IDENTIFICATION AND MEASUREMENT OF ONLINE COLLABORATION AND PROJECT MANAGEMENT TECHNOLOGY VALUE

A Public Owner Perspective: 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[1] (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[2] (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] http://www.headlines.ips.k12.in.us/
[2] http://www.schmidt-arch.com/

Doctor of Design Candidate Burcin Becerik prepared this case study under supervision of Professor Spiro N. Pollalis as part of "Identification and Measurement of Online Collaboration and Project Management Systems' Value" study for research purposes and as the basis for class discussion than to illustrate either effective or ineffective handling of an administrative situation. The author would like to thank Brenda Havens, Debra Kunce, Jack Metcalf and Steve Spangler of Schmidt Associates, Steve Young of Indianapolis Public Schools, Joseph Uhlenhake of InterDesign and Marvin Baker of J. Beard Management/Geupel DeMars Hagerman Partnership for their assistance in developing this case.

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 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 quotation (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.

Figure 1. New elementary school

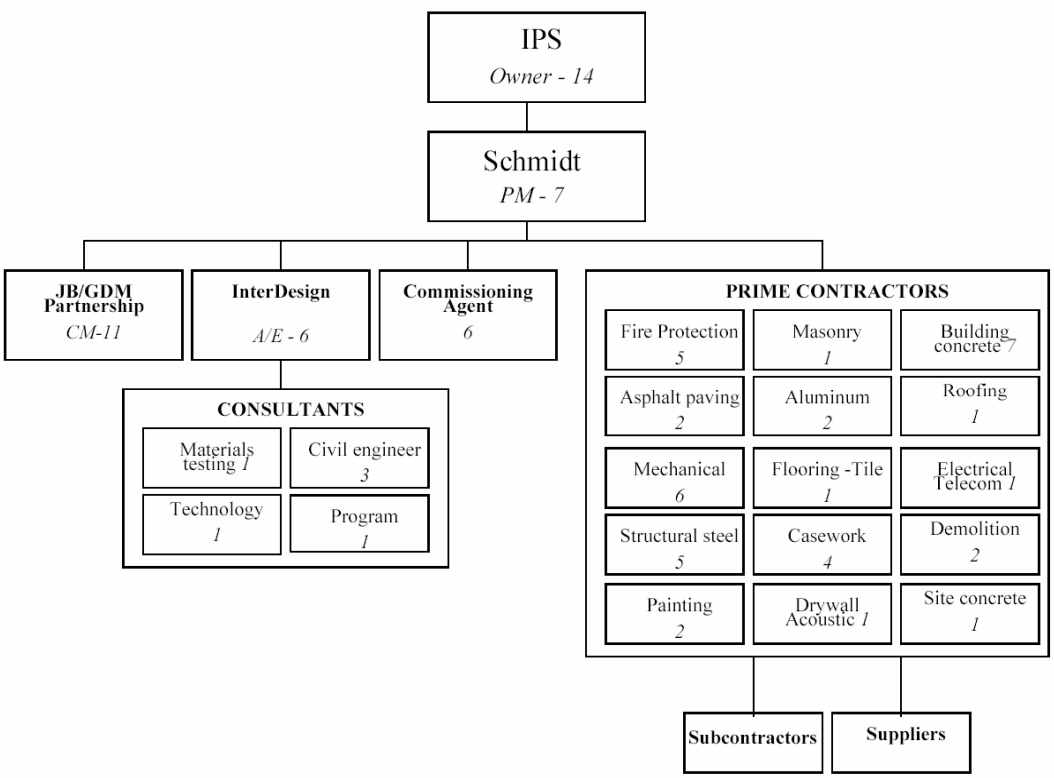

Figure 2. Project team organizational diagram and number of members that have access to the OCPM solution

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.**	**StnDev**
Enabled faster reporting and feedback	4	5	4	5	5	4.6	0.5
Improved information management	4	5	5	5	4	4.6	0.5
Enabled better project/program 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/accurate decisions	4	5	4	5	3	4.2	0.8
Improved process automation (RFIs/Change Orders, automatic updated master budget, etc)	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	4	4	4	4	2	3.6	0.9

* 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.

members/within organization							
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

-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 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).

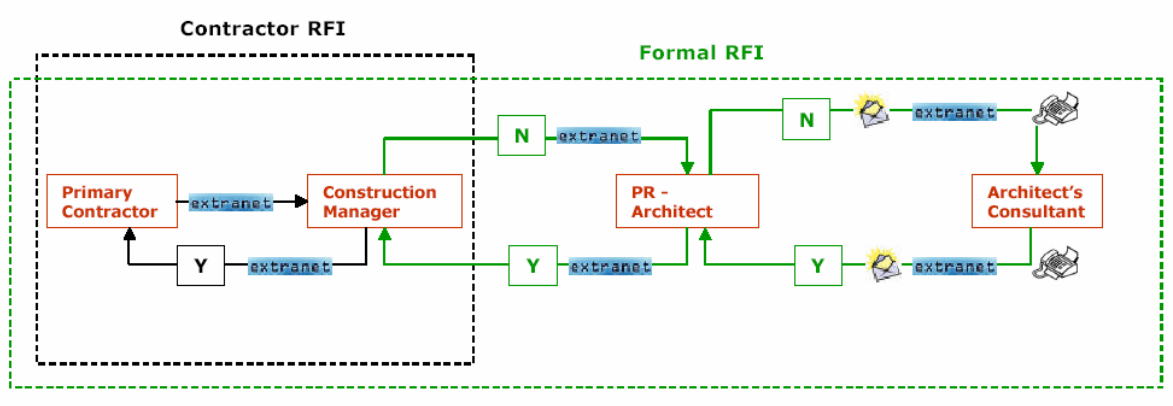

Figure 3. RFI process in IPS projects

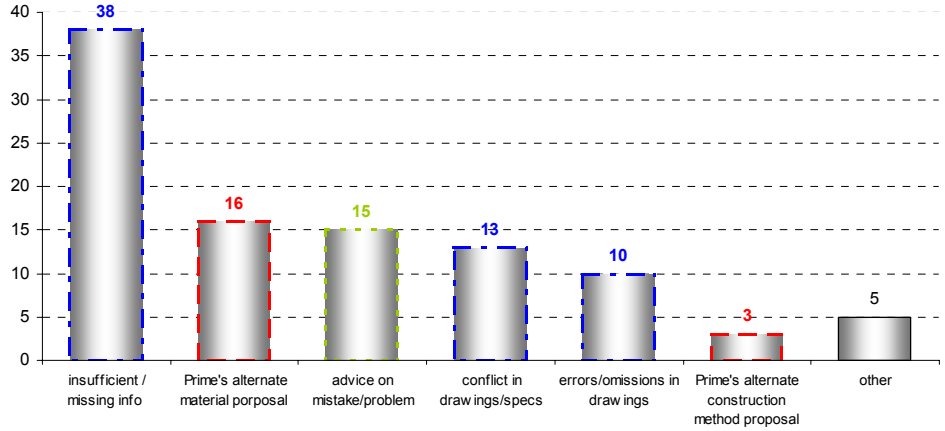

Figure 4. Reasons for RFIs in Riverside Elementary School project

2.51. 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.

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.

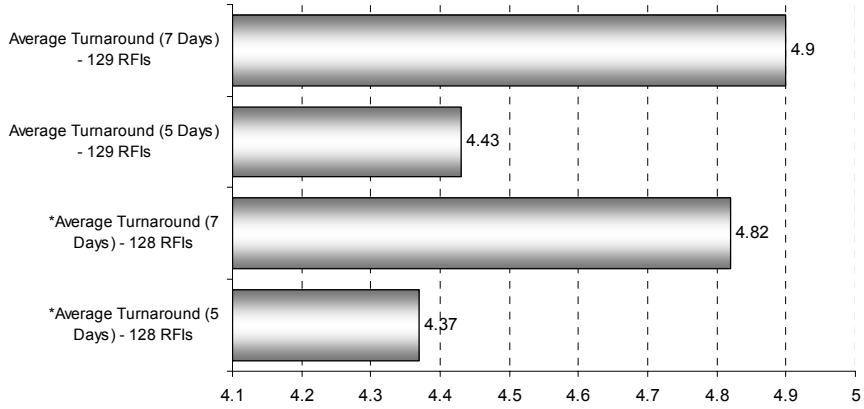

Figure 5. Average RFI turnaround times (* one RFI is omitted)

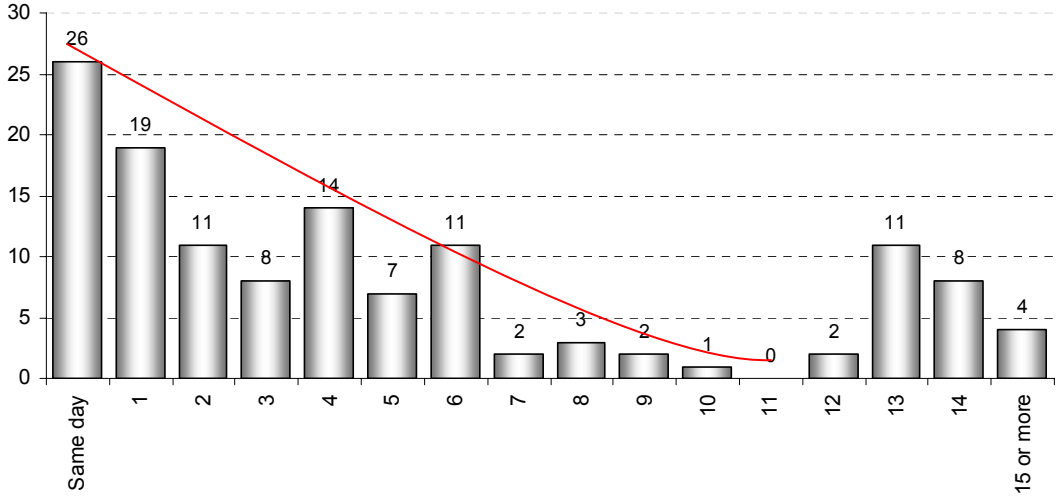

Figure 6. Number of RFIs and turnaround times *More than 20 days are omitted

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.

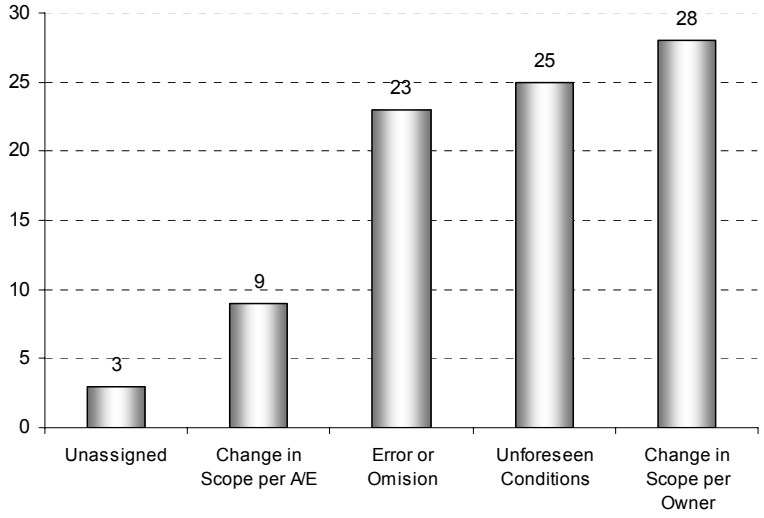

Figure 7. Reasons for change orders in Riverside Elementary School

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 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.

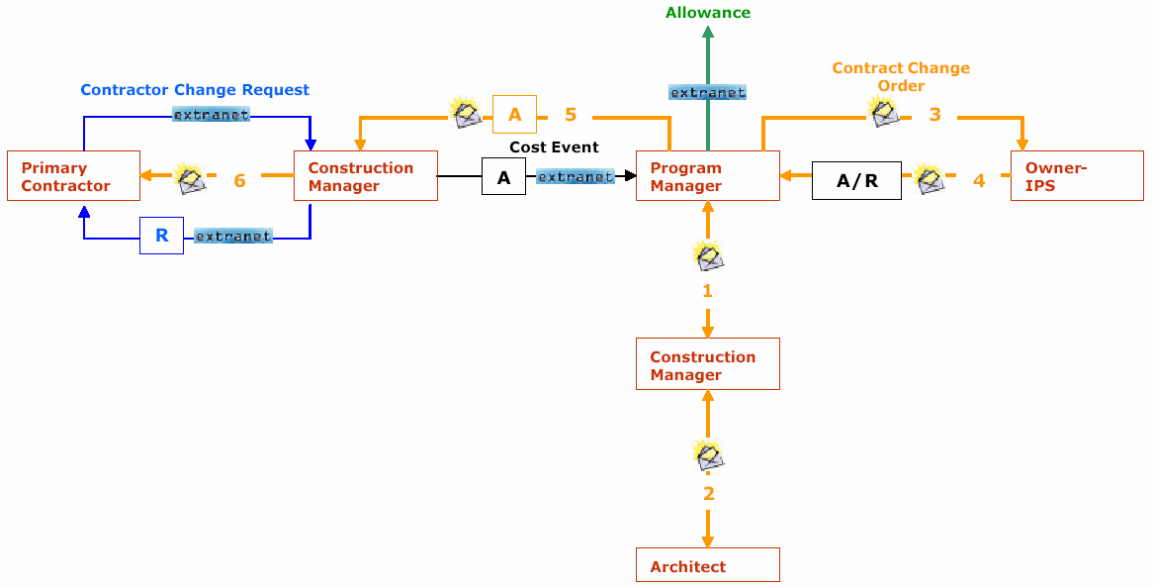

Figure 8. Change order process in IPS projects

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.

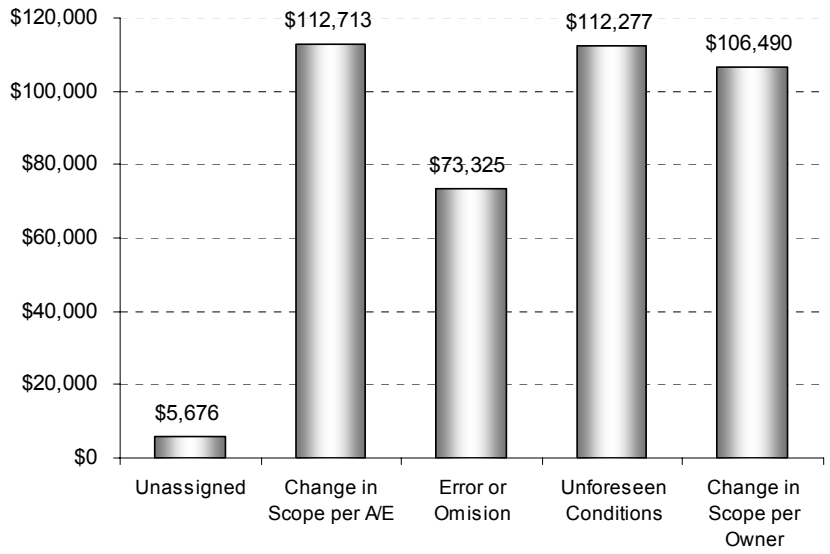

Figure 9. The cost of change orders categorized according to the type of change orders

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.

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

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

<u>Assume at least 3 parties would print if the system wasn't implemented</u>
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.)

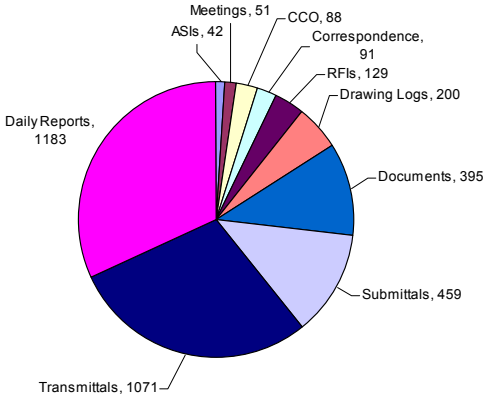

Figure 10. Stored documents in the system

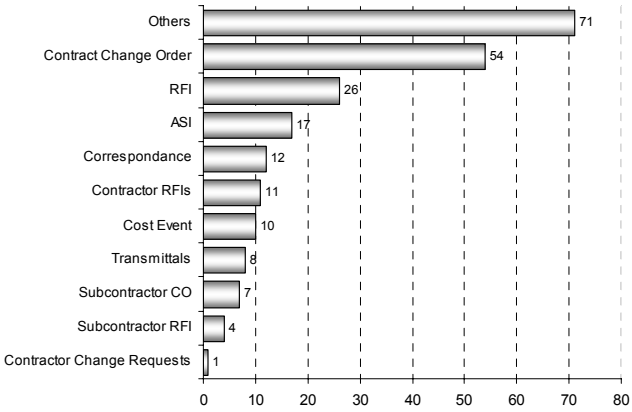

Figure 11. Number of documents with attachments

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