresponding company" and "corresponding person" from the contact list. This lets the system forward the RFI to the recipient's OCPM inbox and also send notifications to the recipient's email inbox. These tools also enable the originator to consistently use the same recipient and set the same review time. (Review time is the number of calendar days after the creation of an RFI by which a response needs to be received. This value automatically populates the Date Required box.)

In addition, the need for the RFI request (confirmation, clarification, inconsistency, field condition, errors/omissions, site condition, etc.) and the discipline of the RFI question (architectural, civil, electrical, plumbing, structural, landscaping, etc.) could be selected from a slider bar. The originator can type in their question, add notes (suggestions and comments), attach related drawings/documents/sketches, and mark the importance of the RFI, and its impact on budget, schedule, and drawings, and whether that specific RFI record will require drawing updates.

The minute the RFI is posted, the recipient receives a notification in his/her email inbox indicating that there is an RFI he/she has to answer. The Recipient can click on the link in the notification email, or log in to the tool and view the RFI automatically. Then he/she can fill in the answer and reference/attach any specifications/drawings/documents/sketches. As soon as the recipient (responder) posts the document, the originator receives a notification indicating that his/her question has been answered and is ready for viewing. Notifications are also sent to other users for RFI updates (such as project managers who need to review the RFIs). RFIs usually involve some form of collaboration with at least one other person. Some RFIs might require one answer or response from a single contact, while others may have to be redirected to several contacts before reaching the appropriate person who can answer the RFI

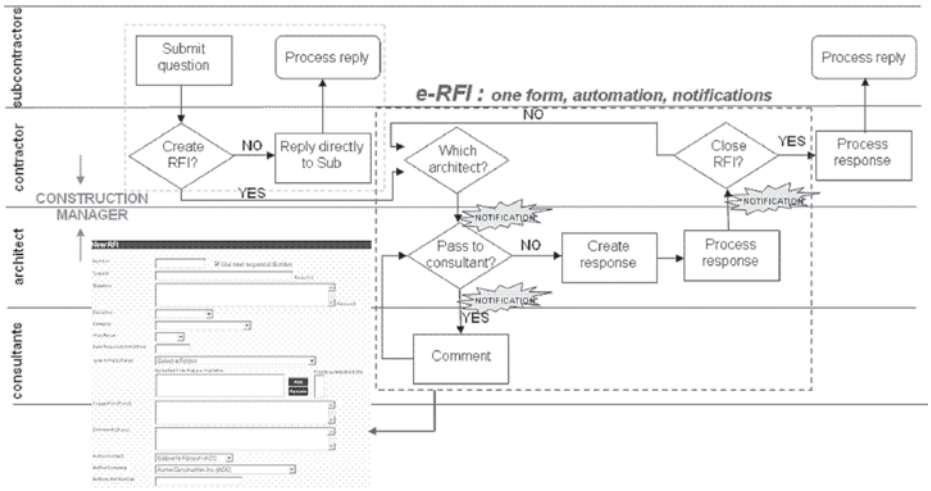

Figure 4. Manhattan's e-RFI process

question. Similarly if the recipient believes that the question should be answered by another party such as his/her consultant, he/she can forward the RFI to the appropriate person by selecting from the slider bar. The whole process is done automatically and the history of all actions is recorded. The user can view either all RFIs in a project (if he/she is granted access) or those specifically assigned/redirected to him/her.

2.5.1. Realized benefits of e-RFIs

Audit Trail:

Team members agree that one of the valuable benefits of e-RFIs is having a complete audit trail. Collaborators can easily track the dates, such as when an RFI was submitted and returned. The history of who did what and when is also traceable (Figure 6). Michael Imbergamo, Project Architect, says, *"If there is a discussion, it is very easy to find all related RFIs. If they are related, they are numbered as 5001a, 5001b."*

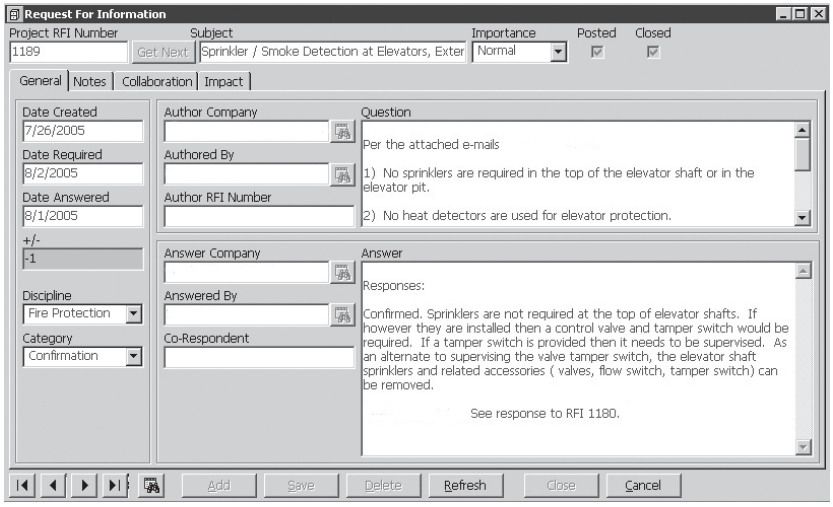

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Figure 5. Electronic RFI form of the OCPM solution in the DIA Center addition project (General Tab: RFI creation and answering; Notes Tab: referencing necessary documents; Collaboration Tab: redirecting/copying to other parties; Impact Tab: cost, schedule, and drawing)

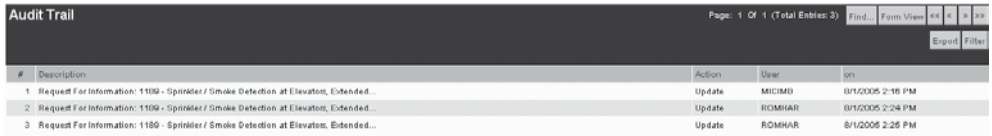

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Figure 6. Audit trail record of RFI # 1189 in DIA Center addition project

Enforcing timely response:
The tool provides the responsible party with a list of overdue RFIs, and requests their prompt action to maintain a timely construction process. It also sends letters that advise a company that their lack of response to an RFI is causing construction delays. Additionally, it warns that the Owner may be notified via an official delay claim. Tony Teritehau, US Navy Project Manager, says, *"We can run reports for returned RFIs or more importantly for outstanding RFIs, which helps us to take timely measures."*

Reduction of turnaround time:
As of August 2005, there are a total of 1,320 RFIs in the DIA Center addition project; 7 are still open. Most RFIs were issued by Manhattan to Engineering Field Activity Chesapeake (1,068) and SmithGroup (228). The average turnaround time for RFIs in the DIA Center addition project is 7.9 business days (21-day turnaround is the industry average), and 662 RFIs were retuned before the required date. The tool brings speed to issuing and answering questions as the process is well automated. The tool enables team members to type in the question in an electronic form and to send it to the relevant parties by just clicking a button rather than faxing, emailing, and posting the documents back and forth. The OCPM solution prevents any mail delay or any risk of an RFI not being noticed in time due to its real-time communication features and automated notifications.

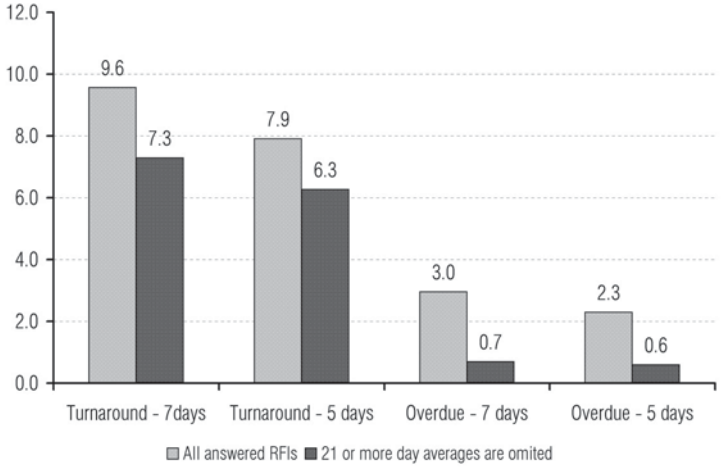


Figure 7. Average turnaround time and overdue based on 7-day and 5-day work week in DIA Center addition project. Based on 1,320 RFIs; RFIs not answered (7) and those with over 39 days turnaround time (104) are eliminated.

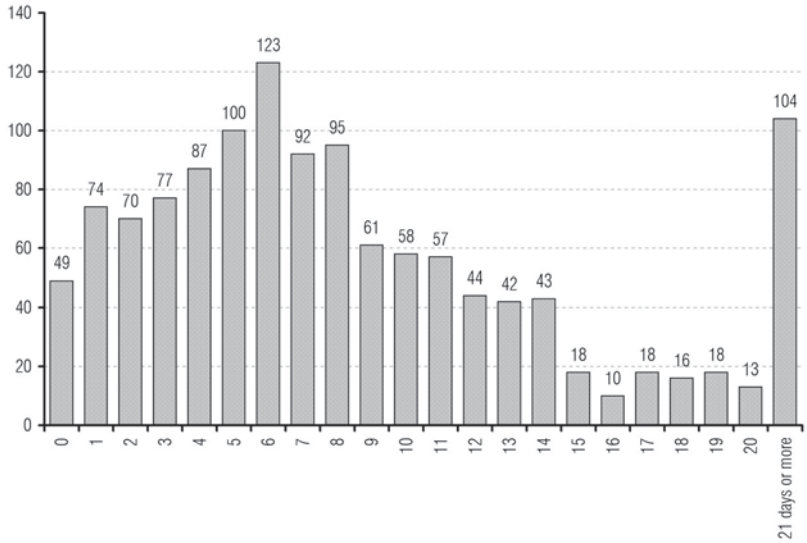


Figure 8. Number of RFIs and their turnaround time in days in DIA Center addition project

Decrease in time spent on issuing an RFI and reduction in numbers:
According to the team, the tool definitely decreases the time spent on issuing an RFI by days and hours. There is no evidence that the OCPM solution in this project reduces the number of RFIs. However, it might also be unrealistic to expect OCPM tools to reduce the number of RFIs, as they are related to so many factors, like original design, quality of drawings, etc. However, the system clears up the question early in the process in a speedier manner. This avoids mistakes and helps to solve problems early in the process.

2.6. Electronic submittals (e-submittals)

The DIA Center addition project team used the OCPM tool's submittal module extensively, only for tracking purposes. Submittals are created using the tool but are not transmitted across the Internet. The reason for this is that most submittals are very large in size; they need to be sent printed, and there are physical samples that need to be transferred. The OCPM tool forms are printed and sent to the responsible party by mail. However, the team has a general agreement that they keep a strong log of sent and received submittals through the OCPM tool. There are three submittal data entry forms available for the team's use:

1. Submittal Register form; creates a list of all the items that need to be included in a submittal package,
2. Submittal Packages form; creates and organizes the actual submittal packages,
3. Submittal Transmittal form; tracks sent submittal packages and creates cover sheets for the submittal package transmittals.

As of August 2005, a total of 2,762 Submittal Registers, 742 Submittal Packages, and 887 Submittal Transmittals have been used. The actions taken are summarized in Figure 9.

2.6.1. Benefits of e-submittals

Audit trail:
The tool enables the team to track their submittals and their status immediately from wherever they are. Brian Killion, Manhattan Project Manager, comments, *"Some packages we view ourselves, some packages we send to the architect, and some packages we send to a third-party consultant. So you can clearly track where the package is and who has seen it."*

Efficient control of the late submittals:
The system sends letters to inform the related party of late submittal packages, noting that their complete and prompt submittal is essential to the project schedule. This letter demands the immediate submission of overdue submittal packages. Additionally, it informs the noncompliant company that their neglect may have consequences, such as a damage assessment.

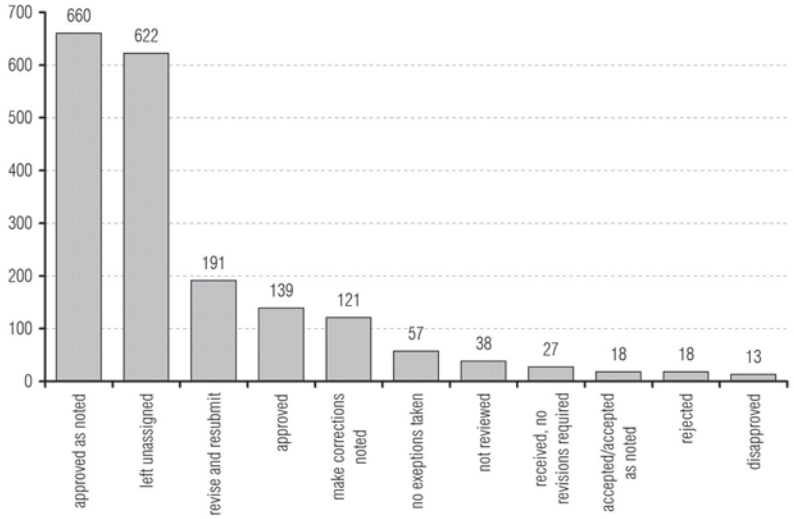


Figure 9. Actions taken after reviewing submittals of DIA Center addition project

2.7. Other Utilized Modules

Submittal tracking, RFIs, and meeting minutes were extensively used in the DIA Center addition project, as required by the contract. Change orders, potential change orders, and punch list were used internally by Manhattan. Drawings and specifications were posted by the contractor as a record. If we consider those documents that were transmitted and shared among team members (Figure 3), the total number of documents is 3,363 (transmittals, correspondence, meeting minutes, and RFIs).

In all, we know there are 3,363 documents (we assume half are 1 page, the other half 2 pages) Total number of pages = 1,682 + (1682 x 2) = 5,046

Assume 50% of documents do not need to be printed
5,046 x 50% = 2,523 pages

Assume at least 3 parties would print if the system wasn't implemented
2,523 x 3 = 7,569 pages of document

Assume cost of printing is $0.1 per page
$0.1 x 7,569 = $757 per project

Assume 3/4 of the documents don't need to be mailed due to efficient electronic transfer and cost of mailing is $1 per document
$1 x 3/4 x 3,363 = $2,522 per project

TOTAL SAVINGS:
2,522 + 757= **$3279** per project ~ **$59,000** for 18 projects (Manhattan has 6 offices and each office has, on average, 6 projects that last 14 months to 3 years and they are valued around $100 million/each. Assume each project lasts for 2 years; that gives us 18 projects a year.)

3. FUTURE OPPORTUNITIES

The use of OCPM tools is increasingly becoming a requirement in large projects. Managers agree that the owners increasingly would like to know what tool the contractor will use to control the project. Therefore, Manhattan would like to increase the use of the OCPM tool modules, especially the cost module, and the use of the OCPM tool in their other divisions and regions in order to maximize the benefits. The architect mentioned that they haven't used the system in the design phase but indicated that they would like to use it on future projects and added, *"It could be useful in the design phase. Multiple consultants can retrieve information and we could still be aware of the discussion."*

4. BENEFIT/ VALUE SUMMARY

Tangible, quasi-tangible and intangible benefits of the Manhattan case are summarized in the table below. Savings of $59,000 annually from the electronic document exchange are the base for the tangible benefits. The DIA Center project is used as an example and the results are projected to 18 Manhattan projects. The electronic survey is used to quantify the quasi-tangible benefits (improvements) by ranking. No performance (intangible) benefits are observed in this OCPM technology implementation. The cost of the system is around $158,640 for annual licenses.

Types of Benefits	**Measured Benefits**
Tangible	**$59,000** annually (for 18 projects)
Quasi-tangible	Survey: **3.6/5** (14 benefits identified out of 27)
Intangible	Not identified
Cost of the system	**$158,640** for annual licenses ($5,000 for implementation, $25,000 for training in the last four years)

INTERVIEWEES

- Brian Killion, Senior Project Manager, Manhattan Construction Company, 06/01/2005
- Michael Imbergamo, Project Architect, SmithGroup, Inc., 06/08/2005
- Mike Parkinson, Project Manager, Quality Control Division, Manhattan Construction Company, 06/01/2005
- Scott Grissom, Project Management Systems Coordinator, Rooney Holdings, Inc., 06/03/2005
- Tony Teritehau, Project Manager, The US Navy Engineering Field Activity Chesapeake (EFA-CHES), 06/01/2005

REFERENCES

Mead, S. P., (2001), "Developing Benchmarks for Construction Information Flows," Journal of Construction Education, vol. 6, no. 3 (Fall 2001), pp. 155-166.

CASE STUDY 7. NATIONWIDE BUILDING SOCIETY

1. INTRODUCTION

This case study focuses on identification and measurement of the value of online project collaboration and project management (OCPM) technology from the perspective of a non-profit organization. The case covers semi-tangible and intangible benefits and values, at the organizational level only. The following subsections give a brief description of the program and outline the need, selection, cost, and implementation of an OCPM tool in a channel development program.

1.1. Channel Development Program

Nationwide Building Society (Nationwide) is the UK's fourth largest mortgage lender and eighth largest retail banking, saving, and lending organization, with more than £100 billion in assets. More significantly, Nationwide is the largest building society[1] in the world. Nationwide's services include online banking via the Internet, online mortgage quotations, savings products with online interest rate comparisons, and a wide range of other financial services. Nationwide has a mutual status, which means that it is owned by and run for the benefit of its members. Building societies emphasize simplicity and convenience, and, unlike profit-driven financial institutions, they turn surpluses into member benefits such as competitive mortgage rates. Nationwide has 16,052 employees located in their two main buildings and seven administrative centers and a network of over 680 branches.

The Property Services Department (PSD) at Nationwide is responsible for the organization's refurbishment projects; they buy, design, refurbish, manage, and maintain its properties. With over 681 branches in the network, this is a challenging and substantial task. PSD has recently initiated the Channel Development Program (CDP), a major capital investment program, which is going to integrate the branch channels with the technology and intermediary channels. The total cost of the program is £300 million, and it will be completed by 2010. The principal purpose of CDP is to upgrade Nationwide's high street outlets, Internet banking facility, and telephone services. Nationwide aims (1) to improve access to its services for members and (2) to improve the systems available to employees to meet the members' demands. In the scope of this program, every branch office will be refurbished and automated and they could be measured for profitability. The goal is to review and refurbish the branch network to gain consistent branding and style within a 6-year period. The projects in the program vary from full refurbishment down to virtual strip-out and replacement.

1.2. The Need for an OCPM Solution

Nationwide is owned by its members, not shareholders, so it is naturally different and expected to be different from profit-driven banks. Committed to staying mutual, Nationwide continually innovates to enhance and streamline member services. CDP was initiated as part of this mission. For the success of this £300 million program, Nationwide realized there was a need to (1) integrate its supply chain and (2) standardize the projects and their execution. The question Nationwide's executives faced was *"Where could we go for a common resource that would improve our operations?"* The management team needed to know the stages and the status of the projects concurrently with the overall picture of the program. How the information is populated and stored was an important issue. Although there

was a system in place internally, due to the strict firewall it was impossible for external parties such as contractors, subcontractors, and/or suppliers to have access to it.

Therefore, executives in Nationwide have decided to implement a system that can provide them a communication platform and information repository while external collaborators can easily reach it from outside Nationwide's firewall. In mid-2002 PSD decided to review its activities and processes with the aim of creating more efficient operations and better capacity for dealing with peaks of activities. The main goal was to establish transparent and continuous communication with the entire supply chain. *"Property Services is dependent on its extensive supply chain, and we believed there was room for improvement in the way that we managed our supplier relationships,"* explains Steve Head, Service Support Manager at Nationwide.

1.3. OCPM Technology Selection

Having reviewed most of the well-known collaboration software products on the market, Nationwide found that while most were strong on document management, they were usually weak on process management. Nationwide wanted not only to be able to store and monitor the information but also to have an interactive system that pushes the information and informs participants about the projects as well as the processes. Nationwide also wanted a system that would match their processes while all the information was hosted by the technology vendor, outside Nationwide's firewall. Therefore, they wanted to have a vendor that could work with them in the process of tailoring the tool. Having had internal experience of working with the Business Collaborator (BC) system and also being convinced of that vendor's willingness to develop its system to meet Nationwide's specific requirements, Nationwide decided to continue working with them. *"It was the can-do attitude, flexibility, and enthusiasm of BC's Directors that heavily influenced our decision. They were considerably ahead of their main rivals in this respect, who seemed determined to sell us an out-of-the box solution,"* comments Steve Head.

1.4. The Cost

The system has undergone a number of changes and ongoing redevelopment over the last three years. The costs associated with the developments and licenses are considered to be commercially sensitive. However, one-time costs of development of WideXchange Program Management and TeamRoom and costs of one-time user licenses are close to £350K. Nationwide pays maintenance and support fee of £30K a year.

1.5. Implementation

The existing BC system needed to be extended and enhanced to cover all the activities involved in a Nationwide project, from physical delivery to implementation management to a continuous improvement loop built on capturing knowledge. The whole program management regime had to be reengineered, because although project work flows were documented as a best practice, they weren't defined in detail and implemented truly in Nationwide's projects prior to standardization of the OCPM tool. (See Table 1 for the new framework of Nationwide projects' execution.) Passing from one stage to another wasn't formalized and monitored. The OCPM technology would be a key tool in the implementation of these changes to create a more program-centric approach as well as a strategic drive to work more closely with the supply chain. Therefore Nationwide, with the collaboration of the vendor, has started to tailor the system.

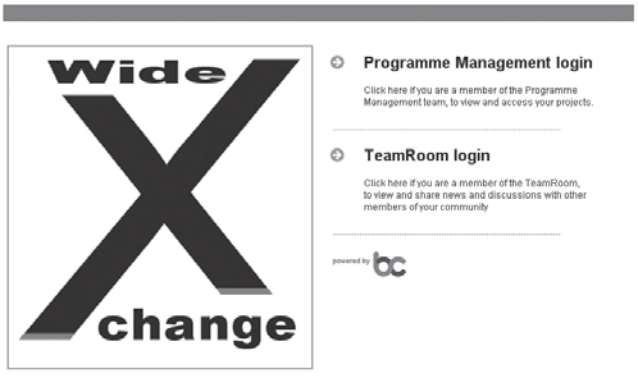


Figure 1: Login page for WideXchange

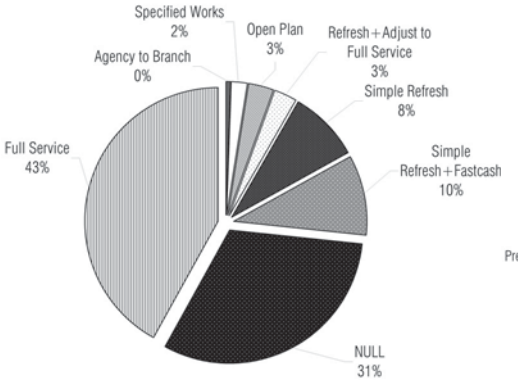
After several months of build-up and tests on pilot projects to ensure that the processes are aligned to support the program roll-out, Nationwide started to use the system in October 2004. They named their collaboration and project management platform WideXchange, which consists of two parts: (1) Program Management and (2) TeamRoom. The Program Management portion of the tool stores project-specific information, while TeamRoom is a knowledge management and practice tool providing virtual work space/meeting place for individuals who might work with/in Nationwide.

1.6. The Use of the OCPM Solution in Nationwide Projects

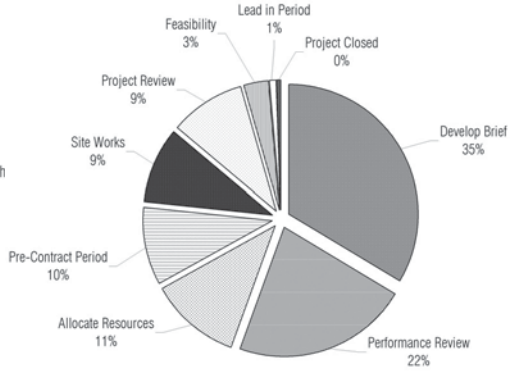
Nationwide works with a pool of contractors, consultants, and suppliers, with most of whom they have long-standing relationships. Usually design is executed by Nationwide's in-house team with the help of external consultants. They have a total of six main contractors working in CDP as of May 2005. To ensure they are obtaining a competitive deal, their supply partners have to re-tender for work on a regular basis. Nationwide also uses its knowledge of the construction market to identify potential new partners. As of January 2005, there are 250 users and 202 refurbishment projects managed by Nationwide's OCPM tool, with an average cost of £335,000. The status of these 202 projects and their types can be seen in Figures 2 and 3.

1.6.1. Program management

Nationwide mandates that all contracted team members use the program management portion of the system for Nationwide's refurbishment projects. Projects are organized to have nine phases, with gates between them: develop brief, allocate resources, feasibility, pre-contract period, lead-in period, site works, project review, performance review, and close project (Table 1). Users cannot proceed from one phase to the next unless all the data is complete in the current phase. The main contractors are the biggest supplier of the documents. Subcontractors can't access the tool at the moment. The system is used for all data-storing requirements in Nationwide refurbishment projects.



Figures 2. Types of projects managed through WideXchange



Figures 3. Status of projects managed through WideXchange

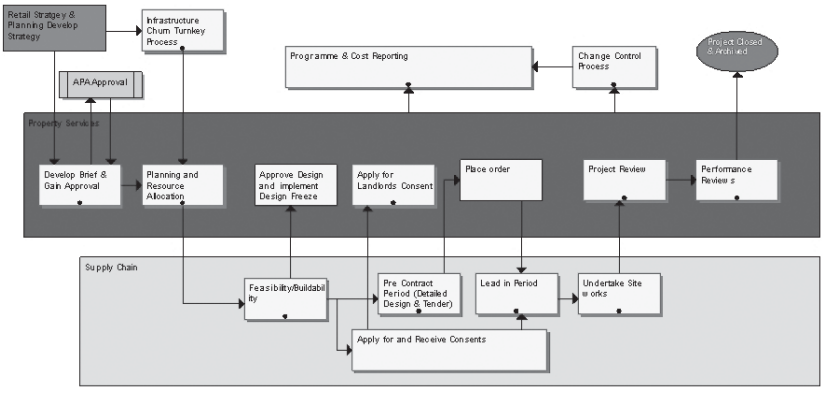


Figure 4. Refurbishment key gates/milestones (from Nationwide OCPM solution)

1. Develop Brief (12 Weeks): When a project brief is issued, an initial exercise undertakes to prepare preliminary concept drawings and produce a budget. This is then submitted for approval. Once approval to proceed is obtained, the project is allocated resources.
2. Allocate Resources (4 weeks): The project is approved to proceed and a project manager and main supplier (plus any other appropriate parties) are appointed (allocated). An initial program plan is developed to ascertain provisional planned dates.
3. Feasibility (4 weeks): After the project brief is issued to the project manager, the initial concept design and full scope of works is developed to suit the on-site conditions. This generates a feasibility drawing for approval. Once approved, the stage of feasibility design freeze is reached. This means that this design can no longer be changed without impacting on the project delivery.
4. Pre-Contract Period (8 weeks): Working from the feasibility design, full detailed design drawings are prepared and all risks and statutory consents (building, planning, listed building approvals) are identified and dealt with. Where applicable, the landlords' approval for any changes is also obtained. The tender is prepared, and firm on-site dates are agreed at this stage. Completion of this stage confirms that the project may proceed and an official order can be issued to the main supplier. (The main supplier is involved from the early stages and is involved in a great deal of the project preparation work. Until all final design details and the tender are agreed, an official order isn't issued for the works. Should the project not proceed, the main supplier is paid reasonable abortive costs.)
5. Lead-In Period (6 weeks): The main supplier makes preparations to commence the works on site and place firm orders for all goods and services. Confirmation of all risk items and statutory consents (building, planning, listed building approvals) together with the landlord's approval (where applicable) is required at this stage. The project cannot be allowed to commence on site if all risks/consents aren't confirmed.
6. Site Works (varies, avg. 10 weeks): The site works stage means that the works are being executed on site. There is a requirement to resolve all snagging items within 1 week of practical completion.
7. Project Review (13 weeks): After the project is completed (the site works stage) and is handed back to the client, a project review undertakes to ensure that the project has been delivered in accordance with the project brief, built to the design standards, and operates as intended. The main supplier is also required to provide appropriate documentation to enable ongoing operation and maintenance of the property. A customer satisfaction survey also undertakes to measure the customers' views of how the project has been delivered.
8. Performance Review (54 weeks): Over the next 12 months, three performance reviews and a final post-investment review are undertaken. This means that the project is evaluated against the intended benefits and whether it is generating the business to justify itself. The final account for the works is agreed with the main supplier, and any outstanding final payments are settled.
9. Close Project: The project is closed and sealed and will remain in view in the OCPM tool for a period of 3 months. After that it can be archived. No changes are possible during this stage.

Table 1. Description of 9 stages of Nationwide projects (courtesy of Robert Harrison, Support Manager of WideXchange)

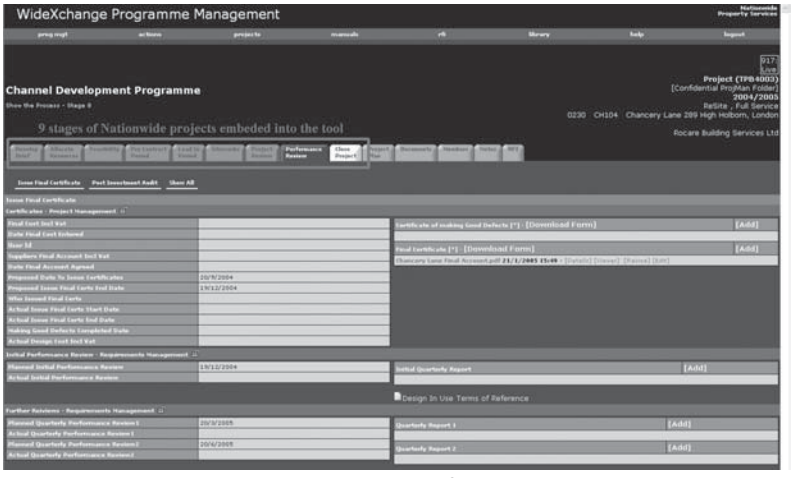


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Figure 5. A screen shot of a project collaboration space in CDP; the project is in stage 9 (marked with white background)

Requests for information (RFIs) are used as an electronic means of questions and answers or for raising concerns and/or points of action. The party raising the RFI can request a reply from any of the participants invited to use the tool, via a drop-down menu of names. The RFI is then sent only to the participant(s) selected. If specific names do not appear in the menu, they do not form part of the direct process. RFIs can also be used for getting general information about a project; in this case, no name is required. Then the information sites within the RFI field but is not automatically sent out to any participants. There have been a total of 911 RFIs in 202 refurbishment projects as of January 2005; the average turnaround time has been less than 8 days. Nationwide had not yet chosen a single contractually binding method of raising and agreeing variations through change orders. However, the process is now being updated and all change requests are going to be logged through RFIs.

Percentages of entries in the database for all Nationwide projects can be seen in the figure above. General documents include (in the order of their size): drawings, correspondence, images, health and safety documents, programs, instructions, briefs, forms, legislation, specifications, meeting notes, reports, contracts, project costs, and signing lists. Some examples of process documents are: detail design drawings, schematic drawings, M&E drawings, as-built drawings, instructions, etc.

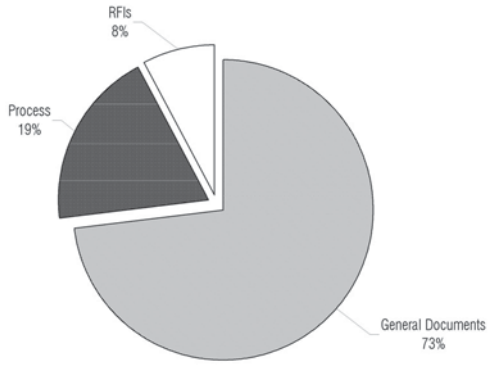

Figure 6. Percentage of entries in the database

1.6.2. TeamRoom

One of the problems raised in the June 2003 supply chain conference was the need for (1) better communication among the supply chain and (2) capturing/sharing of the knowledge that already exists in the supply chain. The idea was to capture and then distribute business knowledge and strategy, project information, best practices, and experience gained from different consultants, suppliers, contractors, and projects. Having the program management system in place, Nationwide requested additional collaboration space – TeamRoom – from the OCPM solution provider. With TeamRoom, Nationwide not only aimed to capture comments and observations on the use of the system but also wanted to capture the information in the spatial context of the project. This capturing of information could be done within the organization or among wider groups involved in Nationwide's projects.

The first TeamRoom community launched in late 2003, and it was about sustainability. With interest increasing, 30 different companies became members soon after the launch. In March 2005 there were 15 different communities based on specific projects or special-interest subjects. Currently Nationwide's employees and external partners have access to TeamRoom. Being a lot larger than their competitors and having a different way of operating and servicing, Nationwide sees this chance of collaboration as an important learning opportunity rather than a sharing of their competitive advantage. With the new version of TeamRoom, the relevant parties will be notified if a document is updated and/or a new version is added. Also, if a participant has a rough document that he/she wants others to comment on, he/she can post it in the library and can open a discussion and link the document. Participation is voluntary; however, Nationwide is planning to request the use of TeamRoom contractually in the future. Nationwide currently holds 500 licenses of TeamRoom, and plans to increase the number according to demand. The opportunity for the organization is that with TeamRoom they can open a discussion and/or have a chat room, address questions and answers, and capture people's ideas and experiences for future benefit.

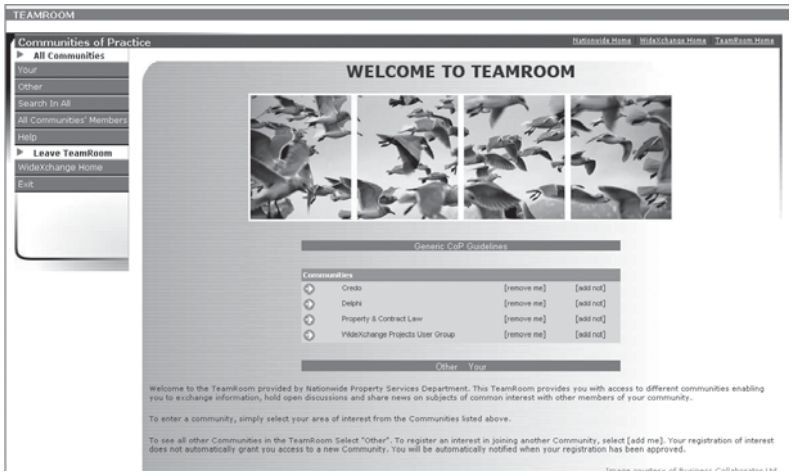

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Figure 7. TeamRoom welcoming page

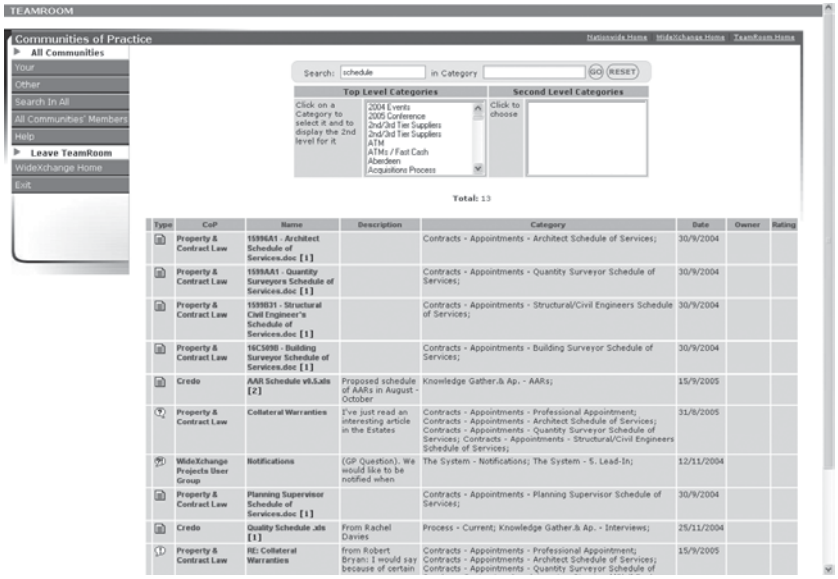

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Figure 8. Results of *"schedule"* search: people, documents, discussions, categories, and dates

In TeamRoom, one can find agendas, project and contact information, etc. TeamRoom is linked to WideXchange and Nationwide's website. TeamRoom's communities all include special-interest groups, discussion rooms, news and event arenas, and a library where the participants can post documents. A participant can find all community members' names and contact information. The tool also provides useful links and a search engine. Participants can address a question to an expert listed specifically in that community. For example, someone who needs to know something about asbestos can search for the word "schedule" (Figure 8). As a result of the search, a couple of people will appear with specific expertise from the management to whom one can address one's questions. This way one doesn't have to go though the process of brainstorming or research to solve the problem.

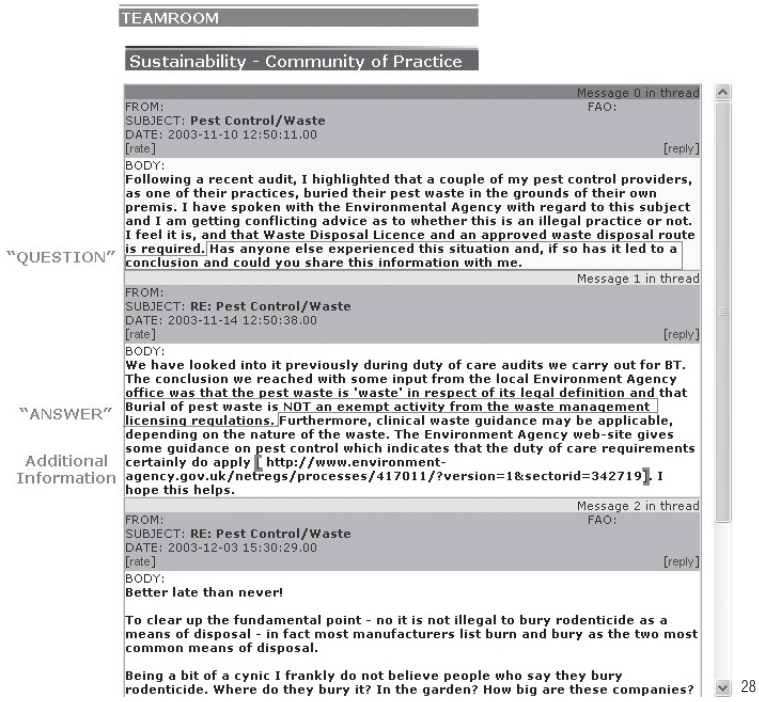

Figure 9. Answer and additional information to a question about pest waste

2. BENEFIT/VALUE ANALYSIS

When considering the implementation of a new system, it is essential to understand whether you seek benefits in efficiency (tangible), effectiveness (quasi-tangible), overall business performance (intangible), or a particular combination of these. This case study focuses on organizational-level benefits rather than individual project-level benefits. The reason for this is that Nationwide refurbishment projects are small in size and also in cost, and business benefits rather than cost savings have always been more important for the organization. Performing the right tasks correctly, staying consistent with the organization's mission, vision, and values, and supporting its goals and objectives – as well as providing an ability to measure CDP – have been among Nationwide's most important goals in deciding to implement this technology.

Therefore we will look at two areas in this case study: *performance (intangible)* and *effectiveness (quasi-tangible)*. Performance is the level of new outputs enabled (doing better things). The nature of modern business is such that, increasingly, senior managers are required to think beyond the direct tactical issues of efficiency and effectiveness, toward more strategic issues. Business performance, in its broadest terms, is a major strategic issue and one that OCPM technology has much to contribute to. A major argument of this case is that OCPM technology's benefits in construction extend beyond the tactical into strategic business performance improvement. Effectiveness is the rate of actual outputs compared to planned (doing the right things) – the ability of a program, project, or work task to produce a specific desired effect or result that can be measured.

There are three main questions for us to ask in order to understand the business of the investors and what they are seeking from their investment: (1) Who are the investors and what values would they like to get out of their OCPM technology investments (potential benefits)? (2) What did they get from their investment in terms of benefits/values (realized benefits)? (3) What would they lose if they didn't implement these systems (lost opportunities)?

-Performance and Effectiveness-

2.1. Potential Benefits

Nationwide invested in an OCPM tool for the following reasons: (1) to have the possibility and the benefits of having all project-related information in one place where all project participants can reach it, and (2) to have information

in a form consistent with their processes where the information system can push the process along. They want their supply chain to be integrated in the project, to be able to add and change information in the common project space, while Nationwide can control the level of access. Nationwide also wants this tool (3) to enable the right participants to get involved at the right time; (4) to give an easy overview for management; (5) to enable collaboration requests such as virtual meetings.

2.2. Realized Benefits

2.2.1. Supply chain integration *(Performance):*

Refurbishment is a big team effort which requires the collaboration of several parties within the Nationwide organization, such as branch staff (needs to know what's happening when and what it will look like), financial staff (needs to know the costs), and/or technical staff (installs the IT systems). However, not only do departments within the organization work together, but external parties (a wide range of suppliers and subcontractors) also collaborate to realize refurbishment projects for Nationwide. An example would be the need for communication between the Automated Banking Department and the Technology Department in planning an ATM installation, and communication with the main contractors for execution of the work.

Previously Nationwide didn't have a single source to monitor what was being done when and by whom. It was impossible for external parties to get through Nationwide's firewall. With the implementation of the OCPM solution and hosted databases by the vendor, the organization started pushing (and pulling) information not just to the internal parties, but also to the external parties. The tool brought multiple projects together and made them visible to the whole project team. The system is substantially supplementing PSD's delivery capability. The major benefit has been the improved communication both internally and across the supply chain. Whilst this is a benefit, the more significant benefit is that it provides consistency in management and co-ordination in an efficient approach and more importantly, enables knowledge exchange and management of risks. The tool brought reliability and easiness to information distribution and allowed anyone in the supply chain with access to view all records and project/program progress. It ensured that information for all the projects was maintained and kept up to date at all times.

2.2.2. Performance measurement *(Performance):*

Nationwide now can review the performance of the project and the main contractors once the project is completed. As data from earlier work is not integrated into the system, contractor performance cannot yet be measured against past performance. However, the tool can measure how they performed on this particular project. This enables Nationwide to set a benchmark of their work performance and evaluate main contractors' performances. According to these assessments, Nationwide rewards some contractors with more projects if their performance is good or improved, and reduces the workload of others if their performance level is low. There are several benchmarking capabilities built into the tool that allow PSD to manage the process and key drivers. Contractors and all other nominated parties are also able to manage their own key performance indicators (KPIs) to ensure they can also manage their individual processes and make changes as necessary.

KPIs are measures of different aspects of a project that can be used to monitor how a project/program is performing against targets to review the delivery efficiency. For example, Nationwide could assess how accurate the final cost is compared to the budget cost as a percent of accuracy. This would enable them to assess and compare accuracy across all projects. Similarly Nationwide could measure the number of defects on completion as a score, to assess and compare the impact on the end user of any defects at the time of handover. Measures like this would enable some key performance statistics to be generated on a project/program to assess how it has performed across a number of different categories. Nationwide in turn can track these changes through the tool. The performance module allows Nationwide to mine its project data to see whether it is hitting KPIs at project and also program level. Nationwide can also generate performance reports based on these KPIs.

2.2.3. Process Reengineering *(Performance):*

The tool enabled Nationwide to review its existing processes, and it also provided a new way to reengineer them. The organization gained the capacity to standardize and learn from what they have actually been doing for years. As explained above, within the refurbishment process there are a number of gates the project actually goes through (Table 1). Nationwide built these gates into the tool, which forced the information to be populated in these gates as the users cannot pass through one gate if the previous one is not filled in (Figure 4). For example, the project cannot proceed to the feasibility stage until a program plan for resource allocation has been prepared and uploaded to WideXchange. Similarly, the site works stage cannot be complete until all snagging items have been rectified. This

gives Nationwide a standard way of working and assures a certain level of quality in all of their refurbishment projects while saving time by setting solid milestones.

2.2.4. Knowledge sharing and management *(Performance):*
TeamRoom helps to solve people's problems easily and intuitively by creating new solutions rather than repeating the same problems or wasting time searching for solutions. Communities for special interest areas as well as projects are built into the tool. Nationwide not only shares the knowledge within the organization with its employees but also shares it with its subcontractors and suppliers through discussion boards and libraries. Security companies working with Nationwide are the biggest contributors of TeamRoom.

The tool proved to be very useful in terms of time and cost savings in practical issues. Steve Head, service support manager at Nationwide, says: *"We have been feeding the learning gleaned from each project back into our knowledge store – for example how difficult-shaped branches were handled, imaginative use of materials, effective building techniques, etc. We have even had competitive suppliers learning useful tips from each other and sharing expertise!"* An example of knowledge sharing is a question asked by a contractor in the "sustainability" room about "pest waste". His question was answered by another contractor in another project (Figure 8). Not only was this question answered in a short period of time, but some suggestions for where to find more information were provided by other people. Another example is immediate question-and-answer in the "property and contract law" community. If anybody has building-related legal issues, experts will answer these questions. For example, a question was asked by a supplier about field access. His question was answered immediately, free of charge. Although there is no direct benefit for Nationwide in this example and several other examples, Nationwide is pleased to assist this collaboration and be able to work with its contractors in a better way. *However, the question still remains: How can you measure the gains/benefits of knowledge management?*

2.2.5. Centrality *(Effectiveness):*
The tool contains design manuals, and provides precise guidance on all the potential levels and styles of refurbishment. This is a huge time and cost saving since every change to the manual means the manual must be recopied and sent out to potentially dozens of contractors and suppliers. Now Nationwide has much improved version control and a master copy that is centrally available, which reduces errors and ensures consistency. The tool allows others to act on anyone's behalf should they be absent. All information logged is recorded back to the user inputting the data via password verification. Having one central source for project information has proved to be invaluable for keeping everyone informed about the progress of the program.

2.2.6. Better decision making *(Effectiveness):*
The tool helps managers in the decision-making process in various ways. For example, before the project comes to life, there is a good deal of work up front to determine its needs. A project manager can log in and check out the projects in the pipeline. According to the project plan and his/her availability, he/she can decide if he/she can work on that property or not. Program managers now can see the whole program and what is going on, whereas before they weren't able to see the overall picture. With the tool in place, the project manager can easily realize any changes that would affect any project or the contractors. Moreover, they can see the effect on the whole program with the better view of the program's progress. The tool facilitates faster decision making by enabling faster and more complete flow of information and speedier communication. The OCPM tool, as a management tool, increases the contractors' awareness of PSD processes in managing CDP. Having a single source for the projects helps managers with general management information – what projects they have in the system and the status of those projects – which was previously managed by databases where all project participants had to rely on somebody updating the information. Steve Head says, *"We now have an internal and external team who could previously only have coped with relatively low numbers of projects - now we estimate that with this tool in place we could considerably ramp up our activity with no loss of quality or loss of control."*

2.3. In the Absence of the OCPM Solution
Robert Harrison, support manager of WideXchange, comments on what would have happened if they hadn't implemented the solution: *"We would lose time, quality, cost, ability to talk directly with a large number of people at any time, accessible record and data storage facility, performance enhancers, members' experience enhancements, technology and project management improvements, contractors' key performance indicators and best practices capture."* Most importantly, if Nationwide hadn't implemented the system, they wouldn't have the work processes they have

reengineered. According to the top management, not having the system is a major risk now. The information is available to everybody anywhere; there are no physical boundaries or worries about transfers. The biggest value stated has been informing people. If they didn't have the system, the distribution of documents would be a problem, whereas now they can do it real time instead of needing 2-3 days to update technical documents, print, and send them. By implementing the system, the team eliminated the whole distribution and administrative exercise. According to upper-level management, that itself has been a great bonus. The greater value is in the ability to manage program risk and the system provides visibility and awareness to all parties.

In summary, if Nationwide didn't have the OCPM tool in place they would lose (1) the ability to enforce the work flow; (2) the ability to enforce data population: information management would be chaotic again; (3) the ability to have a single reference point/depository for each project; (4) the ability to have control of the overall program and ability to manage risk issues effectively; and (5) the visibility across the phone project team.

2.4. Quasi-tangible Benefits' Ranking

Besides interviews, an electronic survey of quasi-tangible benefits was designed and distributed via email to all interviewees to measure the improvement in a more consistent and less subjective way. The aim of the survey was to uncover as much information as possible and to quantify quasi-tangible benefits of OCPM technology investments. Each respondent received the identical set of benefits, phrased in exactly the same way in order to reduce errors resulting from the recording of responses, and the respondents were free to rank the benefits according to their relevance at responder's own pace. The survey covered several benefits that were stated during the interviews. The responders were asked to rank the benefits 1 through 5 (where 5 is *'very high'*, 4 is *'high'*, 3 is *'neutral'*, 2 is *'low'* and 1 is *'very low'*). Benefits and values ranked by Nationwide case interviewees can be seen in the table below.

Benefits/Values	**A***	**B***	**C***	**Ave.**	**StnDev**
- Improved information version control	5	5	4	4.7	0.6
- Improved process automation (RFIs/COs, automatic updated master budget, etc.)	4	5	5	4.7	0.6
- Provided accurate and timely information to make valid/accurate decisions	5	5	4	4.7	0.6
- Enabled faster reporting and feedback	5	5	4	4.7	0.6
- Improved information management	5	5	4	4.7	0.6
- Enabled better project/program control	5	4	5	4.7	0.6
- Improved timely capture of design/ construction decisions	5	5	3	4.3	1.2
- Enabled quicker response to project status and budget	5	5	3	4.3	1.2
- Enabled better forecasting and control	5	4	4	4.3	0.6
- Reduced errors and omissions	5	4	4	4.3	0.6
- Improved data availability	5	5	3	4.3	1.2
- Enabled having complete audit trail	4	5	4	4.3	0.6
- Improved idea sharing among team members/within organization	5	3	4	4.0	1.0
- Improved quality of the output	5	4	3	4.0	1.0
- Minimized project/business risks	5	4	3	4.0	1.0
- Enabled fewer information bottlenecks	4	4	3	3.7	0.6
- Reduced delivery lead times	4	4	3	3.7	0.6
- Improved project relationships with strategic partners	3	4	4	3.7	0.6
- Reduced personnel costs due to improved efficiency	2	5	4	3.7	1.5
- Reduced rework/data reentry	3	5	2	3.3	1.5
- Enabled faster launch to market due to faster delivery	4	4	2	3.3	1.2
- Enabled better resource allocation; more effective assembly of project teams	2	4	4	3.3	1.2

Nationwide Building Society

- Enabled better inventory management	2	4	3	3.0	1.0
- Enabled more effective identification and assessment of new suppliers	1	3	3	2.3	1.2
- Enabled advance purchase of materials	3	2	1	2.0	1.0
Enhanced working within virtual teams	3	5	X		
Improved public relations	3	4	X		

Table 2. Ranking of various benefits/values by Nationwide case interviewees (*The names of the respondents are hidden for confidentiality reasons. However, the respondents are managers of Nationwide Building Society. "X" stands for when the question is not relevant or the responder doesn't know the answer.)

3. FUTURE OPPORTUNITIES

Nationwide is very satisfied with the functionality of WideXchange and they are not planning to change the product. It is important that they have a system enforced. However, there were some problems that Nationwide has worked hard to overcome, related to change and cultural barriers. They are continuously training their employees and the supply chain to use the system, as WideXchange requires a particular way of working. Nationwide is constantly discussing integrating TeamRoom and WideXchange so they can capture knowledge from each other and feed it to one another. However, no decisions on this have been taken so far. Nationwide has another facilities management tool in place, and WideXchange is not used for post-refurbishment operations. Although Nationwide is aware of the opportunities in terms of using the information captured during the management and execution of the projects, they are not considering any type of integration at this moment. Nationwide is at the stage of implementation, but they are confident that they have already gained efficiencies.

4. BENEFIT/VALUE SUMMARY

Tangible, quasi-tangible and intangible benefits of the Nationwide case are summarized in the table below. Tangible benefits were not considered in this case as the investor's main goal was to gain quasi-tangible and intangible benefits through their OCPM investment. The electronic survey is used to quantify the quasi-tangible benefits by ranking. Four performance (intangible) benefits are observed in this OCPM implementation: the supply chain management, knowledge sharing and management, performance measurement, and process reengineering. Upon the OCPM investor's request, the cost of the system is preferred not to be presented in detail as the development and licensing costs are considered to be commercially sensitive.

Types of Benefits	**Measured Benefits**
Tangible	Not considered
Quasi-tangible	Survey: **3.9/5** (25 benefits identified out of 27)
Intangible	**Four identified**: Supply chain integration, knowledge sharing and management, performance measurement, and process reengineering
Cost of the system	Close to **£350K** (one time cost) and £30K annual

INTERVIEWEES

- Lynne Keech, Knowledge Management Consultant at Nationwide Building Society, 03/11/2005
- Mark Skinner, Project Manager at Nationwide Building Society, 03/11/2005
- Robert Harrison, Support Manager of WideXchange, 02/22/2005, 05/04/2005
- Steve Head, Service Support Manager at Nationwide Building Society, 11/29/2004, 03/04/2005

CASE STUDY 8. P.J. DICK INCORPORATED

1. INTRODUCTION

This case study focuses on identification and measurement of the value of online collaboration and project management (OCPM) technology from a general contractor's point of view. The case covers tangible and intangible benefits and values at both the project and the organizational level. The following subsections give a brief description of the organization and outline the need, selection and implementation of an OCPM tool in a general contractor's business. A project of P.J. Dick Incorporated, the Collaborative Innovation Center at Carnegie Mellon University, is selected as a model for identification and quantification of the OCPM tool's value. The value of the OCPM tool is discussed in depth in three areas: efficiency (tangible benefits), effectiveness (quasi-tangible benefits), and performance (intangible benefits). The focus is on the effectiveness and performance areas as P.J. Dick executives have been more interested in semi-tangible and intangible benefits of their investment, realizing that quantification of the benefits of investing in information technology has always been a challenging task.

1.1. P.J. Dick Incorporated

P.J. Dick Incorporated (P.J. Dick) is ranked as one of the nation's top 100 general contractors (GC) and construction managers (CM) by Engineering News Record. P.J. Dick manages and constructs projects in a variety of markets, including commercial, health care, education, government, and industrial. The organization has managed over $3 billion in commercial, industrial, federal, and specialty projects since 1979. Their services include preconstruction, general contracting, agency construction management, construction management at risk, and design-build services.

1.2. The Need for an OCPM Solution

Execution of construction projects requires working with several other parties such as owners, architects, engineers, consultants, and suppliers. Serving the building industry, P.J. Dick's work typically requires subcontracting out and managing several companies that are not directly tied into their company. P.J. Dick recognized the need for efficient communication among these parties in order to facilitate numerous construction work flows such as RFIs, change orders, and submittals and to share construction documents such as drawings and specifications. P.J. Dick decided to implement a system that will (1) create standards and certain policies, (2) facilitate the communication with the entire project team as well as with their own staff, and (3) help them in gaining competitive advantage by providing a better service to the owner.

1.3. OCPM Technology Selection

P.J. Dick has been using Constructware's OCPM solution in its operations since 1998. They have recently renewed their agreement with Constructware through 2010. They have been satisfied with this well-established product and have invested time and effort in learning how to make the best use of it. However, with the renewal, P.J. Dick has decided to make a substantial advance in the use of the OCPM tool within their organization and in their projects.

1.4. The Cost

P.J. Dick offers the OCPM system as part of its contracting services, a traditional strategy that has provided P.J. Dick a great competitive advantage. P.J. Dick will not publicly state the exact cost of the system. However, the total cost for the system includes a certain amount of customization of the tool, implementation, and an unlimited number of users.

1.5. The Collaborative Innovation Center at Carnegie Mellon University

The Collaborative Innovation Center at Carnegie Mellon University (CMU) is a $27.9 million construction of a 133,000 sq ft dry-lab research facility in Pittsburgh. The center provides on-campus office and lab space for corporate partners who collaborate with CMU on innovations in science, engineering, and technology. Built into a hillside, the facility features four floors of office and lab space on top of a four-level parking deck. To maximize flexibility for tenants, the center utilizes a post-tensioned concrete structural system, which eliminates interior support columns, as well as raised floors that house variable air diffusers and electrical, telephone, and data access boxes. Designed as a leadership in energy and environmental design (LEED) certified facility, the center incorporates energy-efficient systems and working windows for fresh air and natural light. Construction of the center started in April 2003 and was originally scheduled to be completed in about 17 months. P.J. Dick is serving as CM at risk for this new high-tech office and research facility.

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Figure 1. Rendering of CMU Collaborative Innovation Center in relation with the surrounding buildings

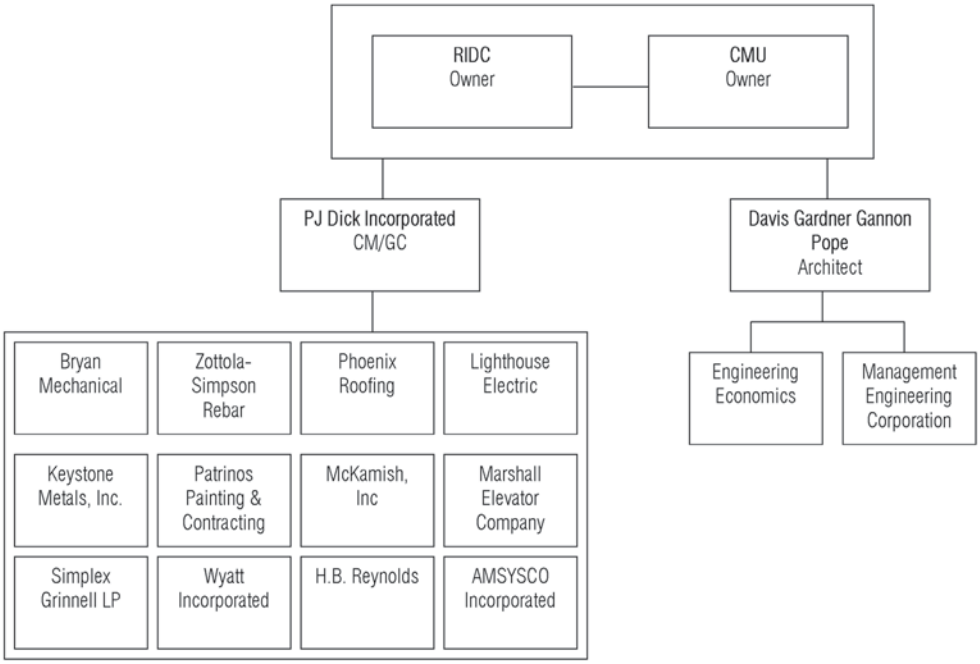

Figure 2. Organizational diagram and the number of OCPM solution users

1.5.1. The project team

The land for the project has been leased from CMU by the Regional Industrial Development Council of Southwestern Pennsylvania (RIDC), the owner of the building. J.J. Gumberg, the building developer and operator, represents RIDC on site during the construction. J.J. Gumberg is responsible for day-to-day activities whereas the RIDC manages the financing and CMU oversees the whole process. CMU has a master lease; therefore they are also involved with the owner decisions. The building will be given back to CMU after 3 years. P.J. Dick provides the construction management and general contracting services with a core and shell contract and a tenant build-out contract as a result of competitive bidding. Davis Gardner Gannon Pope Architecture (DGGP) provides design services (figure 2). At the beginning of the project, another architecture office was involved in helping the team to identify where to locate the building on the small piece of land allotted for the site.

1.5.2. Challenges of the project

The CMU Collaborative Innovation Center has been a challenging project for several reasons, such as the location of the site, the tight schedule of the project, and the coordination of the sheer number of parties and multiple owners.

(1) Logistical: The location of the project is ideal in terms of master planning, but not in terms of construction. The site allows CMU to continue with its plan to create more usable green space within its campus while providing additional facilities to accommodate future needs. However, the site is located at the edge of a small on-grade parking lot and the steep sloping hillside that forms the Junction Hollow. The soil providing a large amount of cover over the existing rock ledge was placed there as waste material from previous university construction projects dating back to the turn of the century. Soil reports advised that it was not suitable for load bearing, though the excavation into the hillside for the parking structure would serve to stabilize it. In addition to the soil conditions, the side is bordered by a railway track, a campus maintenance garage, and a bridge. Therefore, there wasn't much room for construction activities. The team needed to use a tower crane to coordinate deliveries, which meant shutting down the roads and coordinating with the university and the city. In addition, they had to deal with the challenges of building on a university site and keeping the students moving and safe.

(2) Schedule: The construction schedule of the project was only 17 months, and it required extensive planning in advance. For the concrete work, for example, P.J. Dick targeted forming 10,000 sq ft a week in order to turn over and maintain for 4 months. Unfortunately, due to occurrences out of PJ Dick's control, they completed the building in the 20th month because of an inaccurate survey that located a 50-inch city water line incorrectly. Halfway through the construction they were told by the local water authority that they were building on top of a 50-inch water main. Although it didn't crack, this delayed the schedule for 3 months.

(3) Coordination: P.J. Dick has been tasked with making sure that each owner group – the developer, RIDC, CMU – receives the information it needs in a timely and consistent manner to facilitate the decision-making and coordination processes. While the developer has managed the overall design and construction, RIDC oversaw the project's

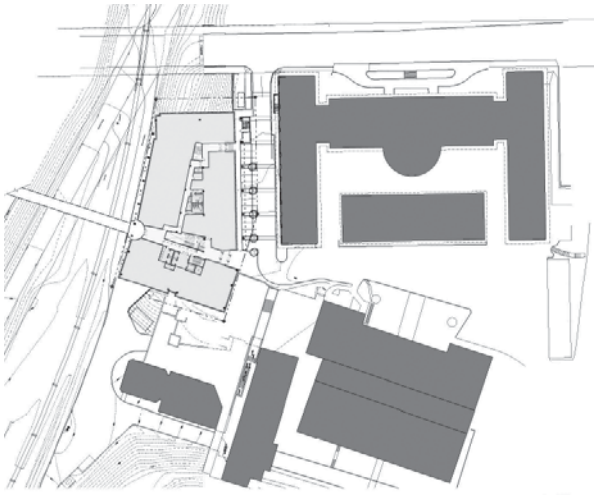

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Figure 3. Site plan of CMU Collaborative Innovation Center

financing. CMU, as landowner, was responsible for ensuring that construction activities were carefully coordinated with ongoing campus activities. The project's site on an active university campus has presented a tremendous coordination challenge for the on-site construction team. Worker access and material deliveries have been scheduled to minimize the impact on surrounding educational facilities. However, the extremely tight site has required daily, just-in-time deliveries, further hampered by limited site access imposed by the site's steep slope. A live train track immediately adjacent to the site has meant that the on-site team also has to coordinate with rail transportation officials. The team also had a lot of higher-level participants such as executives and committees from both the university and some participating institutions.

1.6. Implementation

P.J. Dick has 58 projects as of May 2005, and all are managed by the OCPM tool. Typically, on a particular job all stakeholders – including subcontractors – get training by P.J. Dick personnel at least once, if not more. If the users have additional questions or if they are not comfortable enough with the use of the system, there might be extended training, whether one-to-one or over the phone. All training costs are covered by P.J. Dick as the system is offered as part of their services. Although P.J. Dick adds the OCPM solution cost to its bids, this doesn't cover the entire cost. Dennis DiPalma, OCPM administrator, says, *"We have decided to make the investment because at the end of the day this will make us more efficient."* The only time they won't use the OCPM solution is if a specific owner requires them to use another system. However, not all P.J. Dick projects have the same level of use. Some projects are better suited to it than others, and it mostly depends on the project manager and the owner's willingness to use it. The goal is to have a standard level of use of the system in all P.J. Dick projects.

On the CMU Collaborative Innovation Center project, P.J. Dick offered its use to the owner group as it was the best way to keep everybody informed on a real-time basis and to make all the information accessible to the parties simultaneously. The owner's intention was very similar, so they backed up P.J. Dick on the decision to use an OCPM solution. They started using the tool for this project in the summer of 2002 for preliminary construction activities and correspondence. P.J. Dick has in-house administrators who are responsible for day-to-day operations (the project's set-up, administration, the tool's speed, etc.). P.J. Dick owns all the data at the end of the day. In this project, they are going to turn over all project information to the owner at project completion.

In the course of system implementation, P.J. Dick realized the importance of allocating resources in its implementation and operation: training, decisions of how the tool will be set up and used, how the business will be run, what features are going to be used and how. After renewing the contract with the OCPM vendor in November 2004, P.J. Dick decided to have a new implementation strategy to get the best results out of their investment. They have developed an extensive implementation plan in 4 phases: document management, cost management, bid management, and file management. Phase 1 started in January 2005 and was to last until June 2005. They have established a steering committee within the company – executives, project managers, secretaries, IT and accounting professionals – to oversee the implementation and use of the tool internally and have also purchased implementation services from the vendor.

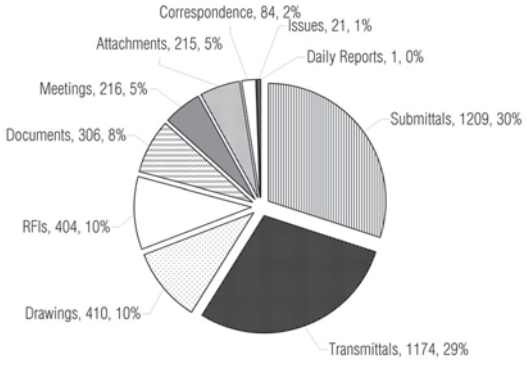

Figure 4. Number and percentage of the stored documents in document management module in CMU project as of May 2005

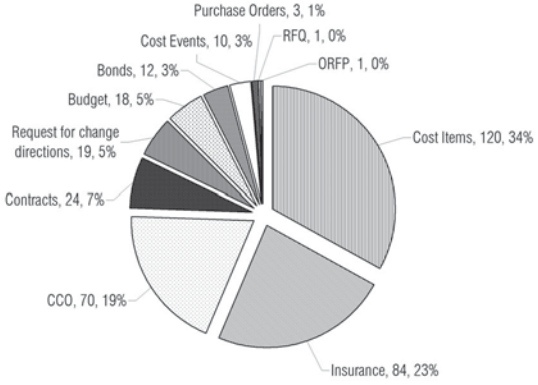

Figure 5. Number and percentage of the stored documents in cost management module in CMU project as of May 2005

1.7. The Use of the OCPM Solution in the CMU Collaborative Innovation Center Project

The CMU Collaborative Innovation Center project team used the document and cost management modules extensively, except for the cost tracking and payment applications. The design team and the construction team, especially the contractors and subcontractors, were among the most frequent users of the system. Project meeting minutes, transmittals, submittals, daily logs, RFIs, and change order features were the most used features (Figures 4 and 5). There are 36 active users as of May 2005, of whom 15 are subcontractors and consultants (figure 2). The CMU project is actually the first project in which P.J. Dick had significant participation from the subcontractors. This success can be attributed to the initiation and strong support of Brett Pitcairn, project manager of the CMU project. He says, *"The OCPM tool allows users to present accurate information to team members in order to make timely decisions, track correspondence and deliver a successful project."* Although the developer's team doesn't use the tool, they believe in its necessity and benefits. John King from J.J. Gumberg says, *"It absolutely helps. I don't use it daily but I know what it accomplishes and I don't think we would be as successful without it."* William Widdoes, the only user from RIDC, uses the tool only for meeting minutes.

The CMU Innovation Center project utilized most of the modules of the OCPM, including:
- Document management: attachments, correspondence, documents, issues, drawing log, meetings, RFIs, submittals, transmittals
- Cost management: budget, cost events, cost items, request for change orders, contracts, contract change orders, purchase orders, contractor change orders
- Project information: project calendar, calls, outbox, details and team

2. BENEFIT/VALUE ANALYSIS

In order to measure the benefits, we need to understand the business of the investors and what they are seeking from their investment. There are three main questions: (1) Who are the investors and what values would they like to get out of their OCPM technology investment (potential benefits)? (2) What did they get from their investment in terms of benefits/values (realized benefits)? (3) What would they lose if they didn't implement these systems (lost opportunities)? When considering the implementation of a new system, it is essential to understand whether the investors seek efficiency (tangible), effectiveness (intangible), or overall business performance (intangible) benefits, or which combination of these.

For our purposes the benefit/value analysis is based on three factors: effectiveness, efficiency, and performance. All three factors will be discussed in the scope of this case study. *Performance (intangible benefits)* is not directly measurable in quantifiable terms but is judged qualitatively on the basis of the impact of a successful implementation in influencing long-term business performance and market share. *Effectiveness (quasi tangible benefits)* is the ratio of achieved outputs to planned outputs (doing the right things): the ability of a program, project, or work task to produce a specific desired effect or result that can be measured. It is performing the right tasks correctly, consistent with organizational mission, vision, values, and in support of the organization's goals and objectives. *Efficiency (tangible benefits)*, in this context, is defined as the rate at which inputs are converted to outputs (doing things right). Efficiency is financially measurable and is represented by money.

Although efficiency is equally important, P.J. Dick executives were much more interested in the *effectiveness* and *performance* areas when investing in their OCPM tool. They were not concerned about the hard numbers; on the contrary they really looked at the intangible benefits of their investment.

-Performance and Effectiveness-

2.1. Potential Benefits

P.J. Dick is a long-time user of the OCPM tool. P.J. Dick first decided to purchase the software as they started experiencing rapid growth in the late 90's and needed a project management tool that would help them manage the growth and set them up for the future. One of the main ideas behind this investment was gaining competitive advantage. In addition, the management team wanted to enhance their work processes while keeping a complete history of the project. Dennis DiPalma, OCPM administrator of P.J. Dick, says, *"The goal was to bring communication efficiency to our projects, especially to the ones as complicated as the CMU Collaborative Innovation Center."*

2.2. Realized Benefits

2.2.1. Gaining competitive advantage *(Performance):*

P.J. Dick believes that they have gained competitive advantage by utilizing the OCPM tool earlier than their competitors. The managers agree that having an OCPM tool in place is becoming a bigger topic of conversation with the owners; therefore it is becoming a larger part of P.J. Dick's sales presentations. From a new business standpoint, it is a huge plus to show what capabilities P.J. Dick can positively contribute to the owners beyond the standard way of thinking. Also, some sophisticated owners already demand the use of an OCPM solution for the execution of their projects. The use of these systems is increasingly becoming part of the criteria of selection – if not of requests for proposals – and a lot of contractors or construction managers are still not using anything similar to this technology.

2.2.2. More effective (higher) decision-making process *(Effectiveness):*

The tool helps P.J. Dick project managers to make decisions and/or to get an approval for an issue more easily as all the project information is at one place, organized and accessible from anywhere. Although John King of J.J. Gumberg mentions that none of the executive committee used the tool, he agrees that the tool makes the job go as smoothly as possible: *"The information is available and understandable and makes the processes go efficiently. It is so much better than waiting for the telephone call. It makes the entire process more efficient."* He adds, *"The sooner you can get the information in front of the right people the better you get them prepared for your next discussion as far as resolving a problem."*

The water line situation in the CMU project is a good example. In that case, the architect was responding to several RFIs, issuing sketches, getting different schemas for revisions in front of the parties (the architect, engineers, owners, GC, some contractors, geotechnical services, and Pittsburgh's water and sewer authority), and everybody was able to conveniently print the information at their desk and make decisions. The tool helped different groups to be on the same page for a fast resolution. Also P.J. Dick managers were able to get different information that was required to help them make a decision and also to get it approved by the owner.

2.2.3. Complete record of project information in case of construction disputes *(Effectiveness):*

The tool certainly provides P.J. Dick an accurate source for documenting events. According to John King, with 30 years of experience in construction, it is hard not to have any unpleasant experiences during construction. He says, *"There are all kinds of things that can happen; litigations or weak memories. It is always good to have good record keeping. The CMU project has been a very smooth project. But if there would be a structural problem 5 years from now, we would be able to go back and see if there were any questionable methods of doing something."*

This means that, in case of any claims or disputes, P.J. Dick doesn't have to go back and spend a lot of time trying to research their archives or the email files of their employees. Dennis DiPalma asks, *"What if the key personnel to solve the problem left the company?"* If all the information is in the system, it is documented and nothing can be deleted. From the owner's point of view having access to all project information is also crucial. For example, although the owner doesn't usually get involved with the RFI process directly, they would have access to all modules and could track any RFI in case of any disputes.

2.2.4. Speedy and effective communication *(Effectiveness):*

Increased speed and effectiveness of communication among the team players as well as within the executive team is another benefit that P.J. Dick has realized in their projects. Project teams believe that their jobs' schedules have improved due to the quick turnaround of questions and easiness of information transfer. John King, CMU project developer for J.J. Gumberg, explains the necessity of the tool: *"These tools were critical to be on time. Our time frame for this project was very compressed in terms of meeting major goals. Without this tool, answering questions, getting information back and forth when people needed to, would be painful."*

2.2.5. More efficient working means and methods *(Effectiveness):*

P.J. Dick's processes have changed from emails and faxes to OCPM software, which is a huge benefit itself. There is obviously reduced paperwork and people are able to share information through a web-based application. In the CMU Collaborative Innovation Center project, every email and piece of paperwork went through the OCPM tool. Brett Pitcairn, the CMU project PM, says, *"Construction is becoming more fast-track on every job, I can't imagine project management only using faxes and conventional letters."*

2.3. In the Absence of the OCPM Solution

If P.J. Dick didn't have the system in place, they would lose (1) their decision-making advantage, (2) the ability to fast-track information in and out between contractors and subcontractors, (3) the ability to get the information in front of the right people immediately, (4) standardization throughout their projects, (5) the level of communication, (6) a lot of operational capabilities. Dennis DiPalma confirms, *"The people would be spending more time on managing the paper than managing the projects."* Brett Pitcairn adds, *"If we didn't have the system in the CMU project, we would lose our ability to maintain the tight schedule. It helps us to expedite compared to traditional methods."*

2.4. Quasi-tangible Benefits' Ranking

Besides interviews, an electronic survey of quasi-tangible benefits was designed and distributed via email to all interviewees to measure the improvement in a more consistent and less subjective way. The aim of the survey was to uncover as much information as possible and to quantify quasi-tangible benefits of OCPM technology investments. Each respondent received the identical set of benefits, phrased in exactly the same way in order to reduce errors resulting from the recording of responses, and the respondents were free to rank the benefits according to their relevance at responder's own pace. The survey covered several benefits that were stated during the interviews. The responders were asked to rank the benefits 1 through 5 (where 5 is *'very high'*, 4 is *'high'*, 3 is *'neutral'*, 2 is *'low'* and 1 is *'very low'*). Benefits and values ranked by P.J. Dick case interviewees can be seen in the table below.

Benefits/Values	A*	B*	C*	Ave.	StnDev
- Improved process automation (RFIs/COs, automatic updating of master budget, etc.)	5	5	4	4.7	0.6
- Provided accurate and timely information to give valid/accurate decisions	4	5	4	4.3	0.6
- Enabled fewer information bottlenecks	4	5	3	4.0	1.0
- Improved information management	4	4	4	4.0	0.0
- Improved data availability	5	5	2	4.0	1.7
- Enhanced working within virtual teams	5	4	3	4.0	1.0
- Improved timely capture of design/ construction decisions	4	5	2	3.7	1.5
- Enabled faster reporting and feedback	4	4	3	3.7	0.6
- Reduced personnel costs due to improved efficiency	4	4	3	3.7	0.6
- Enabled having complete audit trail	5	4	2	3.7	1.5
- Improved idea sharing among team members/within organization	3	5	2	3.3	1.5
- Improved project relationships with strategic partners	3	4	3	3.3	0.6
- Enabled better project/program control	4	4	2	3.3	1.2
- Enabled better resource allocation; more effective assembly of project teams	4	4	2	3.3	1.2
- Enabled better forecasting and control	4	4	1	3.0	1.7
- Improved quality of the output	4	4	1	3.0	1.7
- Minimized project/business risks	4	4	1	3.0	1.7
- Enabled advance purchase of materials	3	4	1	2.7	1.5
- Reduced delivery lead times	3	4	1	2.7	1.5
- Reduced errors and omissions	4	3	1	2.7	1.5
- Enabled better inventory management	X	4	1		
- Enabled more effective identification and assessment of new suppliers	X	4	1		
- Enabled faster launch to market due to faster delivery	X	4	1		
- Improved public relations	X	5	1		
- Enabled quicker response to project status and budget	X	3	3		
- Improved information version control	4	X	X		
- Reduced rework/data reentry	3	4	X		

Table 1. Ranking of various benefits/values by interviewees (*The names of the respondents are hidden for confidentiality reasons. However, the respondents are managers of P.J. Dick and the users of the OCPM solution in the CMU Innovation Center project. "X" stands for when the question is not relevant or the responder doesn't know the answer.)

-Efficiency-

2.5. Request for Information (RFI)

There are 404 RFIs in the CMU Collaborative Innovation Center project, of which 387 are closed as of May 2005. The architect's office and P.J. Dick communicate the RFIs directly; there is no one in between to facilitate the communication. If a subcontractor needs information, they can send RFIs electronically, and if it is a valid question P.J. Dick creates a formal RFI. Only a couple of big subcontractors use the system for RFIs; the smaller ones still hand-write a question and fax it to P.J. Dick. however, it is worth mentioning that smaller subcontractors typically create a small percentage of RFI activity. There are 9 subcontractor RFIs stored in the system, 8 of which have been turned into formal RFIs. Insufficient information is the top reason for RFIs, and clarification is requested in most cases (figures 6 and 7).

2.5.1. Realized benefits of electronic RFIs:

Reduction of turnaround time:

The team agrees that there is no comparison between paper and electronic RFIs as long as the project team is involved with it. Electronic RFIs are so much faster and they enable instantaneous communication. Jack Jones, the CMU project superintendent, comments, *"There is no doubt the tool improves the RFI process. We used to have 12 days turnaround time but now it is possible within hours."* Average turnaround time in this project is 7.99 days based on a 7-working-day week. There are 45 RFIs with more than 21 days turnaround; if we don't include those in the calculation, the average reduces to 5.25 days.

Decrease in time spent on issuing an RFI:

Jack Jones agrees that if somebody asks him a question or if there is a conflict in the documents, it takes him a few minutes to get to his computer and type in the question. The architect gets instant notification and within a few hours the site may have an answer. He thinks this tool is helpful in processes like RFIs where there are many groups of people who need to be kept aware of the process at the same time.

Reduction in numbers:

The team doesn't believe there is an increase or decrease in the number of RFIs by using an OCPM system. Some in the industry believe that the level of RFIs will increase since OCPM systems make it easier to ask questions. However, Brett Pitcairn comments, *"RFIs are related to the quality of the documents. If someone has a question, he has a question."* P.J. Dick notes that there is not a correlation to the number of RFIs to the use of the system.

2.6. Change Orders in the CMU Collaborative Innovation Center Project

P.J. Dick typically identifies the cost events early on in the project when there is a potential situation on site. Cost events are the initial indication of a potential change to the project; they might or might not evolve into a legal change

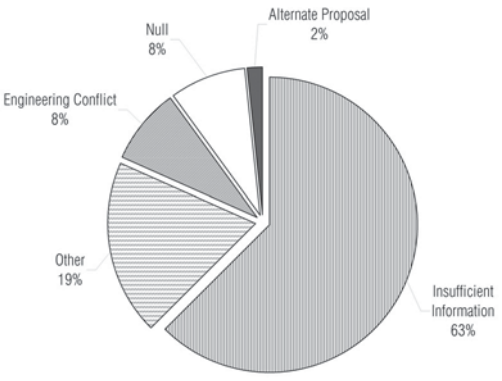

Figure 6. Reasons for request

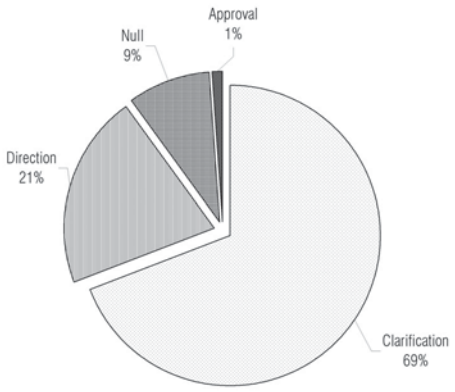

Figure 7. Action requested

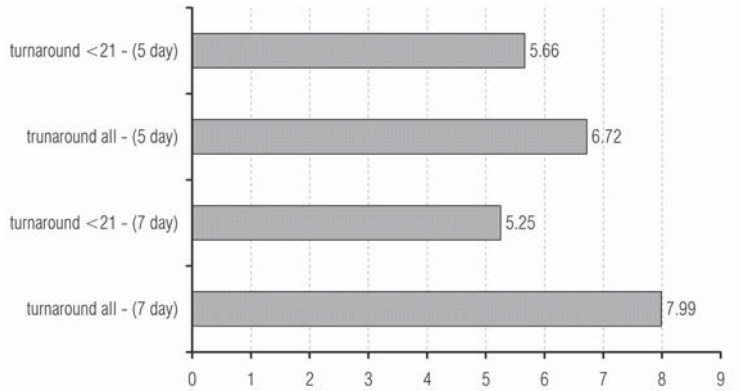

Figure 8. Average turnaround time of CMU Collaborative Innovation Center project RFIs (turnaround<21 is based on 357 RFIs)

order. This change could be an internal change or could be submitted to the client. Both types may be tracked as cost events. The cost item is the detail item on cost management documents that relates a budget code, a company, and units/dollars. For example, the "items" on a cost event are cost items. Likewise, the "items" on a purchase order (PO) are cost items. Typically, cost items are created only as a by-product of other processes. There are 122 cost items in the CMU Innovation Center project as of May 2005. There are 19 Request for Change Orders (RCOs) and 69 contract change orders (CCO) in the project. Purchase orders are not used extensively in this project.

The change order module is very important for P.J. Dick because they have a GMP contract and accurate and up-to-date information is highly critical. In a typical job the CM would be in control of expenditure of contingency methods. In this particular situation the owner controls the contingency. Therefore, speed is crucial and the OCPM tool is the prime way to achieve that. P.J. Dick usually pulls up the change order and sits down with the owner – who would typically be excluded from this process – on a monthly basis in order to decide. Brett Pitcairn agrees, *"The tool helped because at the end of the project all the information is accurately tracked so there were no surprises. During the project, we were all prepared for what to expect before coming to the meetings."*

2.7. Other Utilized Modules

The RFI and change order modules are only two of the several modules utilized in the CMU Collaborative Innovation Center project. In addition, document and cost management functionalities are utilized extensively. Most of the documents are in their native format except the architectural drawings, which are transferred and stored in pdf format, but they can still be viewed, reviewed, and marked up. Documents stored and their quantities are listed in figures 4 and 5. Attachments of these documents and their quantities are shown in figure 9. Almost all communication and document transfer has been electronic in this project unless a document is: (1) a document requiring legal signatures and legal stamps such as change orders and/or shop drawings, or (2) a physical submittal – in which case the submittal form is created and stored in the system. In any of these cases the documents are sent by FedEx.

2.7.1. Paper reduction:

Estimating the reduction in printing and copying is a challenge, because most of the parties print the documents, either to have a record or back-up for internal systems or to communicate with upper management as they are not usual users of the tool. Brett Pitcairn comments, *"At some point they want to be paperless, but it is years away. There are still some executives who want to see information in paper, and there are still some subcontractors who are not technology-savvy."* We can assume from the data gathered through the interviews that 50% of the documents are printed for the reasons above.

In all, we know there are 4407 documents (assume 1 page) + 413 documents with attachments (assume 2 pages).
Total number of pages =
4407 + (413 x 2) = 5233

Assume 50% of documents do not need to be printed
5233 x 50% = 2616 pages

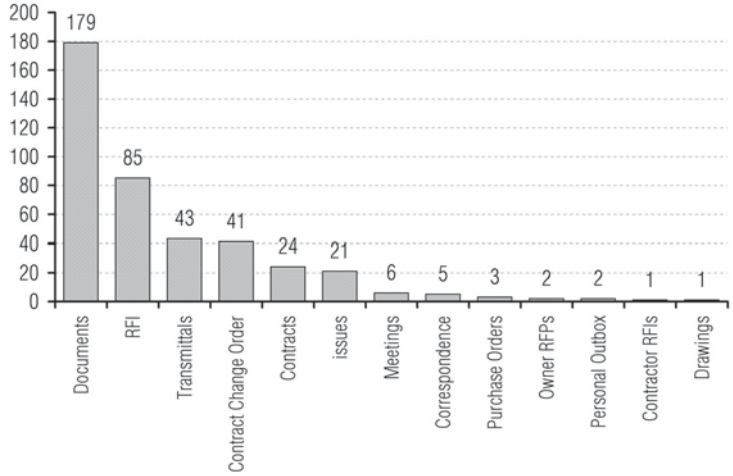

Figure 9. Documents with attachments in CMU Collaborative Innovation Center project

Assume at least 3 parties would print if the system wasn't implemented
2616 x 3 = 7849 pages of document

Assume printing cost $0.1 per page
$0.1 x 7849 = $785 per project
Assume 3/4 of the documents don't need to be mailed due to efficient electronic transfer and mailing cost $1 per envelope on average
$1 x ¾ x 5233 = $3925 per project

TOTAL SAVINGS:
3925 + 785 = **$4710** per project ~ **$47,100** for 10 projects

3. FUTURE OPPORTUNITIES

P.J. Dick is going through an optimization. Their policy is to generate all official communication through the OCPM tool. As of July 2005, P.J. Dick has completed the implementation of the document management (correspondence, daily reports, design review, documents, issues, meetings, permits, punch lists, RFIs, submittals, and transmittals) and bid management modules and they are in the process of training internal users for cost management (budget, cost events, cost items, RFQs, change orders, contracts, invoices, payment applications, bonds, insurance, contractor change orders). By September 2005, P.J. Dick will be able to conduct a new analysis for benchmarking. The team members cannot imagine going back to paper; they all agree that they have passed the learning process so they will be more comfortable and efficient in future projects. Dennis DiPalma adds, *"We have also been approached by a local masonry subcontractor to greatly expand their use of the OCPM tool with us. I expect our use of the tool on future projects will be much more effective than they were at the CMU Collaborative Innovation Center and we are already seeing it through our reimplementation process."*

4. BENEFIT/VALUE SUMMARY

Tangible, quasi-tangible and intangible benefits of the P.J. Dick case are summarized in the table below. Savings from the electronic document exchange are the base for the tangible benefits. The CMU Collaborative Innovation Center project is used as an example and the results are projected to 10 P.J. Dick projects. The electronic survey is used to quantify the quasi-tangible benefits (improvements) by ranking. No performance (intangible) benefits are observed in this OCPM implementation. Upon the request of the investor, the cost of the system is kept confidential.

Types of Benefits	**Measured Benefits**
Tangible	**$47,100** annual (for 10 projects)
Quasi-tangible	Survey: **3.5/5** (20 benefits identified out of 27)
Intangible	**1 identified**: gaining competitive advantage
Cost of the system	Confidential; not released

INTERVIEWEES

- Brett Pitcairn, CMU Collaborative Innovation Center Project Manager, P.J. Dick Incorporated, 03/07/2005, 05/25/2005
- Dennis DiPalma, Site Administrator, P.J. Dick Incorporated, 03/16/2005
- John King, CMU Collaborative Innovation Center Developer, J.J. Gumberg, 03/11/2005
- Jack I. Jones, CMU Collaborative Innovation Center Superintendent, P.J. Dick Incorporated, 04/25/2005
- William Widdoes, CMU Collaborative Innovation Center Project Coordinator, Regional Industrial Development Council of Southwestern Pennsylvania, 04/27/2005

CASE STUDY 9. TRM HEALTHCARE

1. INTRODUCTION

This case study focuses on identification and measurement of the value of online collaboration and project management (OCPM) technology from a private owner's point of view. The case covers tangible and intangible benefits/values at both the project and the organizational level. The following subsections give a brief description of the owner's business and outline the need, selection and implementation of an OCPM tool in an internationally known health care organization; TRM Healthcare. A project of TRM Healthcare is examined to identify and quantify the OCPM tool's value.

1.1. TRM Healthcare

TRM Healthcare (TRM) is a broad-based health care company that discovers, develops, manufactures and markets products and services that span the continuum of care from prevention and diagnosis to treatment and cure. TRM's principal businesses are global pharmaceuticals, nutritionals, and medical products, including diagnostics and cardiovascular devices. TRM serves customers in more than 130 countries, with a staff of 55,000-plus at more than 120 manufacturing, distribution, research and development, and other locations around the world. Construction is an ongoing activity in TRM as the company is growing, and laboratories and manufacturing facilities are needed to meet research and development needs. There is always a need for renovations to existing facilities or construction of new research-related and/or production facilities for manufacturing pharmaceutical materials. TRM has approximately 100 engineers in their global engineering organization to manage their construction projects.

1.2. The Need for an OCPM Solution

TRM usually assigns a construction manager (CM) to monitor and control a project. The information flows through the project engineer (PE), who sorts out the information and provides it to the CM and also to the rest of the team. Historically, the process has centered on the PE, which has been an inconsistent and time-consuming arrangement. Having several projects going simultaneously in different parts of the world, TRM realized that they would (1) gain efficiencies if there were a system in place that worked as a central repository for documents/drawings and relieved the PE of the responsibility to be a facilitator. This way (2) the architect/engineer (A/E) and CM as well as the rest of the team could communicate directly and more openly.

In addition, (3) better allocation of the information and (4) the ownership and security of the project information have been very critical for TRM. The main idea in utilizing an OCPM tool was to enable extensive collaboration for the team members while providing access to information and maintaining a complete record of what was done by whom and when. Improved design collaboration with version control, smooth information flow, dynamic routing of documents, notifications, and audit trails for documentation and viewing were among TRM's goals. Getting the current versions of the drawings and improving the review and turnaround time of the drawings were important because TRM projects usually have strict deadlines and time to market is crucial. For all of these reasons TRM decided to search for an OCPM system for its projects.

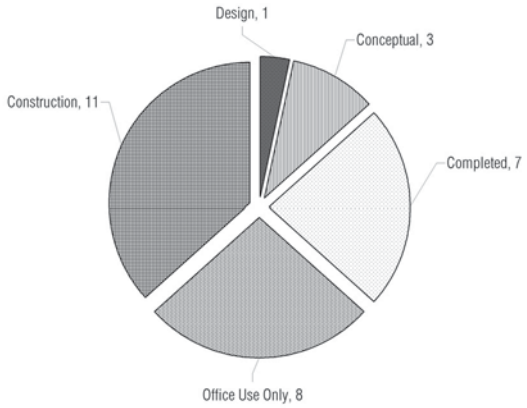

Figure 1. Status of TRM projects in numbers, as of March 2005

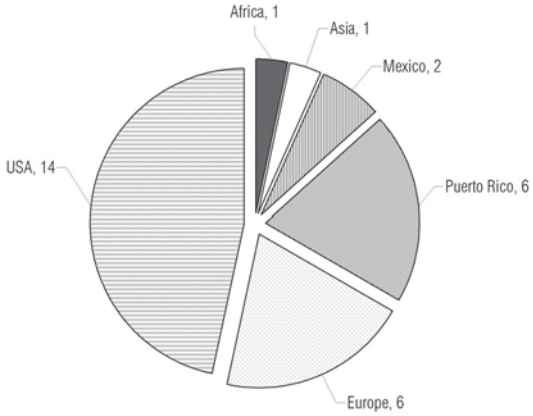

Figure 2. Locations of TRM projects in numbers, as of March 2005

1.3. OCPM Technology Selection

TRM followed a comprehensive method for selection the best OCPM solution for their business. First, a committee of 10-12 people identified the capabilities they were seeking from the software. Among these were: global 24/7 access to all project documentation by all project participants, standard templates for key project documentation, collaborative redlining and meeting tools, multiple levels of security, dynamic routing of documents, notifications of routing bottlenecks, version control, and audit trails on documentation and viewing. The committee considered six vendors and narrowed the selection to three. These three technology providers presented their products and provided hands-on demonstrations. Three groups of architects, general contractors (GCs), and CMs used the products to evaluate how the system would work in communication between these three groups. They evaluated ease of use, ability to sort and red-line drawings, keeping track of who did what, as well as features such as request for information (RFI) and cost management modules. At the end of these demonstrations and the trial period, the committee chose Constructware because it was the most easily accepted and easily learned tool.

1.4. The Cost

The contract was negotiated on a high level and signed for one year and then extended to three years. TRM has an unlimited user agreement with internal and external clients and unlimited file storage space. TRM entered an additional 5 year agreement with the vendor in July 2005, through 2010. The cost of the system is considered as confidential, therefore not included in this case study.

1.5. Implementation

TRM first developed and reviewed the implementation checklists, defining what modules would be used and how. TRM covers the cost of the system and provides access and training to all project participants. The vendor helped in the initial training of TRM personnel, who took over the training sessions as new members were added to the project teams. TRM also assigned an administrator, who is responsible for providing assistance both to TRM's internal users and to the external ones such as consultants, GC, A/E, and CM firms. Implementation was followed by identification of an application sponsor on a team and defining the processes and procedures of the project. TRM-wide rollout happened in October 2002.

As of March 2005, there are 30 projects in the system; 7 are completed (figure 1), and 16 are overseas (figure 2). There are 995 active users who currently have access to these projects. An initial study conducted by TRM in January 2004 shows the total number of logins in the first 15 months (figure 3) and the total number of files posted in the first 14 months (figure 4). Although the level of use improves day by day and TRM strongly encourages the teams to use the system, there are still projects managed by traditional methods. In TRM projects, the more complex and larger the project, the more likely that it will be handled by the OCPM system. It has been 2.5 years since TRM started using the system locally and globally, including in several cities in USA, Europe, and Africa.

1.6. Methoda Manufacturing Facility

TRM Research Center is a biotechnology drug discovery and biologics manufacturing unit of TRM. The 440,000 sq ft facility is located 35 miles west of Methoda on a 30-acre landscaped site and provides work space for 685 employees. The rationale behind research and development programs at TRM and TRM Research Center represents a paradigm shift in how innovative medicines are discovered and developed. In 2002, TRM announced plans to expand its US biologics manufacturing facility in Methoda, primarily for the anticipated future manufacturing of a drug that was invented in TRM's Methoda laboratories. This expansion project was part of the company's plan to ensure long-term production capacity for commercial biologic products. The $45 million project was to include the remodeling and expansion of the existing facility and would replace the research facility that is currently being used for manufacturing. The building was to include research laboratories and two 6,000-liter trains for manufacturing.

Project team members were directly contracted by TRM. Center Engineering Inc. (CEI) was selected as project engineer and Malkin Contractors (Malkin) as the CM and GC with a guaranteed maximum price (GMP) contract. The project started on September 2002 and is in its punch list stage as of March 2005. The scope of the project was changed during its execution; this was a business decision made by senior management. The original plan included both research labs and manufacturing facilities, but then it was changed to include laboratories only. When the decision was made to move the manufacturing portion of the project to another location, the research portion of the project moved forward, becoming phase I. The original plan to build manufacturing facilities was redesigned as more research labs, becoming phase II. The first phase ended in March 2004. The second phase started in March 2004 and ended in December 2004. The project was completed later than it was scheduled due to the project scope change.

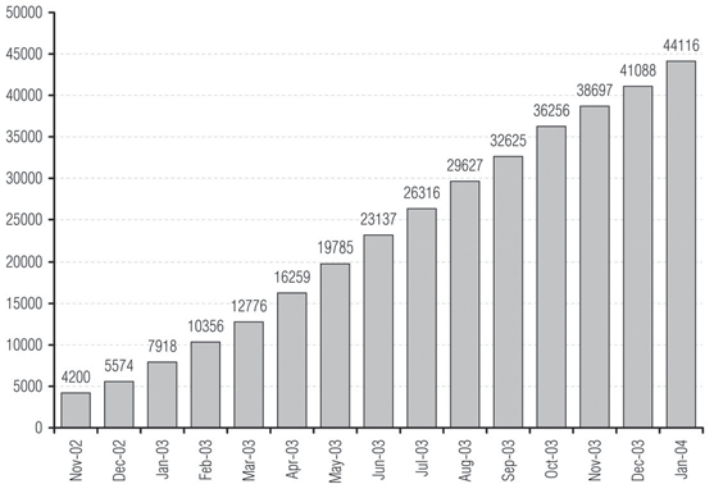

Figure 3. Total number of logins, November 2002 through January 2004 (after TRM, 2005)

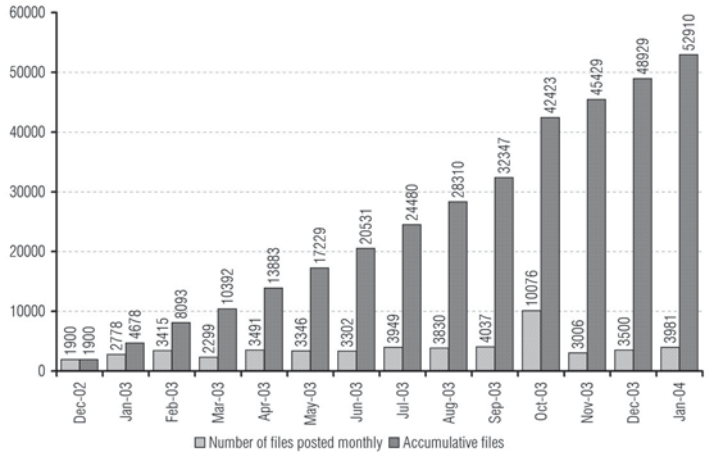

Figure 4. Total number of documents posted, December 2002 through January 2004 (after TRM, 2005)

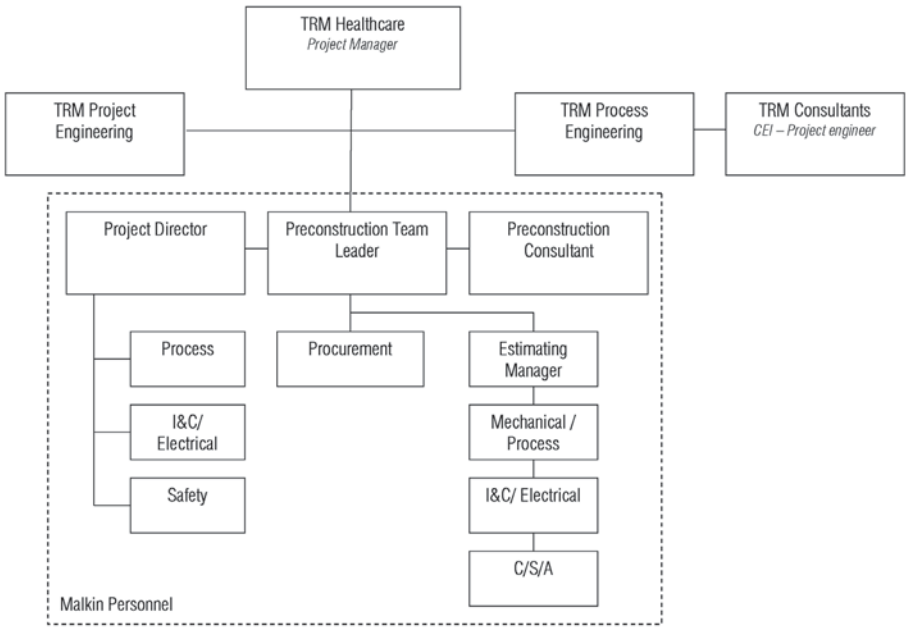

Figure 5. Methoda project organizational chart

1.7. The Use of the OCPM Solution in the Methoda Manufacturing Facility Project

The OCPM tool was presented to this project in 2002 by Harold Heit, TRM manager of project engineers. The main users of the tool were Malkin (CM & GC), CEI (project engineer), and TRM (owner); it was stated in Malkin's and CEI's contracts that they had to use the system. Subcontractors and suppliers used the system throughout the project execution if they were on the project schedule for a significant amount of time, and their membership was deactivated once their involvement in the project was over. The rest of the subcontractors' and suppliers' company names appear in the tool for the purpose of daily construction reports, and for contact information such as business addresses, phone numbers, fax, email, etc.

The tool has been used primarily for RFIs and submittal processing, meeting minutes, file sharing, daily construction reports, transmittals, and as a repository for drawings. Although the team used the tool to post drawings, they didn't use it for drawing reviews because they didn't find it very effective when they needed to flip back and forth between different drawings. The team agreed that it is much easier to do this on a drawing table with full-size drawings than electronically. This decision was also affected by unsuccessful use of online drawing review tools in the past. The team didn't utilize the change order module; because Malkin had their internal tool for managing changes and they wanted to keep using it. Since this was the first project, TRM chose not to include any cost modules for ease of

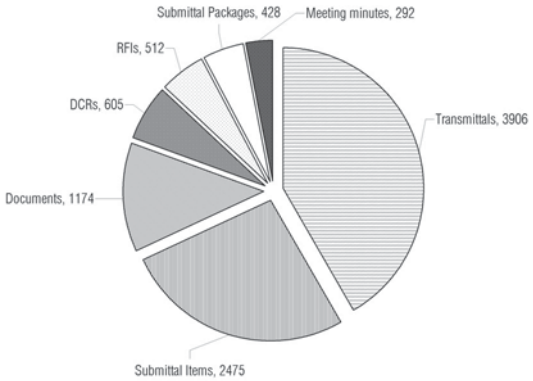

Figure 6. Most-used modules and number of stored documents in Methoda project

implementation. There have been 169 users on this project. The total size of the documents stored is 1,397,084 KB.

2. BENEFIT/VALUE ANALYSIS

In order to measure benefits, we need to understand the business of the investors and what they are seeking from their investment. There are three main questions: (1) Who are the investors and what values would they like to get out of their OCPM technology investments (potential benefits)? (2) What did they get from their investment in terms of benefits/values (realized benefits)? (3) What would they lose if they didn't implement these systems (lost opportunities)? When considering the implementation of a new system it is essential to understand whether you seek efficiency (tangible), effectiveness (quasi-tangible), or overall business performance (intangible) benefits, or which combination of these.

For our purposes the benefit/value analysis is based on three factors: effectiveness, efficiency, and performance. In the scope of this case study only effectiveness and efficiency will be discussed, as no performance areas are discovered. *Effectiveness (tangible benefits)* is the ratio of achieved outputs to planned outputs (doing the right things): the ability of a program, project, or work task to produce a specific desired effect or result that can be measured. It is performing the right tasks correctly, consistent with organizational mission, vision, values, and in support of the organization's goals and objectives. *Efficiency (quasi-tangible benefits)*, in this context, is defined as the rate at which inputs are converted to outputs (doing things right). Efficiency is financially measurable and is represented by money. We will discuss and quantify the benefits in the efficiency area in the following section. *Performance (intangible benefits)* is not directly measurable in quantifiable terms but is judged qualitatively on the basis of the impact of a successful implementation on long-term business performance and market share.

- Effectiveness-

2.1. Potential Benefits

TRM had three business drivers when they decided to implement a global cross-divisional OCPM solution in their construction projects. These were improving (1) globalization, (2) speed to market, and (3) quality and compliance standards in TRM projects. Harold Heit, manager of project engineers at TRM, says, *"We needed to improve our communication and collaboration. We have several international projects, and our key driver is getting the current versions of the drawings and improving the review and turnaround time of the drawings. Our initial implementation reason was improving the design review collaboration."*

The main goals in utilizing the OCPM tool in TRM projects were to facilitate the communication between project participants and to have every communication, document, and piece of project information reported. The OCPM tool was intended to be the primary communication tool between the CM and the project engineer from the project's inception to completion. This effective communication would enable TRM to (1) decrease project cycle time, (2) streamline and standardize processes, (3) manage and track project change effectively, and (4) capture project metrics and benchmarks.

2.2. Realized Benefits

2.2.1. Enhanced accessibility to project information *(Effectiveness):*

When the project team travels and/or is in a remote location or at home, there is no need to carry any computer or hard copies; anybody authorized can access the network and download the most updated project information wherever they are, as the entire project resides in the Internet. Accessing the internal TRM database was much harder before, one of the reasons TRM decided to go ahead with a pure web-based solution. This also provided a common archive for information that could be reviewed off-site and after hours by TRM engineers and individual contributors, which has been very valuable to the OCPM users. Kim Verdier, document control manager of Malkin, says, *"The fact that I didn't have to be on the site in order to do my function was great; I could take work in the weekends or at nights, just by having the computer at home."* Having a central repository for project documentation also gave the management team better monitoring and tracking for project changes.

2.2.2. Better archive of project information – dispute discovery and resolution *(Effectiveness):*

Having an archive of all communication and information is important in case of any reviews and/or construction disputes. TRM has been fortunate enough thus far to solve disputes in a timely manner, but if they needed to prove a point the OCPM tool would give them access to final documentation as well as the previous communication in a

structured and credible way. Michael McKay, Methoda project manager, says, *"I think the increase of communication and having an archive of all of this communication in case of reviews are important benefits of the tool. We didn't have any claims or a major problem that we had to go back and resolve. But if we did, if a document wasn't there it wasn't anywhere."*

2.2.3. Enhanced project communication and version control *(Effectiveness):*
In a construction project, it is important to make sure that all participants have access to the most updated documents to ensure that all parties are working from the same page and don't have to wait for the hard copies. With the use of an OCPM tool, everybody can have access to the latest documents and files at the same time from anywhere in the world (figure 8). TRM also believes that efficiency is gained by reducing the use of mailing. For example, TRM has a project in Africa; one of the issues they might have had if they had used Federal Express (FedEx) was waiting for customs approval to ship the drawings, which was delaying the process and adding complexity. Besides the savings in cost (efficiency), by utilizing this OCPM technology TRM saved an enormous amount of time – especially in international projects – by transferring and accessing drawings through the Internet.

2.3. In the absence of the OCPM solution
If TRM didn't have the system in place, they would (1) be spending more time, as the project participants might be wasting their time working on different versions of the drawings, (2) be spending a lot more money and time to ship drawings all over the world, (3) lose accountability and the accessibility of the information, leaving mediocre com-

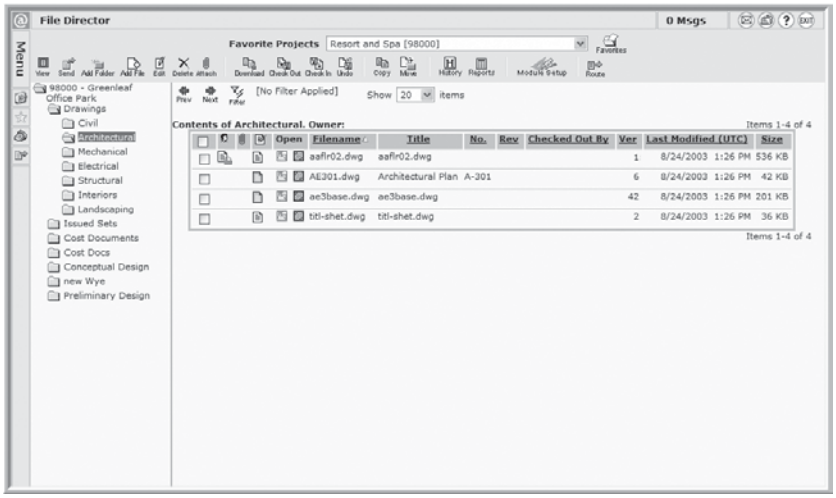

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Figure 7. Tracking items: This file is used to track action items: who is responsible, due date, and status. Multiple team members maintain this file. The entire team has access to it and is responsible for their respective disciplines.

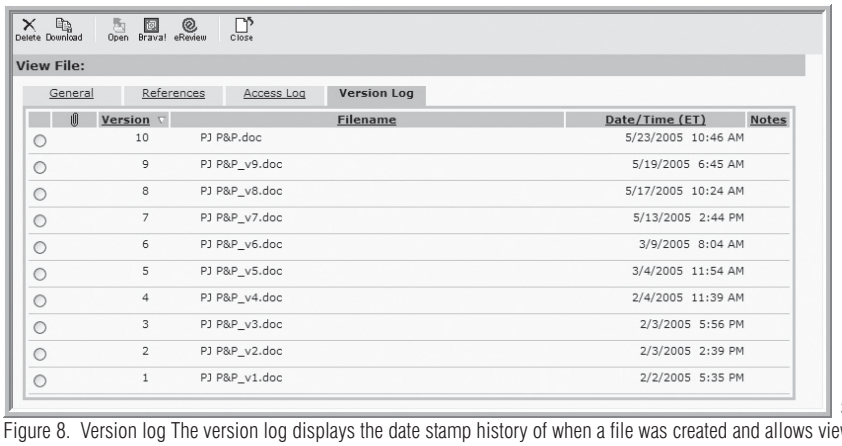

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Figure 8. Version log The version log displays the date stamp history of when a file was created and allows viewing and downloading of old versions. (Permission-driven.)

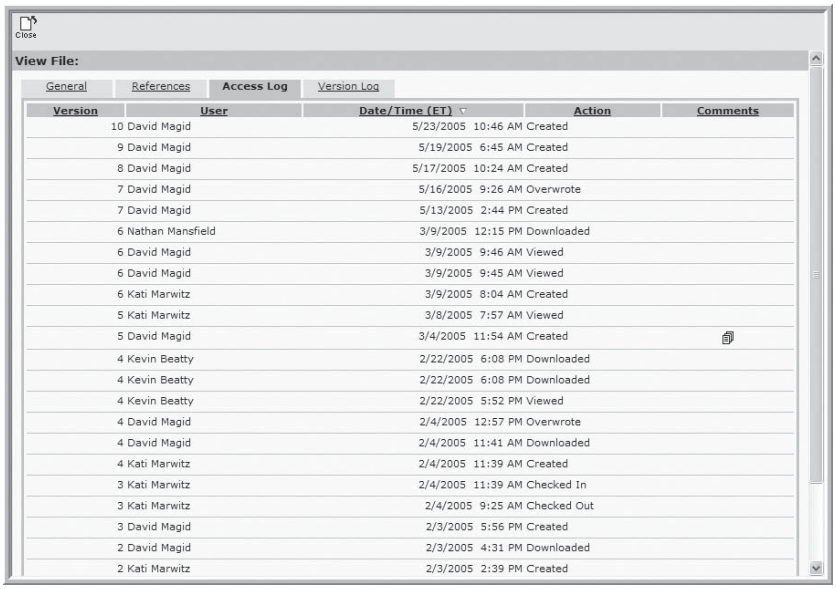

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Figure 9. Access log The access log displays the date stamp history of individuals and their action taken.

munication and less trust between their collaborators, and (4) lose the ownership of the data (and if the project went to litigation, getting the information from vendors would be extremely hard, as unfortunately TRM has experienced before).

Harold Heit, manager of project engineers at TRM, says, *"We would be back where they were. People would be looking at the drawings and each would be looking at different versions of the drawings. They would be spending a lot more money to ship drawings all over the country. And they would be spending a lot more time because not everybody would be looking at the same issue in the drawing."*

2.4. Quasi-tangible Benefits' Ranking

Besides interviews, an electronic survey of quasi-tangible benefits was designed and distributed via email to all interviewees to measure the improvement in a more consistent and less subjective way. The aim of the survey was to uncover as much information as possible and to quantify quasi-tangible benefits of OCPM technology investments. Each respondent received the identical set of benefits, phrased in exactly the same way in order to reduce errors resulting from the recording of responses, and the respondents were free to rank the benefits according to their relevance at responder's own pace. The survey covered several benefits that were stated during the interviews. The responders were asked to rank the benefits 1 through 5 (where 5 is *'very high'*, 4 is *'high'*, 3 is *'neutral'*, 2 is *'low'* and 1 is *'very low'*). Benefits and values ranked by TRM case interviewees can be seen in the table below.

Benefits/Values	**A***	**B***	**C***	**D***	**E***	**Ave.**	**StnDev**
- Improved data availability	5	5	5	4	4	4.6	0.5
- Improved process automation (RFIs/COs, automatic updating of master budget, etc.)	5	4	5	4	3	4.2	0.8
- Enabled having complete audit trail	5	4	4	5	3	4.2	0.8
- Provided accurate and timely information to give valid/accurate decisions	5	4	4	4	3	4	0.7
- Improved information management	5	4	4	4	3	4	0.7
- Enabled faster reporting and feedback	3	5	4	4	3	3.8	0.8
- Enabled fewer information bottlenecks	4	4	4	4	3	3.8	0.4
- Improved timely capture of design/ construction decisions	4	3	4	4	4	3.8	0.4
- Enabled better project/program control	4	4	2	5	3	3.6	1.1
- Enhanced working within virtual teams	5	2	3	3	4	3.4	1.1

- Improved idea sharing among team members/within organization	3	2	4	3	3	3	0.7
- Improved project relationships with strategic partners	3	2	1	4	3	2.6	1.1
- Enabled better resource allocation; more effective assembly of project teams	4	1	2	3	2	2.4	1.1
- Enabled quicker response to project status and budget	X	X	4	4	X		
- Enabled better forecasting and control	X	X	3	3	X		
- Improved quality of the output	X	X	3	4	2		
- Reduced errors and omissions	X	X	3	3	2		
- Minimized project/business risks	X	X	1	3	2		
- Enabled advance purchase of materials	X	X	2	2	3		
- Reduced rework/data reentry	X	X	2	4	2		
- Reduced delivery lead times	X	X	1	3	3		
- Enabled better inventory management	X	X	4	3	X		
- Enabled more effective identification and assessment of new suppliers	X	X	2	3	X		
- Enabled faster launch to market due to faster delivery	X	X	2	4	3		
- Reduced personnel costs due to improved efficiency	X	2	1	3	2		
- Improved information version control	4	X	3	4	4		
- Improved public relations	4	X	1	3	X		

Table 1. Ranking of various benefits/values by TRM case interviewees (*The names of the respondents are hidden for confidentiality reasons and to get more truthful responses. However, the respondents are managers of TRM and the users of the OCPM solution in TRM projects. "X" stands for when the question is not relevant or the responder doesn't know the answer.)

- Efficiency-

In this section we will investigate two potential savings areas: decreased processing time for documents and work flows, and electronic file transfer. In the first of these, we will demonstrate the benefits of the electronic request for information (RFI) process without displaying any monetary quantification. In the second, we will look at FedEx savings in just one project to demonstrate the impact of organization-wide savings.

2.5. Decreased Processing Time for Documents and Work Flows: Request for Information Example

RFIs were created by Malkin and directed to CEI directly in the Methoda project. No individual subcontractor had access to the RFI module; thus they were directing their questions to Malkin for formal RFI creation. There was a designated person to answer RFIs on the CEI side. This primary responder to RFIs would answer the question if he knew the answer or would discuss it over the hard copies with senior engineers in CEI. When he had a formal answer, he would go back to the OCPM tool and answer the question. This gave accountability to one person to answer the

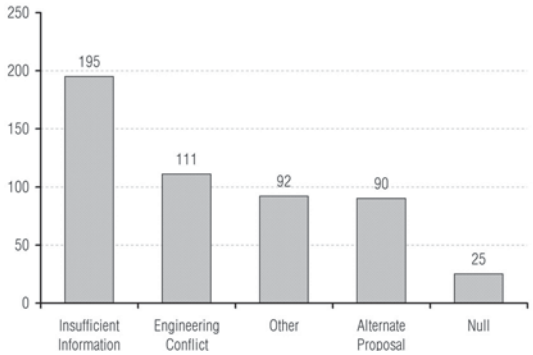

Figure 10. RFI reasons for request in numbers

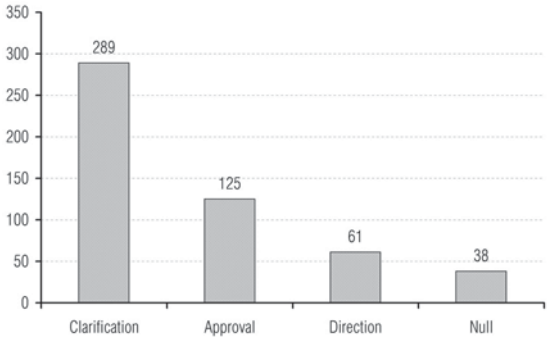

Figure 11. Action requested in numbers

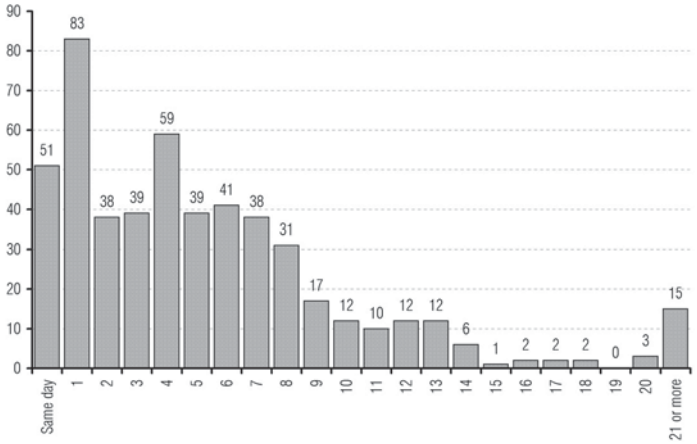

Figure 12. Methoda project's RFI turnaround time (based on a 7-day working week)

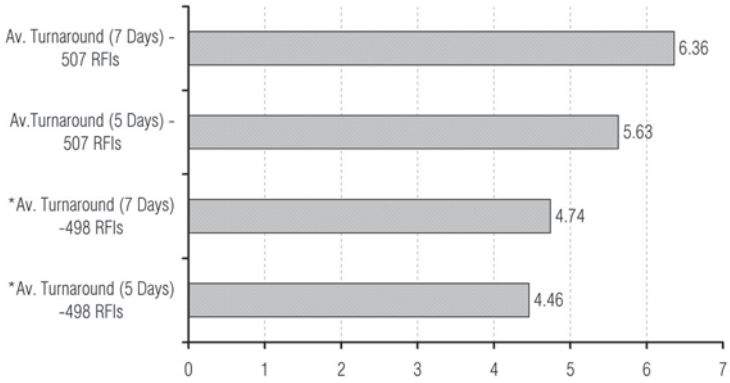

Figure 13. RFI turnaround time in Methoda project (*) 9 RFIs are omitted; turnaround time for these was 21-231 days

question, so he always had the final approval of what was reflected to the field. A total of 513 RFIs have been issued and 507 of them answered as of April 2005. Insufficient information, engineering conflicts, and proposals for alternative methods and materials were among the reasons for RFIs (figure 10).

The team acknowledges that the electronic RFIs are absolutely faster and more consistent than paper RFIs. TRM actually documented that before the program was implemented the RFI turnaround time (on average) was about *2 weeks*, whereas now it is around *2 days*. Actually this improvement in the RFI turnaround time was more than TRM initially expected. Michael McKay, TRM project manager, says, *"Somewhere along the line, shorter RFI turnaround time should improve the construction schedule and reduce the costs if you are receiving hundreds of RFIs and reducing the turnaround time to 2 days."* However, they also agree that the overall schedule of a construction project depends on several factors and that it is very difficult to prove the effect of reduced RFI turnaround time on project schedule.

The average turnaround time of 507 returned RFIs is 6.36 days based on a 7-day working week and 5.63 days based on a 5-day working week. In figure 13, it can be seen that the average turnaround time is 4.46 days if we don't include 9 RFIs which took exceptionally longer that the others. The team members agree that the number of RFIs in Methoda was more than usual because the CM did fewer phone calls for simple answers to questions, because, in fact, communication through the tool was more effective than phone calls.

2.6. Electronic File Transfer:
FedEx Savings

TRM calculated their savings from reduced FedEx costs in their international projects. The actual savings were more than they initially projected. As can be seen in figure 14, below, the design review process requires the attention of several parties. What happens usually is that the designer/engineer prepares the drawings and sends them to TRM by FedEx for review. TRM professionals review the drawings and make changes and/or add comments, then send them back to the designer/engineer by FedEx again. The designer/ engineer's team interoperates the comments and sends the final copy to TRM by FedEx, which is then sent to the construction site.
FedEx charges for 7 lbs between the destinations are stated below.

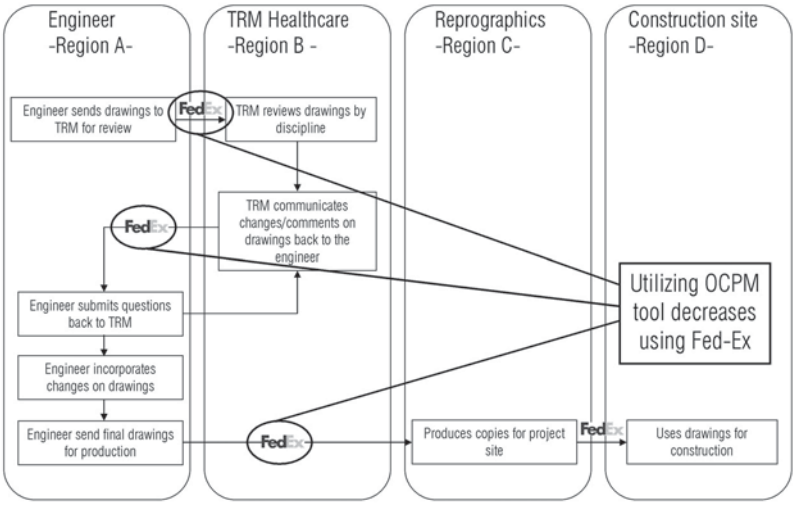

Figure 14. Drawing review process for Methoda project

	Next day	*2 day*
Region A to Region B	$ 54.34	$11.55
Region B to Region A	$ 54.34	$11.55
Region A to Region C	$70.61	$17.54
Total	**$ 179.29**	**$40.64**

We will assume that a package of 50 drawings will weigh 7lbs. The number of drawings posted on the OCPM tool for this project is as follows, with an estimate of how many packages would have been shipped had the drawings not been posted electronically.

	# of drawings posted	*# of packages shipped*
2nd quarter of 2003	6742	134
3rd quarter of 2003	6271	124
4th quarter of 2003	5428	108

Let's assume half of the packages are sent by 2nd day shipping and the other half by next day shipping. Based on these assumptions, the savings are shown in figure 15.
Total savings over a year and over three years for one project are as follows:

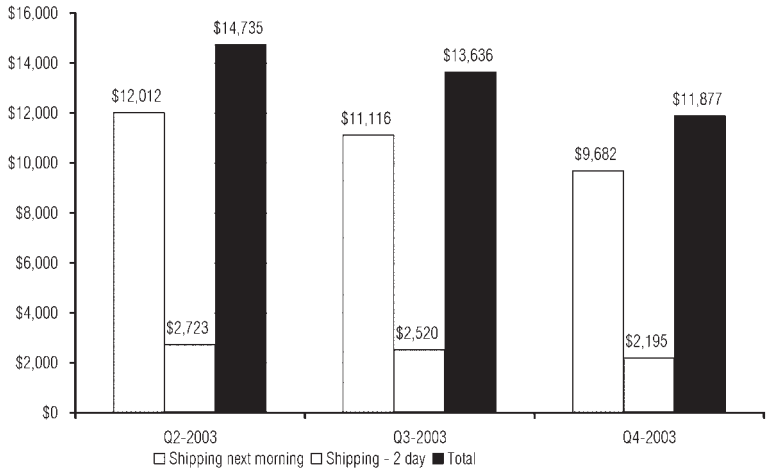

Figure 15. Estimated FedEx shipping charges

Total Savings:	
9 months	$40,248
1 year	$53,664
3 years	**$160,992**

We know TRM has 16 projects oversees that use the OCPM solution as of April 2005. If we assume that at least 10 of these projects will have a similar design review process and that it will last for at least a year, the savings will be around **$536,640** for 10 international projects.

3. FUTURE OPPORTUNITIES

TRM's intention is to continue to roll the application out. They have recently developed a communications specification that is the first in the industry to formally document and contractually bind all parties how to facilitate communication on a project; what modules will be used and how, according to the project stakeholders' roles. This specification has been included on 3 projects (and 7 organizations; AE's and CM's). Early indications show that this is proving to add tremendous buy in and adoption of OCPM solutions. In addition, TRM's next goal is to incorporate the cost management portion of the OCPM tool in more projects. As of September 2005, there are 2 projects that have fully implemented the cost modules now. TRM have also started development of accounting system integration in September 2005. TRM is also planning to integrate other TRM applications, such as other financial, contracting, and purchasing software, into the OCPM tool. By this integration, TRM is planning to eliminate double data entry. The use of the OCPM tool in other areas such as validation, capital planning, and facility management is being considered by top management.

4. BENEFITS/VALUE SUMMARY

Tangible, quasi-tangible and intangible benefits of the TRM case are summarized in the table below. Savings from the FedEx charges are the base for the tangible benefits. The Methoda project is used as an example and the results are projected to 10 TRM international projects. The electronic survey is used to quantify the effectiveness benefits (improvements) by ranking. No performance (intangible) benefits are observed in this OCPM implementation and the cost of the system is kept confidential upon the OCPM vendor's request.

Types of Benefits	**Measured Benefits**
Tangible	**$536,640** (annual FedEx savings for 10 international projects)
Quasi-tangible	Survey: **3.65/5** (13 benefits identified out of 27)
Intangible	Not identified
Cost of the System	Not released

INTERVIEWEES

- Harold Heit, Manager Project Engineers, TRM Healthcare, 12/06/2004, 02/15/2005
- James Kumar, Construction Administrator, Malkin Contractors, 03/16/2005
- Kim Verdier, Document Control Manager, Malkin Contractors, 03/14/2005
- Michael McKay, Group Leader-Process Engineering, TRM Research Center, 02/15/2005
- Richard Rege, Project Engineer, Center Engineering Inc., 01/13/2005
- Todd Wynne, Systems Administrator, TRM Healthcare, 02/18/2005, 03/16/2005, 05/17/2005

IMAGE CREDITS

Cover Image:
David Jason Gerber

Images 1 & 2 & 26 & 27 & 28:
Nationwide Building Society's knowledge management solution: TeamRoom

Image 3 & 24 & 25:
Nationwide Building Society's OCPM technology solution: WideXchange

Images 4 & 5 & 6 & 12 & 13 & 14 & 15 & 16 & 17:
ITG Group's OCPM technology solution

Image 7:
LAUSD anticipated cost report - Courtesy of Charlie Anderson

Image 8:
Atkins Management Consultants

Image 9:
Riverside Elementary School progress photos:
http://www.ips-cip.constructware.com/fsCurrentProjects.asp

Image 10:
Inscape's collaborative project management environment:
https://ourinscape.ebuild.ca/

Image11:
eReview feature from eBuild.ca's OCPM technology solution

Images 18 & 19 & 20:
Kitchell Contractor's OCPM technology solution

Image 21:
SmithGroup's website: http://www.smithgroup.com/

Images 22 & 23:
Manhattan Construction Company's OCPM technology solution

Image 29 & 30:
Davis Gardner Gannon Pope Architecture's website: http://www.dggp.com/

Images 31 & 32 & 33:
From 2004 Constructware user conference presentation

Publication of this book would not have been possible without the generous support of …

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