

IDENTIFICATION AND MEASUREMENT OF ONLINE COLLABORATION AND PROJECT MANAGEMENT TECHNOLOGY VALUE

A General Contractor's Perspective: 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 Company¹ (Manhattan), one of the four companies of Rooney Holdings, Inc.,² 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 Agency³ (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.,⁴ 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

¹ <http://www.mccbuid.com/index2.cfm>

² <http://www.rooneybrothers.com/home.htm>

³ <http://www.dia.mil/>

⁴ <http://www.smithgroup.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 Brian Killion and Mike Parkinson of Manhattan Construction Company, Michael Imbergamo of SmithGroup, Scott Grissom of Rooney Holdings and Tony Teritehau of EFA-CHES for their assistance in developing this case.

Services Administration's Construction Excellence Peer Program,⁵ 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 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.



Figure 1. Rendering of DIA Center addition

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.

⁵ <http://www.gsa.gov/Portal/gsa/ep/>

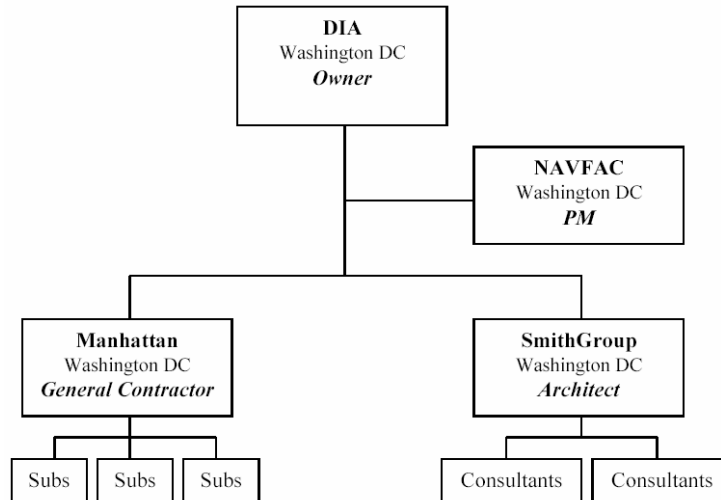


Figure 2. DIA Center addition project's organizational diagram

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 placed 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.

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.

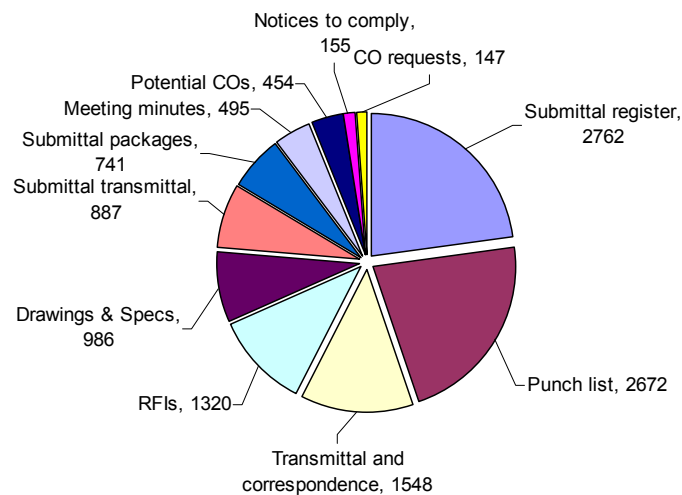


Figure 3. Document types and numbers posted on the OCPM tool

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/change orders, 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 | | |

* 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.

| | | | | |
|--|---|---|---|---|
| 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

-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.

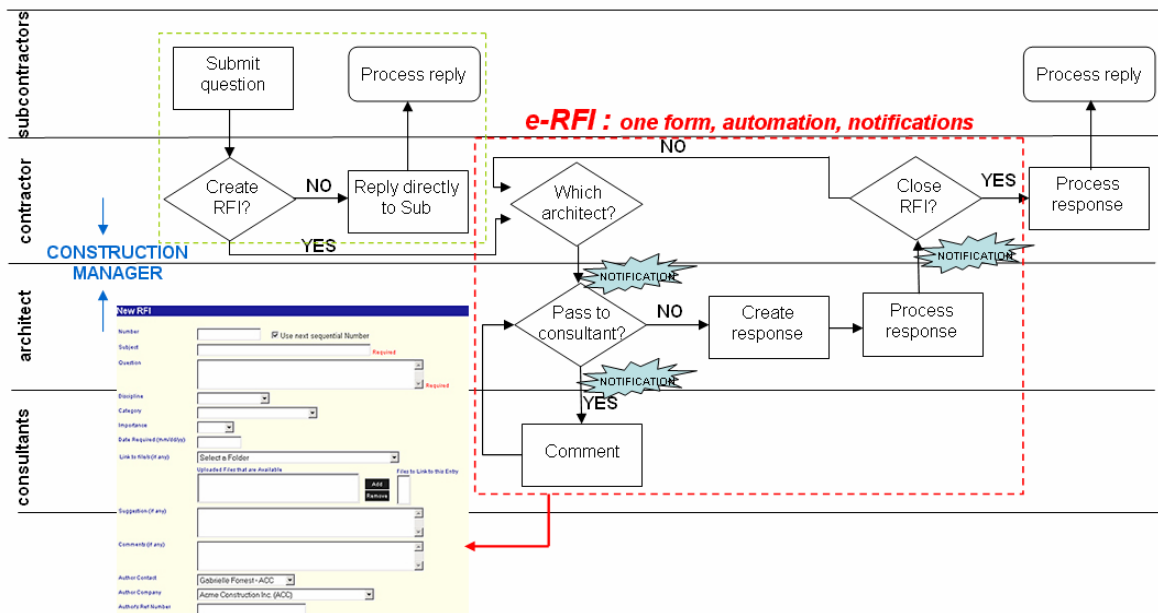


Figure 4. Manhattan’s e-RFI process

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 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.

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)

2.51. 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.”*

| Audit Trail | | | | |
|-------------|---|--------|--------|------------------|
| # | Description | Action | User | on |
| 1 | Request For Information: 1189 - Sprinkler / Smoke Detection at Elevators, Extended... | Update | MICIMB | 8/1/2005 2:16 PM |
| 2 | Request For Information: 1189 - Sprinkler / Smoke Detection at Elevators, Extended... | Update | ROMHAR | 8/1/2005 2:24 PM |
| 3 | Request For Information: 1189 - Sprinkler / Smoke Detection at Elevators, Extended... | Update | ROMHAR | 8/1/2005 2:25 PM |

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 returned 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.

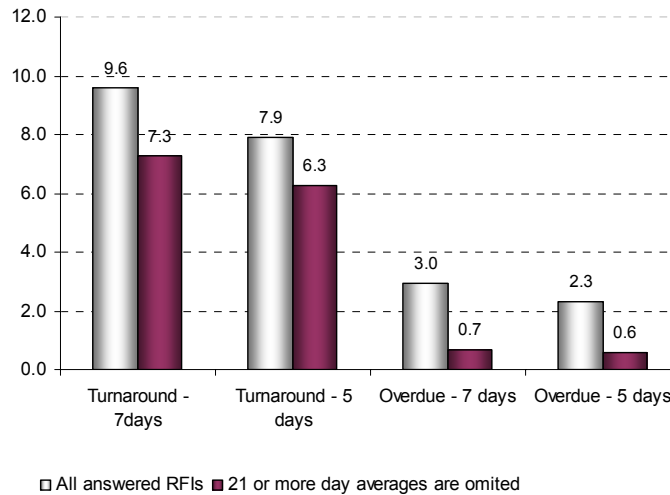


Figure 7. Average turnaround time and overdue based on 7-day and 5-day work week in DIA Center addition project. Based on 1,320 RFIs; RFIs not answered (7) and those with over 39 days turnaround time (104) are eliminated.

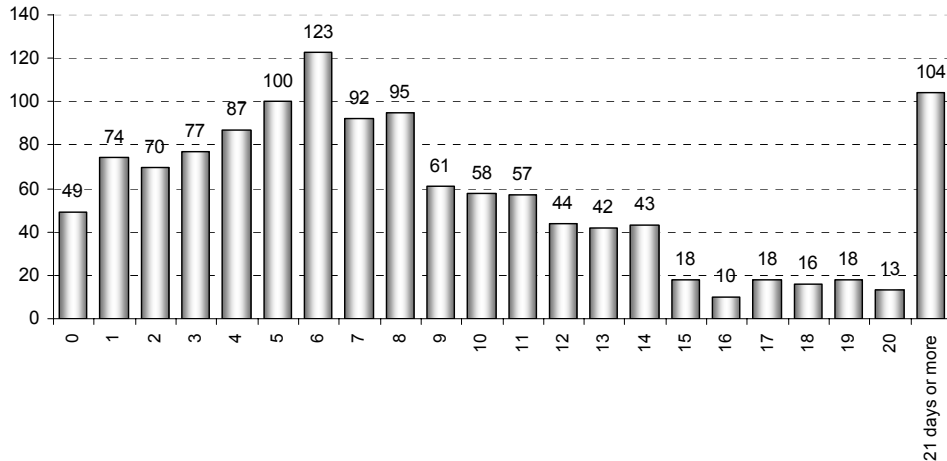


Figure 8. Number of RFIs and their turnaround time in days in DIA Center addition project

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.

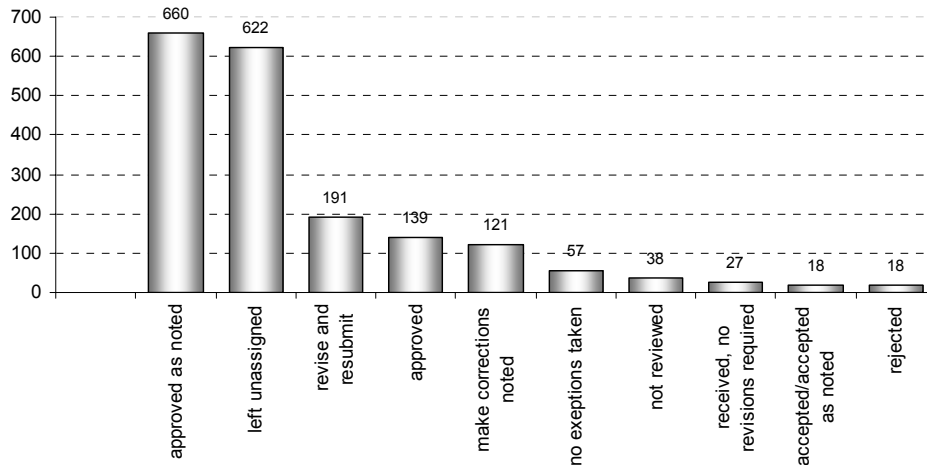


Figure 9. Actions taken after reviewing submittals of DIA Center addition project

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

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