



2017-12-01

Project Management: Skills, Tools, and Knowledge Construction Professionals Consider Important for Keeping Projects on Schedule

Lyle Scott Davies
Brigham Young University

Follow this and additional works at: <https://scholarsarchive.byu.edu/etd>



Part of the [Construction Engineering and Management Commons](#)

BYU ScholarsArchive Citation

Davies, Lyle Scott, "Project Management: Skills, Tools, and Knowledge Construction Professionals Consider Important for Keeping Projects on Schedule" (2017). *All Theses and Dissertations*. 6608.

<https://scholarsarchive.byu.edu/etd/6608>

This Thesis is brought to you for free and open access by BYU ScholarsArchive. It has been accepted for inclusion in All Theses and Dissertations by an authorized administrator of BYU ScholarsArchive. For more information, please contact scholarsarchive@byu.edu, ellen_amatangelo@byu.edu.

Project Management: Skills, Tools, and Knowledge Construction Professionals

Consider Important for Keeping Projects on Schedule

Lyle Scott Davies

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of
Master of Science

Evan D. Bingham, Chair
D. Mark Hutchings
Jay P. Christofferson

School of Technology
Brigham Young University

Copyright © 2017 Lyle Scott Davies

All Rights Reserved

ABSTRACT

Project Management: Skills, Tools, and Knowledge Construction Professionals Consider Important for Keeping Projects on Schedule

Lyle Scott Davies
School of Technology, BYU
Master of Science

Project managers have a major role in the construction and completion of projects. Much of their work consists of reviewing, clarifying, and coordinating information required by the field management and subcontractors performing the work on the job site. The assistance they give with the transfer of information helps with successfully completing projects. For many people, the largest indicator that a project was successful is that construction activities were completed on schedule. While finishing on schedule may be the primary focus of those involved with construction activities, projects still struggle to finish on time. The purpose of this study is to find out what construction industry professionals consider important skills, tools, and knowledge for helping project managers finish the projects they manage on schedule. Research results found the general topics of management and scheduling are the most important for project managers to understand. Within the topic of scheduling, the importance of material procurement ranked highest of the specified subcategories. Construction professionals also ranked working with subcontractors, understanding project documents, weekly project meetings, working with owners, and having interpersonal and communication skills as important topics that will help project managers keep their projects on schedule.

Keywords: project management, construction management, scheduling

ACKNOWLEDGEMENTS

I would like to thank everyone who has encouraged me through the process of completing this research. Special thanks go to my wife, Elaine. Without her support, this would never have been possible. I would like to thank my committee chair, Dr. Evan Bingham, who continually encouraged me to keep moving forward, as well as Dr. Mark Hutchings and Dr. Jay Christofferson for their help and support.

Thank you to all the construction professionals who participated in this research. Their honest feedback and answers helped provide insights and understanding to the challenging work of project management.

TABLE OF CONTENTS

TITLE PAGE	i
ABSTRACT.....	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS.....	iv
LIST OF TABLES.....	vi
LIST OF FIGURES	viii
1 Introduction	1
1.1 Viewpoints of Successful Projects	3
1.2 Purpose of Study	4
1.3 Research Questions	5
1.4 Limitations of the Research.....	5
1.5 Common Construction Industry Definitions	6
2 Literature Review	9
2.1 Perceptions and Observations	10
2.2 Purpose of Schedules	11
2.2.1 Project Team Scheduling	11
2.3 Project Performance	12
2.3.1 Technology in Project Performance.....	14
2.4 Research Focus.....	14
3 Methodology.....	15
3.1 Research Design – Online Surveys	15
3.2 Development of the Survey Instrument	16
3.2.1 Survey Questions	16
3.3 Population of Interest and Sample Size.....	17
3.4 Research Procedures	18
4 Research and Results	21
4.1 Survey Questions and Results	21
4.2 Demographic Information of Respondents	22
4.3 Creating Project Schedules.....	24
4.4 Project Schedule Consultations.....	25
4.5 Scheduling Software Programs – Tools	27
4.6 Updating Project Schedules	30

4.7	Tracking Activities.....	31
4.8	Finishing Projects on Schedule	32
4.9	Results to Open Question.....	33
4.9.1	Brief Methodology Review.....	33
4.9.2	General Categories Based on Survey Responses.....	34
4.9.3	Narrowing Survey Responses	35
4.9.4	Management Specific Responses.....	36
4.9.5	Scheduling Specific Responses.....	40
4.9.6	Communication Specific Responses.....	44
4.9.7	Subcontractor Specific Responses	45
4.10	Follow-Up to Responses	46
5	Conclusion.....	48
5.1	Summary of Survey Questions.....	48
5.1.1	Open-Ended Answers	49
5.2	Answers to Research Questions	50
5.3	Recommendations	52
5.4	Suggestions for Further Research	53
	References.....	55
	Appendix A. Survey.....	58

LIST OF TABLES

Table 4-1 - Percentage of Survey Participation Based on Job Title	23
Table 4-2 - Years of Experience in the Construction Industry Based on Job Title	23
Table 4-3 - Who was Responsible for Creating Project Schedules	24
Table 4-4 - Number of People Consulted by the Individual Creating the Project Schedule	25
Table 4-5 - Who was Consulted During Schedule Creation?	26
Table 4-6 – Distribution Percentages of Subcontractors Consulted During Schedule Creation.....	27
Table 4-7 - Number of Software Programs Used to Create Project Schedules	28
Table 4-8 - Schedule Creation Using a Single Software Program.....	28
Table 4-9 - Schedule Creation Using Two Software Programs.....	29
Table 4-10 - Schedule Creation Using Three Software Programs.....	30
Table 4-11 - How Often were Project Schedules Updated?	31
Table 4-12 - Method Used for Tracking Construction Activities to Update ProjectSchedules	32
Table 4-13 - Percentage of Projects that Finished on Schedule.....	33
Table 4-14 - General Topic Response Rates from All Open-Ended Survey Question.....	34
Table 4-15 – General Topic Response Rates of Open-Ended Question with 90% - 100% Filter	35
Table 4-16 - Categories in the General Topic of "Management"	37
Table 4-17 - Subcategories in Category of "Personal Understanding"	37
Table 4-18 - Subcategories in Category of the "Project Manager's Ability to Work with People Related to the Project"	38
Table 4-19 - Subcategories in Category of the “Project Manager's Understanding of Project Paperwork and Documents”	39

Table 4-20 - Subcategories in Category of "How a Project Manager Works with a Project Site"	39
Table 4-21 - Categories in the General Topic of "Creating and Following a Project Schedule"	40
Table 4-22 - Subcategories in Category of "A Knowledge of Scheduling Considerations and How They Effect a Project Schedule"	41
Table 4-23 - Subcategories in Category of "Tasks that Should Be Performed During Construction Activities"	42
Table 4-24 - Subcategories in Category of "Reflecting Knowledge of Topics Required for "Creating a Project Schedule"	43
Table 4-25 - Subcategories in the General Topic of "Communication"	44
Table 4-26 - Subcategories in the General Topic of "Working with Project Subcontractors"	45
Table 4-27 - Where Were Skills, Tools and Knowledge Learned?	46
Table 4-28 - Number of Learning Methods	47
Table 5-1 - Subcategories Representing a Skill, Tool or Knowledge.....	50

LIST OF FIGURES

Figure 1- Manufacturing vs Construction Productivity in the United States from 1995 to 2014.....	2
---	---

1 INTRODUCTION

The commercial construction industry struggles with a reputation of not finishing projects on time. Commercial construction “includes buildings and structures used by the retail, wholesale, and selected service industries” (census.gov). When these projects finish later than intended, it can be costly to owners, general contractors, subcontractors, and tradesmen associated with these projects. “In construction, delay could be defined as the time over-run either beyond completion the date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project” (Assaf & Hejji, 2006). The research by Assaf & Hejji, found that:

“about 76% of the contractors indicated the average schedule over-run for the projects they have experienced is between 10% and 30% of the original project duration. Approximately 56% of the consultants participating in the same survey specified the same percentages and another 25% of the consultants indicated 30% to 50% average time over-run for completing projects.”

Owners participating in research surveys specified causes of project delay were related to contractor and labor issues. Research done by (Egan, 1998) it was said:

“Recent studies in the USA, Scandinavia and this country, (United Kingdom), suggest that up to 30% of construction work is rework, labor is used at only 0-60% of potential efficiency, accidents can account for 3-6% of total project costs, and at least 10% of materials are waste. There is plenty of scope for improving efficiency and quality simply by taking waste out of construction.”

There are many possible reasons-for schedule over-runs. Subcontractors not performing as scheduled, material procurement problems and weather are a few common factors which impact schedules. Umble & Umble, (2000) commented that “projects almost always seem to be behind schedule and over budget, and project content is often compromised. Simply put, the conventional ways of scheduling and managing projects somehow falls short.”

While some manufacturing industries have made advances in production and product delivery, the construction industry has not made advances that reflect significant changes in productivity or delivery. The following figure shows the difference between manufacturing productivity growth and construction labor productivity, compared to the total economy from 1995 to 2014.

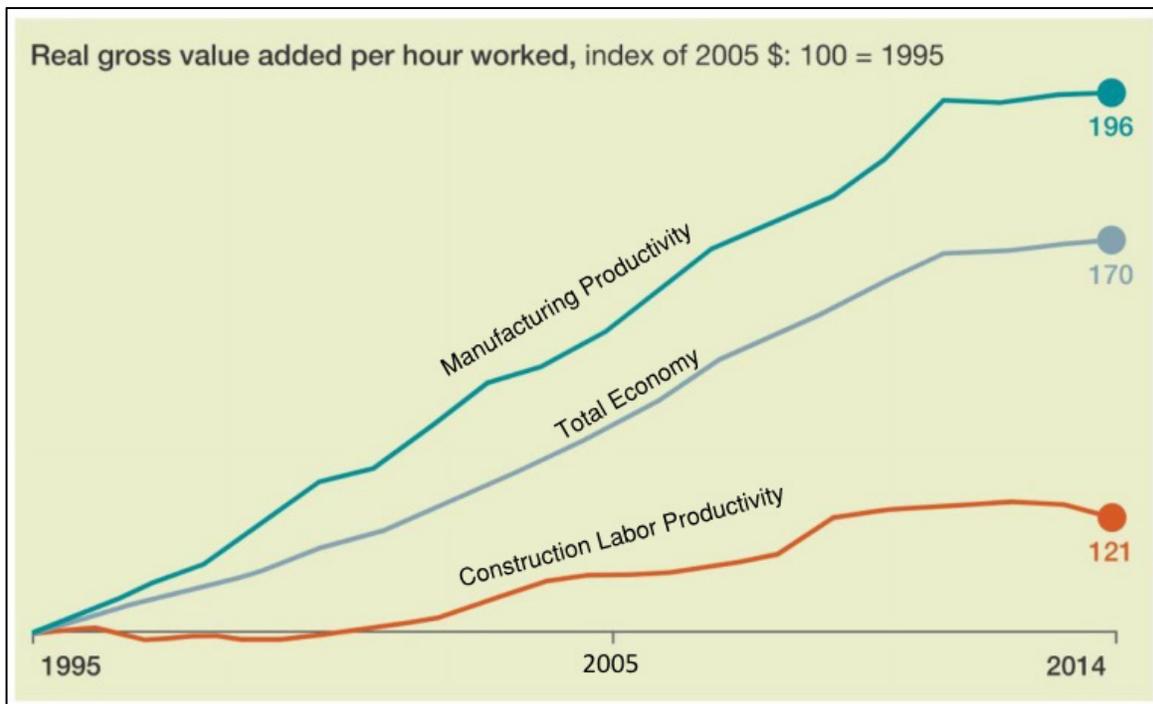


Figure 1- Manufacturing vs Construction Productivity in the United States from 1995 to 2014

1.1 Viewpoints of Successful Projects

Project managers begin their work soon after a new project is awarded to the general contractor and before the work begins at the building site. Their work includes mitigating and managing risks associated with any new job. They are responsible for being sure work on their project moves forward and remains on schedule. A realistic schedule helps project managers plan, coordinate, and delivery the project they are responsible of managing to its owner. However, the project manager's role does not stop here.

Some research suggests finishing a project on a predetermined schedule is not always the best measure of project success. Projects are often considered successful when they meet schedule deadlines and stay within budget. However, project success, even within the same organization, can be measured differently. Some people are interested in technical performance, others with design criteria, and others on meeting schedule deadlines (Pinto & Slevin, 1988).

Project effectiveness may be assessed by different interest groups such as stockholders, managers, customers, employees, and so on. Criteria for measuring project success must therefore reflect different views (Stuckenbruck, 1986). According to Freeman & Beale (1992),

“An architect may consider success in terms of aesthetic appearance, an engineer in terms of technical competence, an accountant in terms of dollars spent under budget, a human resources manager in terms of employee satisfaction, and a chief executive officer rate their success in the stock market.”

Shenhar, Dvir, & Levy (1997) suggest that project managers cannot just focus on their project staying on schedule and within budget. They must be aware of possible gaps between the technical and the practical or actual needs of the customer.

“Project managers must be aware of the results expected from their projects, and they must constantly focus their attention on these results during the project management

process. Project managers must act decisively to rectify any gap between project perceived performance and actual customer needs.”

They must also be mindful of the business aspects of the project to their company and that it represents an aspect of the company’s struggle for competitive advantage in the market.

Construction industry procurement methods are changing, and much of the financial risk is being transferred to the general contractor (Bedelian, 1996). Design improvements and efforts to incorporate new technologies have increased the demands contractors must meet. Delivering projects within the constraints required by its designers can be difficult. Construction professionals are good at solving challenges, but there are costs related to implementing new ideas. Each project is unique and brings its own challenges for the project manager. Requests for information (RFI’s), clarifications, and change orders can often add construction costs. These added “costs” are not always monetary, but they can still impact project delivery dates.

1.2 Purpose of Study

General contractors must coordinate and combine the skills and talents of architects, engineers, subcontractors and material providers with the goal of completing a project on schedule. Construction companies face the challenge of integrating the efforts of separate entities whose ideas and objectives may be difficult to bring together in the way the owner of the project envisioned. When project managers get involved with projects, they generally begin their work before equipment is moved to a construction site and their responsibilities can stretch beyond the time an owner takes possession of his/her new facility. As demonstrated above, project managers must be competent in many aspects of construction to successfully complete the projects they

manage. The purpose of this study is to determine what skills, tools and knowledge construction professionals consider the most important for keeping projects on schedule.

1.3 Research Questions

- What tools should project managers use to help them make decisions that keep projects on schedule?
- What skills do construction professionals consider important for helping project managers keep the projects they manage on schedule?
- What knowledge should project managers have (or draw from) to keep their projects on schedule?
- Are there activities or tasks project managers perform on a regular basis that help keep projects on schedule?

1.4 Limitations of the Research

Limitations to this study include its focus on commercial contractors along the Wasatch Front in Central Utah. Building conditions like those that exist in Central Utah may not be comparable to building conditions found in other geographic locations. For this reason, the conclusions from this study cannot be projected to other regions in the United States. In addition, no specific group of construction professionals was singled out as the only source of data for this research. Construction professionals with varying job descriptions were surveyed to discover different perspectives and viewpoints about this topic.

While certain aspects of project management are identified, further research into specific topics will be necessary for a deeper understanding. For example, it was found that 45% of

subcontractors are typically consulted while project schedules are created. No further inquiry was made as to which specific subcontractors, or trades, were consulted.

Survey question #2 asked “While a project schedule is being created, who of the following are consulted? (Mark all that apply).” A common response to the answer “Other (specify)” was the project superintendent. If the project superintendent would have been included as one of the potential survey answers, the response rate might have been different.

1.5 Common Construction Industry Definitions

For clarification, the researcher has provided generally accepted definitions used to describe job titles commonly found in commercial construction companies along the Wasatch Front in Central Utah. These definitions are not intended to be exhaustive. They are meant to give common understanding of job titles used in this research. These definitions were reviewed for accuracy by industry professionals with executive level experience at the commercial construction companies they work for (Pratt, Smith, & Calder, 2017).

Project Executive – A project executive is a company employee involved with creation, oversight, and implementation of company policies. Their years of experience provide them opportunities to develop relationships and business opportunities in advance of actual project construction, with owners and industry professionals, through their tenure in the construction industry. Their experience is critical as business proposals are written. Their influence is present during their company’s bidding process. They provide insight, experience, and oversight to project managers and the projects they manage. A project executive is typically responsible for overseeing several projects and assisting project managers with risk management as well as resolving difficult issues that arise during construction of specific projects.

Project Manager – A project manager is a company employee that has direct responsibility for initiating, planning, coordinating, executing, monitoring, controlling, and closing a project. A project manager might oversee more than one project at a time. The project manager coordinates major resources for the project, including meetings among owners, architects, engineers, on-site employees, and the transfer of information between project team members. A project manager is also responsible for the acquisition of materials, labor, trade contractors, and other project resources. The project manager works closely with the project engineer and project superintendent. The project manager may visit job sites but typically works from company headquarters. However, with large and particularly complex projects, the project manager might work on-site with the project superintendent.

Project Engineer – A project engineer is a company employee that assists the project manager and is tasked with taking care of project documentation (RFIs, submittals, warranties, change orders, schedules, etc.). A project engineer might be assigned to more than one project and typically works from company headquarters. Again, with large and particularly complex projects, the project engineer might work on-site with the project superintendent.

Scheduler – A scheduler is typically responsible to document, update, and monitor project schedules as directed by the project superintendent and the project manager. Not all companies have a designated scheduler.

Project Superintendent – A project superintendent is a company employee that directly oversees construction activities at a project construction site. A project superintendent is typically responsible for overseeing and coordinating on-site efforts of trade contractors, material deliveries, inspections of construction activities, direct company labor, and subcontractor

sequencing. A project superintendent also provides regular updates to the project manager to compare the project schedule with actual project progress.

Wasatch Front – The Wasatch Mountain Range runs from central to northern Utah and is referred to as “the Wasatch Front.” Roughly 80% of Utah residents live in towns and cities along the western borders of this mountain range (Wikipedia, Census 2010).

2 LITERATURE REVIEW

Competent project managers are an important component to project success (Hwang & Ng, 2013). According to Frank (2002), the project manager has direct influence over 34-47% of project success. He also states that from a general perspective, the project manager influences approximately 50% of project success, the project office organization about 20%, the project host organization about 20%, and the external environment about 10%.

Project managers represents the general contractor and lead project support. They assist owners, architects, and engineers with implementation of design ideas by facilitating the communication and flow of information required to successfully complete a project. A few of the important coordinating activities they perform include reviewing architectural plans for possible questions, forwarding addendum and requests for information (RFI's) to and from subcontractors, tracking project progress, as well as tracking and reviewing project budgets. Regular meetings between the project manager, owners, architects, and engineers facilitate the flow of required information to the project team.

The role of project managers is different than the on-site superintendent. The project manager works with the on-site superintendent to coordinate efforts of subcontractors who provide skilled labor and materials. Superintendents require information updates to complete their projects within the scheduled timeframes. Accurate schedules facilitate accurate planning and coordination efforts between all parties involved in projects.

2.1 Perceptions and Observations

An original assumption made by the researcher was that commercial construction projects generally finish late. Scheduled completion dates are often missed by general contractors. An informal interview of architects who regularly work with commercial contractors supported this perception. Using an historical perspective seeks to capture the individuals' life experiences from their own perspective (Gall, 2003).

During the researcher's informal interview, architects were asked about their experience working with commercial contractors. Questions were directed to the topic of project schedules and how often commercial contractors finish their projects on schedule. When the architects were asked this question, their general response indicated that no more than 10% of commercial contractors they work with finish their projects on schedule. When asked how many projects finished early, they answered that less than 5% of the projects finish before their scheduled finish date. Additionally, a senior architect said, "The problem of project schedules not being met is probably the biggest issue the construction industry faces." He went on to ask why commercial contractors do not make multiple CPM (Critical Path Method) models of the schedule, suggesting that doing so might help them with contingency plans for unanticipated changes. Very often, unanticipated events will occur with construction of the project that affect the critical path in the schedule.

Owners believe the cause of most delays is due to both the contractor and the subcontractors. Awarding jobs to the lowest bidder is the most frequent cause of project delay. From the contractor's perspective, the owners are the largest reason for project delay. Owners also hire the lowest bidder and their capabilities to perform can often lead to delays as well (Assaf & Al-Hejji, 2006).

2.2 Purpose of Schedules

Schedules communication performance expectations for the project. They communicate dates of milestones, when construction activities should to be performed, and how long they should last. Schedules can help plan labor requirements, material delivery, and the coordination of work with all trades involved with the project. As architects and engineers follow construction progress, schedules provide timing that can help prioritize which questions (RFI's) need answers. Timely updates of required information keep projects moving forward without delay. "The schedule should be used to motivate the work team and to communicate to them the details of who is doing what, when, and where (Newitt, 2005). Open and clear communication of questions and answers is vital for keeping a project on schedule.

2.2.1 Project Team Scheduling

Fearne & Fowler (2006) stated in their research, "The construction industry is arguably the least integrated of the all the major industrial sectors, characterized by adversarial practices, disjointed supply relationships and a lack of trust between clients, main contractors and subcontractors. Projects are invariably treated as a series of sequential and predominantly separate operations where the individual players have very little stake in (or commitment to) the long-term success of the resulting building." A project team has significant influence in the cost and timing of a project (Dissanayaka & Kumaraswamy, 1999).

Construction projects are, by nature, unique and project managers must work effectively with the project team to finish projects on schedule. As a project begins, the project manager may be part of the general contractor team that decides which subcontractors should be included as a part of the project team. Most general contractors cannot provide all the resources required

for building a project. Subcontractors provide expertise, materials, skilled labor, as well as a large percentage of the labor force required for building construction projects. Subcontractors are an important component of a project finishing on schedule. All parties involved with a construction project have a vested interest in seeing it finish on time. However, subcontractors are often the cause of delays in a project (NEDO, 1983), (Majid & McCaffer, 1998). One of the main factors of poor project performance is how the contractor cooperates with subcontractors (Cheng & Huang, 2012). Contractor performance is positively and strongly associated with the relationships they have with subcontractors (Kale & Arditi, 2001). If a sense of alienation and mistrust develops between contractors and subcontractors, it can be difficult to build a sense of teamwork, which can become the cause of productivity barriers (Hsieh, 1998). Project managers that effectively work with subcontractors offer value to the general contractor and project team.

2.3 Project Performance

“Assessing project outcome is of extreme importance to everyone involved – managers, customers, and other stakeholders” (Cleland, 1986), (Kerzner, 1994). A contractor’s past performance is one of the most important determinants of predictive performance (Tam & Harris, 1996). A contractor’s project history can have influence in the selection process of future work. General contractors that regularly complete projects successfully are more likely to achieve project targets (stay on schedule) in the future. It is, therefore, contractors of high reputation and better past performance who will bring improved client confidence for completing their project on time (Xiao & Proverbs, 2003).

International studies show poor contractor performance has a large impact in their competitive ability for obtaining work (Enshassi, 2009). In the United Arab Emirates, studies

show that shortages of skilled labor, poor supervision and site management, unsuitable leadership, and equipment failure contribute significantly to poor contractor performance (Faridi & El Sayegh, 2006).

According to (Odeh & Battaineh, 2002), contractors and construction consultants shared four of the top five reasons for project delay. These reasons include (1) owner interference, (2) inadequate contractor experience, (3) financing, and (4) payments of completed work. They also found that improper planning was troublesome to general contractors. Contractors were reluctant to use or update schedules on a regular basis. This claim was substantiated in their research when only eight of the sixty-three sampled contractors responded positively to updating the schedules of their projects. Sweis et al. (2014) reported similar results. “Poor project planning and scheduling by contractors was ranked by both owners and consultants as one of the most important factors of poor contractor performance.”

Accurate schedules assist project managers, but they cannot anticipate challenges or issues that inevitably happen during construction of a project. Project construction has become increasingly complex. Engineering advances, societal expectations with the life span of buildings, complex designs, new technologies, and materials contribute to challenges project managers face while doing their work. However, the previously mentioned list can also give owners more value in their projects. “Clients are the core of the process and their needs must be met by the industry” (Latham, 1994). Project managers must be better prepared to meet these complexities. When contractor performance improves, it will lead to improved client satisfaction, contractor reputation, and competitiveness (Xiao & David, 2003).

2.3.1 Technology in Project Performance

Technological changes and advancements have impacted how commercial contractors conduct business and how project managers oversee their projects. Researchers (Celan & Dorman, 1995), (Russell & Jaelski, 1997) recognized changes that were coming to the construction industry and argued that they (project managers) must supplement traditional functions with other non-engineering knowledge and skills. Their research insights into industry changes were echoed by Ahmad (1997) who suggested that project management functions be paired with information technology (IT) functions. Computer programs and IT functions have become an integral part of how business is transacted since the research done in 1997.

2.4 Research Focus

Performance expectations, roles, and workloads of project managers continue to increase. Their ability to draw upon and use a variety of skills, tools, or knowledge can increase their ability to perform their responsibilities. With the increasing diversity of projects and the requirements that come with them, project managers cannot just rely on skills they have acquired through their years of service to the company they work for (Celan & Dorman, 1995), (Russell & Jaselski, 1997). Project managers must be proficient with more than traditional technical and construction skills. Edum-Fotwe & McCaffer (2000) recommended four essential skills for project managers. Their list includes leading, communicating, negotiating, and problem solving. This research intends to discover other skills, tools, and knowledge construction professionals consider important for helping project managers keep the projects they manage on schedule.

3 METHODOLOGY

The focus of this research was to gather insights from construction professionals that could help project managers with projects they are managing. Perspectives of individuals with varying roles within commercial construction companies were sought to determine what skills, knowledge, or tools would help project managers keep their projects on schedule.

3.1 Research Design – Online Surveys

Online surveys were used to collect data from construction professionals identified in this study. These surveys were administered by Qualtrics, a business specializing in gathering statistical data using online survey methods. Online surveys were used for at least two reasons. First, because the surveys were administered by a well-known third party (Qualtrics), respondents could be assured that their answers, although compiled with other answers for study purposes, would remain anonymous. Second, because some questions might require some time to consider, an online survey allowed the respondents an opportunity to reflect and access information that might not be readily available in a phone interview. An additional benefit to the researcher was that the data (answers) was compiled by Qualtrics and exported for ease of analysis by the researcher.

3.2 Development of the Survey Instrument

Questions designed to yield answers to the research problem were developed by the researcher and a group of industry members, including project managers and owners of commercial construction companies, commercial architects and university professors of construction management. The initial list of questions was reviewed and refined through several steps until the final survey instrument was completed. The survey instrument was then tested on industry professionals and went through two revisions before the final questionnaire was ready to be administered to industry professionals.

3.2.1 Survey Questions

Survey questions were created to gain understanding of tools being used to make and update project schedules. Construction professionals were also asked what they considered important skills, tools, or knowledge to help project managers keep the projects they manage on schedule.

The survey consisted of a total of fourteen questions. Nine questions focused on collecting research data and five questions collected demographic information. One question was open-ended for the purposes of eliciting responses of skills, tools, and knowledge believed to be most helpful for project managers to understand and use. Respondents could give one to five responses to the question. Answers given for the open-ended question were evaluated by the researcher and converted into categorical variables to quantify the data. (See copy of survey in Appendix A)

3.3 Population of Interest and Sample Size

The population of interest for this research consisted of commercial construction companies located along the Wasatch Front in Central Utah. Commercial construction companies can vary widely in the number of employees, the value of the work they perform, and revenue produced from their work. Company size, based on number of employees or revenue, was not used as a consideration for this study.

To narrow the sample size for this research, the executive officer of the Associated General Contractors (AGC) provided the names and contact information for commercial contractors in the AGC who were operating along the Wasatch Front in Central Utah. In addition, professors of Construction Management from a local university, along with members of that university's industry advisory council for construction management, identified additional commercial construction companies in this same geographical area. A random list of 36 commercial construction companies from this original list was compiled. Ultimately, professionals from 22 of these 36 companies agreed to participate in this study and distribute the survey instrument to qualified employees within their respective companies.

Project managers typically take the lead of managing construction activities from the beginning of the project through its completion. Those assisting the project manager make up part of the project team. Some roles may be advisory, while others are more supportive. The common goal of all team members is to deliver the project in accordance with the conditions set by the owner (schedule, budget, specifications, etc.). These teams work to meet deadlines placed on them by the specifications of the projects they manage. Construction professionals with differing roles and responsibilities in the managing of commercial projects would focus on different skill sets, knowledge, or tools which project managers need to employ to be proficient.

The population of interest included construction professionals with varying roles and experience. Job titles, such as project executives, project managers, project engineers, schedulers, on-site superintendents, and other people who might assist the project managers.

3.4 Research Procedures

Professionals from 22 of construction companies were contacted through emails and phone messages and agreed to participate in this research. The initial contact person was asked to distribute the survey to project managers and relevant people working with project managers in their company. If these individuals could not be reached by phone, an introductory email was sent. This email contained a general introduction to this research and to the researcher. An anonymous link, which was generated for the research survey by Qualtrics, was included in the email introduction. A copy of the introductory email can be found in Appendix A. If no response was received within 14 days, a reminder email was sent to the contacts asking for their responses to the survey. A total of 132 surveys were received through this process, of which 129 could be used in this study.

Research results from the Qualtrics survey were exported into an Excel workbook to facilitate analysis of the answers. Data from answers to questions 1-7 were converted into distribution tables for analysis.

Question #8 was an open-ended question. The person completing the survey could respond to this question with up to five written answers. With 129 surveys completed, this question had the possibility of producing a total of 645 answers. A total of 546 answers were received (84.7% of the possible 645 answers). These answers were imported into an Excel

spreadsheet and sorted into five columns that coincided with the order in which the responses were written.

Because answers given by individual respondents were unique, each one was evaluated for a common theme. Answers were then assigned to a category based on one of four common themes identified by the researcher. A number was assigned to each of the four common themes as follows: Answers common to the topic of “communication” were assigned the number 1; “management” answers were assigned the number 2; “scheduling” answers were assigned the number 3; and answers relating to “subcontractors” were assigned the number 4. Answers that were left ‘blank’ were assigned the number 0. The wording of answers from survey respondents was not changed through the sorting process. Results of this initial sorting were reviewed the research committee for accuracy.

After the initial sorting of answers was complete, those responses with the same numbers were grouped together into the four general topics. Answers within each general topic went through a more thorough sorting and were then grouped into seven categories. The answers were sorted again to cluster common phrasing together (revision 2). Based on common verbiage and language, answers were arranged together. Thirty-seven subcategories were identified and each subcategory was grouped within one of the seven categories identified earlier. Through this sorting process, it became evident into which subcategory these answers should be grouped. If there was a question as to whether an answer fit into a specific subcategory, that answer was flagged for closer scrutiny.

A final sorting of answers within each subcategory was completed (revision 3) so that answers with common wording were grouped together. Once categories and subcategories were

assigned, quantitative analyses were performed. Answers to all survey questions were compiled into tables for better understanding and analysis.

4 RESEARCH AND RESULTS

4.1 Survey Questions and Results

This research focused on the question: Are there skills, tools, or knowledge construction professionals consider valuable for project managers to understand, or have proficiency with, that will help them keep projects they manage on schedule?

Representatives from all 22 companies that were contacted agreed to participate in the survey, and the link for the anonymous survey was emailed to that person. These individuals were asked to distribute the survey link to company employees with differing job descriptions to collect research data. These job descriptions included project executives, project managers, project engineers, project (on-site) superintendents, and other people who work with project managers. A summary of the nine research questions is listed below. (The exact wording of the questions along with possible answers to those questions can be found in Appendix A.)

1. Who typically creates the schedule for company projects?
2. Who is consulted as the schedule is being created?
3. Out of all the subcontractors used on a project, what percentage are typically consulted to determine durations for the work they would perform?
4. Which computer software program(s) is (are) used by company to create project schedules?

5. How often are project schedules typically updated?
6. What methods for updating schedules are typically used by the company to track construction activities?
7. What percentage of projects are completed on schedule?
8. Open-Ended Question – What are the 5 most important things (tools, skills, knowledge) a project manager should know or use to keep a project on schedule?
9. Where did the respondent learn the skills/tools/knowledge listed in the previous question?

Because the focus of this research is to determine which skills, tools and knowledge are most valuable to project managers in completing projects on schedule, it was determined that only answers from respondents who reported that their projects were completed on schedule at least 90% of the time would be used in this study. Totals, in the number of responses column, of some of the Tables reported in chapter four may not be consistent. Differences in the number of response totals are due to a survey question being unanswered by a respondent. While this occasionally occurs, all other survey questions were answered and used for data analysis.

4.2 Demographic Information of Respondents

Commercial construction professionals with varying responsibilities and job titles responded to this research. Demographic information of those responding to this research are shown in Tables 4-1 and 4-2 below.

Table 4-1 - Percentage of Survey Participation Based on Job Title

% of Survey Response	Job Title
18.4	Project Executive
38.2	Project Manager
26.3	Project Engineer
17.1	Project Super

Specific job titles of respondents completing the survey instrument included 26 project executives, 44 project managers, 31 project engineers, and 24 project superintendents. The responses shown in Table 4-1 (and all other Tables in this research) are from those who indicated that at least 90% of their projects finished on schedule. Project Managers were the largest group of industry professionals contributing to the results of this research with a response rate of 38%. Project engineers contributed 26%, project executives 18%, and project superintendents 17% of the survey responses.

Table 4-2 - Years of Experience in the Construction Industry Based on Job Title

Job Title	Avg. Number of Years in Construction	Avg. Number of Years in Current Position	Avg. Number of Years to get to Current Position	Avg. Number of Projects Managed
Project Executive	26.5	9.2	17.4	2.4
Project Manager	19.6	9.5	10.1	2.0
Project Engineer	11.2	4.7	6.5	1.7
Project Superintendents	27.8	16.6	11.1	1.6

Project executives had an average of 26.5 years of experience in the construction industry and an average of 9.2 years in their current position. Project managers had an average of 19.6 years working in the construction industry and an average of 9.5 years in their current position. Project engineers had an average of working 11.2 years in construction and 4.7 years in their

current position. Project superintendents had the highest average number of years in construction with 27.8 years. They also had the highest average number of years working in their current position with 16.6 years.

4.3 Creating Project Schedules

Accurate schedules are critical to the successful delivery of projects. Company planning, material procurement, anticipating labor requirements, and knowing when to schedule subcontractors are examples of activities that an accurate schedule must address to help the project manager plan and anticipate the needs of a project. Table 4-3 shows who was responsible for creating project schedules.

Table 4-3 - Who was Responsible for Creating Project Schedules

Job Title or Position	% of Schedules Created
Project Executive only	1.3
Project Manager (only)	32.5
Project Engineer (only)	5.2
Project Superintendent (only)	18.2
Company Scheduler (only)	18.2
Project Executive & Project Super	1.3
Project Manager & Project Super	7.8
Project Manager & Scheduler	6.5
3 People Involved	3.9
Project Team	5.2

As indicated above, project managers were responsible for creating 32.5% of the schedules in the sample. Survey results also showed that project superintendents and company schedulers were each responsible for creating 18% of the schedules.

When two employees work together to create a project schedule, project managers and project superintendents teamed up to create schedules almost 8% of the schedules. Project managers working with company schedulers teamed up to create almost as many schedules (6.5%).

Note that project managers were involved in creating more than half the schedules (55.8%). This figure includes schedules created solely by the project manager or schedules created in collaboration with project superintendents, company schedulers, project teams or when 3 people worked together. Project superintendents created or were directly involved with the creation of more than one-third of the schedules (36.4%). The only other employees involved significantly in creating project schedules were company employees (company schedulers) hired specifically to create project schedules (29.9%).

4.4 Project Schedule Consultations

Table 4-4 shows the results of how many people were consulted by the individual responsible for creating the schedule.

Table 4-4 - Number of People Consulted by the Individual Creating the Project Schedule

No. of People Consulted	No. of Responses	% of Responses
One	2	2.6
Two	4	5.2
Three	16	20.8
Four	12	15.6
Five	25	32.5
Six	13	16.9
Seven	5	6.5
Total	77	100.0

Almost one-third of the schedules were created in consultation with five other people (32.5%). Three other people were involved in creating about one-fifth of the schedules (20.8%). Six people were consulted in the creation of the schedules (17%); four people were consulted (16%); seven people were consulted (7%); two people were consulted (5%), and one person was consulted only 3% of the time.

Table 4-5 adds additional insight into the question of who was consulted as project schedules were created. This response asked for the respondent to “mark all that apply.”

Table 4-5 - Who was Consulted During Schedule Creation?

Person/People Consulted	No. of Responses	% of Responses
Project Manager	72	93.5
Subcontractor	70	90.9
Project Superintendent	45	58.4
Project Executive	43	55.8
Company Owner	31	40.3
Project Engineer	30	39.0
Material Supplier(s)	29	37.7
Company Scheduler	23	29.9
Other	1	1.3

While Table 4-4 reported that the largest number of people consulted while the schedule was being created was five, Table 4-5 tells the reader that two of the five people almost always consulted were the project manager (94%) and subcontractors (91%). Other people most likely to be consulted would include the project superintendents (58%), project executives (56%), and the company owner (40%). Percentages of other people consulted during schedule creation were project engineers (39%), material providers (38%) and the company scheduler (30%).

While the data for question 2 showed that subcontractors were consulted 91% of the time when creating a project schedule, question 3 of the survey specifically asked what percentage of subcontractors were consulted when making the project schedule. Table 4-6 shows the distribution of answers to that question.

Table 4-6 – Distribution Percentages of Subcontractors Consulted During Schedule Creation

% of Subcontractors Consulted for Creating Schedule	% of Responses
0 -10	5.2
11 - 20	23.4
21 - 30	18.2
31 - 40	7.8
41 - 50	10.4
51 - 60	9.1
61 - 70	1.3
71 - 80	15.6
81 - 90	3.9
91 -100	5.2
Total	100.0

When looking at data from questions 2 and 3 together, it is understood that nine out of ten subcontractors working on the project were not consulted when the project schedule was created. The number of subcontractors consulted for creating the schedule was an average of 45% of all subcontractors that worked on a project. This means that while subcontractors were almost always consulted for creating project schedules, less than half of them were consulted for durations of the work they performed.

4.5 Scheduling Software Programs – Tools

Scheduling software has become an important tool for understanding the timing involved with all aspects of a project. Proficiency with scheduling software can help project managers

plan for critical activities that can impact a project schedule. Respondents were asked which software program they used for creating project schedules and they could respond to the question with more than one answer. Table 4-7 shows percentages of how many software programs were used when project schedules are created.

Table 4-7 - Number of Software Programs Used to Create Project Schedules

No. of Software Programs Used to Create Schedules	% of Responses
Responses of Using 1 Scheduling Program	67.1
Responses of Using 2 Scheduling Programs	23.7
Responses of Using 3 Scheduling Programs	7.9
Unsure of Scheduling Program Being Used	1.3
Totals	100.0

Survey responses reported that commercial construction companies overwhelmingly used only one software program to create a project schedule (67.1%). Table 4-8 shows the distribution of respondents using one software program for creating schedules.

Table 4-8 - Schedule Creation Using a Single Software Program

Using One Software Program to Create Project Schedule	No. of Responses	% of Responses
Primavera - P6	36	70.6
Microsoft Project	12	23.5
Suretrak	2	3.9
Viewpoint	1	2.0
Total	51	100.0

For the commercial construction companies using one software program, Primavera – P6 was used most often (70.6%). Microsoft Project was the second highest single use program for creating schedules (23.5%), but was not used nearly as often. Only two other software programs were used alone to make project schedules by the respondents to this research. These were Suretrak and Viewpoint, and they accounted for only 6% of the remaining commercial construction companies using a single software programs.

Using two software programs for creating project schedules was far less common, but done in 23.7% of the responses to this research. Table 4-9 shows the distribution of respondents that reported using two software programs to create project schedules.

Table 4-9 - Schedule Creation Using Two Software Programs

Using Two Software Programs for Creating Project Schedule	No. of Responses	% of Responses
Microsoft Project & Suretrak	5	27.8
Microsoft Project & Bluebeam	1	5.6
Microsoft Project & Primavera - P6 (P3)	5	27.8
Primavera - P6 & Suretrak	5	27.8
Primavera - P6 & Excel	1	5.6
Suretrak & CoConstruct	1	5.6
Total	18	100.0

A smaller number of respondents (23.7%) reported that they used two software programs for creating project schedules. Microsoft Project was used with three other programs (Primavera - P6, Suretrak, and Bluebeam) 61.2% of the time. Primavera - P6 was also used with 3 other software programs (Microsoft Project, Suretrak, and Excel) 61.2% of the time. Suretrak and CoConstruct were used together only 5.6% of the time.

Using three software programs to create project schedules was done only 7.9% of the time.

Table 4-10 shows the distribution of responses for three software programs used to create project schedules.

Table 4-10 - Schedule Creation Using Three Software Programs

Using Three Software Programs for Creating Project Schedule	No. of Responses	% of Responses
Microsoft Project, Suretrak & Excel	1	16.7
Microsoft Project, Primavera - P6 & Excel	1	16.7
Microsoft Project, Suretrak & Pheonix	1	16.7
Microsoft Project, Suretrak & Primavera - P6 (P3)	2	33.3
Primavera - P6, Prolog & Bluebeam	1	16.7
Total	6	100.0

Only six respondents reported that they used three different software programs for creating project schedules. Microsoft project was used with two other software programs 83.4% of the time. Primavera – P6 and Suretrak was used with two other software programs 66.7% of the time. Excel was used with two other software programs in two of the responses given (33.4% of the time). Bluebeam, Pheonix, and Prolog were each used one time with two other software programs.

4.6 Updating Project Schedules

Accurate schedule updates help plan required construction activities. Understanding which activities are on time and which ones are behind schedule help project managers understand if and where adjustments need to be made. Survey recipients were asked how often they updated project schedules. Table 4-11 shows how often project schedules were updated.

Table 4-11 - How Often were Project Schedules Updated?

How Often Project Schedules were Updated	No. of Response	% of Responses
At Least Weekly	39	50.7
Twice a Month	19	24.7
Monthly	14	18.2
Quarterly	2	2.6
Semi-Annually	0	0.0
Random	3	3.9
Never	0	0.0
Total	77	100.0

Most respondents (50.7%) reported that project schedules were updated at least weekly. Schedules were updated at least twice a month 24.7% of the time. Monthly updates to projects schedules occurred 18.2% of the time. This means that 75.4% of the respondents that finished their projects at least 90% on schedule, updated their project schedules at least twice a month. More than 90% (93.6%) of respondents updated schedules at least once a month.

4.7 Tracking Activities

Planned Percent Complete (PPC) method of tracking construction activities compare the scheduled finish date with the actual finish date of a specific activity. This method of tracking construction activities helps project managers know if a subcontractor is ahead, behind, or on schedule with their contracted scope of work. Table 4-12 shows the distribution of methods being used for tracking construction activities.

Table 4-12 - Method Used for Tracking Construction Activities to Update Project Schedules

Method Used for Tracking Construction Activities	No. of Responses	% of Responses
Planned Percent Complete (PPC)	73	94.8
Earned Value Analysis (EVA)	0	0.0
Billing Invoices	1	1.3
Other	3	3.9
No Method	0	0.0
Survey Count	77	100.0

Nearly all those who responded to this research (94.8%) reported that they used “Planned Percent Complete” as the method that best described how they tracked construction activities. Only a few responses were given of differing methods for tracking construction activities. “Other” methods received 3.9%, while “billing invoices” received only 1.3% of the responses. Other possible answers that received 0% of survey responses included Earned Value Analysis (EVA), and no method used.

4.8 Finishing Projects on Schedule

One of the research questions on the survey was: What percentage of the projects you managed were completed on schedule? Table 4-13 gives a closer look at the 76 respondents who indicated that they completed projects on schedule at least 90% of the time.

Table 4-13 - Percentage of Projects that Finished on Schedule

% of Time Projects Finish on Schedule	No. of Responses	% of Responses
100	27	35.5
99	2	2.6
98	4	5.3
97	1	1.3
96	1	1.3
95	16	21.1
94	1	1.3
93	1	1.3
92	3	3.9
91	7	9.2
90	13	17.1
Total	76	100.0

4.9 Results to Open Question

Question #8 asked an open-ended question. It asked the question “What are the 5 most important things (i.e. tools, skills, knowledge) a project manager should know or use to keep a project on schedule?”

4.9.1 Brief Methodology Review

This question could receive up to five answers. Survey respondents were free to answer this question with whatever they considered to be a good answer. Some answers were as short as one word, while others were short sentences. All answers were carefully read for common ideas or themes. Common ideas and themes were categorized into four general topics. These topics were (1) responses related to the topic of communication, (2) responses related to the topic of management, (3) responses related to the topics of creating and following a project schedule, and (4) responses related to working with project subcontractors.

Distribution Tables were created to show the results for each general topic, category, and subcategory. Rows within each of the tables show the numbers and percentages of responses. The different response rates are also separated by the job titles of the respondents. Job titles were abbreviated in the Tables. They appear as follows: Project executive (PX), project manager (PM), project engineer (PE) and project superintendent (PS). Demographic information for each of these positions is shown at the beginning of this chapter and shows the experience of the people responding to this question. (see Tables 4-1 and 4-2)

4.9.2 General Categories Based on Survey Responses

Table 4-14 shows the distribution of all 129 survey responses within the four general topics revealed through sorting the research data. These general topics were analyzed further by grouping respondent response rates next to their corresponding job title. The purpose of this illustration is to help readers recognize what respondents consider important for project managers to have competency in, based on their position or job title.

Table 4-14 – All General Topic Response Rates from Open-Ended Survey Question

Responses to Question #8 (% by Job Title)	PX	%	PM	%	PE	%	PS	%	Other	%	Total	% of Total Responses
Responses related to topics of Communication	10	21%	22	46%	10	21%	6	13%	0	0%	48	9%
Responses related to topics of Management	71	26%	94	34%	60	22%	45	16%	7	3%	277	51%
Responses related to topics of creating and following a project Schedule	41	21%	79	40%	49	25%	25	13%	2	1%	196	36%
Responses related to topics of working with project Subcontractors	7	29%	6	25%	6	25%	4	17%	1	4%	24	4%
Totals	129	24%	201	37%	125	23%	80	15%	10	2%	545	100%

The highest percentage of responses were related to the general topic of management (51%). Responses related to the topic of creating and following a project schedule had the second highest response rate (36%). These two topics, management and schedule, account for 87% of all

survey responses to question #8. The third highest response rate (9%) of the identified general topics was related to the topic of communication. Responses related to the topic of working with project subcontractors had the lowest percentage of (4%) of the four general topics.

4.9.3 Narrowing Survey Responses

Because the purpose of this research was to identify those important skills, tools and knowledge, the researcher used responses to question #7 as a filter for the data reported. Question #7 is “What percentage of time do the projects you manage finish on schedule?” Responses to this research were filtered to reflect those that reported finishing the projects they managed on schedule at least 90% of the time. Understanding what skills, tools, and/or knowledge are necessary for finishing projects on schedule could help project managers focus their efforts and/or educational pursuits in areas of understanding they might currently be deficient in. The researcher is aware that broad interpretations can be used to define a project finishing “on schedule.” However, considerations that might require time additions or deletions in a schedule were not part of this research and will not be discussed in this paper.

Table 4-15 shows percentages of survey responses when filtered to reflect projects finishing on schedule 90% -100% of the time. These filtered responses represent 61% of all responses to this question.

Table 4-15 – General Topic Response Rates of Open-Ended Question with 90%-100% Filter

Responses to Question #8 (% by Job Title)	PX	%	PM	%	PE	%	PS	%	Other	%	Total	% of Total Responses
Responses related to topics of Communication	5	21%	11	46%	5	21%	3	13%	0	0%	24	7%
Responses related to topics of Management	38	23%	66	40%	30	18%	30	18%	2	1%	166	50%
Responses related to topics of creating and following a project Schedule	23	18%	56	45%	33	26%	11	9%	2	2%	125	38%
Responses related to topics of working with project Subcontractors	4	27%	3	20%	5	33%	2	13%	1	7%	15	5%
Totals	70	21%	136	41%	73	22%	46	14%	5	2%	330	100%

No significant change of response percentages between these general topics was seen between Table 4-14 and Table 4-15 when applying the filter of finishing on schedule 90%-100% of the time. In Table 4-15 management received 50% (lower by 1%), schedule received 38% (higher by 2%), communication received 7% (lower by 2%) and subcontractors received 5% (higher by 1%).

Responses suggest that project managers who have a firm understanding and ability with topics requiring the management aspects of projects will have a higher probability of finishing their projects on schedule. Understanding how to create, follow, and manage the project schedule will have the second greatest influence for project managers' finishing their projects on schedule. These two general topics make up 88% of the responses to this question. The general topics of management and schedule are within the sphere of influence a project manager has with their project team.

A closer look at categories and subcategories, within these general topics, will show more specific management and schedule topics considered important to construction industry professionals. A few results in the category and subcategory Tables show the same percentage of responses. When this happens, the researcher uses decimal placements to the hundredths to distinguish a ranking priority for those specific responses (even though the decimal placements are not shown).

4.9.4 Management Specific Responses

The highest number of survey responses were sorted into the general topic of management. This topic represented 50% of the total survey responses received. Table 4-16 identifies categories within this topic that apply specifically to project managers. Categories in

this topic include (1) personal understanding of the project manager, (2) paperwork and construction documents, (3) working with various groups of people (e.g. subcontractors, owners, team members, etc.), (4) weekly meetings, and (5) knowledge of how to work on a project site.

Table 4-16 - Categories in the General Topic of "Management"

Categories within the general topic of Management (corresponding response % by Job Title)	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Category Response %	% of Total Responses
Personal Understanding of a Project Manager	13	25%	21	40%	11	21%	8	15%	0	0%	53	32%	16%
Project Manager's Understanding of Project Paperwork and Project Documents	8	24%	11	32%	4	12%	9	26%	2	6%	34	20%	10%
Project Manager's Ability to Work With People Related to the Project	11	22%	22	45%	8	16%	8	16%	0	0%	49	30%	15%
Weekly Meetings Related to the Project	1	6%	8	47%	6	35%	2	12%	0	0%	17	10%	5%
How a Project Manager works with the Project Site	5	38%	4	31%	1	8%	3	23%	0	0%	13	8%	4%
Totals	38	23%	66	40%	30	18%	30	18%	2	1%	166	100%	50%

The category of personal understanding of a project manager received the highest percentage of answers (32%) within the topic of management and the second highest percentage (16%) of the 17 categories within the four general topics. Subcategories within this category included (1) demonstration of knowledge or experience, (2) paperwork and construction documents, (3) ability to work with various groups of people related to a project, (4) weekly meetings, and (5) how to a manage a project site. Table 4-17 shows the distribution rates of the subcategories within the category of the project managers' personal understanding.

Table 4-17 - Subcategories in Category of "Personal Understanding"

Subcategories of Personal Understanding of a Project Manager	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Subcategory Response %	% of Total Responses
Project Manager's Knowledge or Experience with Construction of a Project	3	15%	10	50%	3	15%	4	20%	0	0%	20	38%	6%
Project Manager's Understanding of a Project Scope of Work	0	0%	1	50%	0	0%	1	50%	0	0%	2	4%	1%
Project Manager Skills or Interpersonal Skills	4	27%	2	13%	6	40%	3	20%	0	0%	15	28%	5%
Project Manager's Ability to use Tools and Software Related with a Project	1	17%	5	83%	0	0%	0	0%	0	0%	6	11%	2%
Project Manager's Understanding of Scheduling for a Project	5	50%	3	30%	2	20%	0	0%	0	0%	10	19%	3%
Totals	13	25%	21	40%	11	21%	8	15%	0	0%	53	100%	16%

The category with the second highest response rate in the topic of management (30%) was the ability of a project manager to work with groups of people involved with the project they are managing. This category also had the third highest percentage of responses (15%) in the 17 categories identified within the four general topics. People identified in this subcategory by construction professionals were (1) subcontractors, (2) owners, (3) project superintendent, and (4) the project team. The ability of the project manager to work with various groups of people that have differing responsibilities and backgrounds highlights the need for a project manager to have the understanding and skills necessary to work effectively with these people. Table 4-18 shows the distribution rates of these subcategories.

Table 4-18 - Subcategories in Category of the "Project Manager's Ability to Work with People Related to the Project"

Subcategories of a Project Manager's Ability to Work with People Related to the Project	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Subcategory Response %	% of Total Responses
The Importance of Effectively Working with Subcontractors	5	19%	12	46%	4	15%	5	19%	0	0%	26	53%	8%
The Importance of Effectively Working with Owners	2	18%	5	45%	2	18%	2	18%	0	0%	11	22%	3%
The Importance of Effectively Working with the Project Superintendent	3	38%	4	50%	1	13%	0	0%	0	0%	8	16%	2%
The Importance of Effectively Working with everyone on the Project Team	1	25%	1	25%	1	25%	1	25%	0	0%	4	8%	1%
Totals	11	22%	22	45%	8	16%	8	16%	0	0%	49	100%	15%

The category with the third highest rate of responses (20%) in the general topic of management was the project managers' understanding of construction paperwork and documents. It had the fourth highest percentage of responses of the 17 identified categories. Table 4-19 shows the distribution rates of the subcategories within this category.

Table 4-19 - Subcategories in Category of "Project Manager's Understanding of Project Paperwork and Documents"

Subcategories of the Project Manager's Understanding of Project Paperwork and Documents	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Subcategory Response %	% of Total Responses
Understanding Project Contracts / Handling & Tracking Submittals and RFIs / Schedules/etc.	6	24%	9	36%	2	8%	6	24%	2	8%	25	74%	8%
Implications of Project Costs and Budgets and their effect on the Project	2	22%	2	22%	2	22%	3	33%	0	0%	9	26%	3%
Totals	8	24%	11	32%	4	12%	9	26%	2	6%	34	100%	10%

The first subcategory was working with contracts, submittals, RFI's, schedules, and related documents received (8%) of the total responses in all four of the general topics, but received the majority (74%) of responses within this management category. The second subcategory was working with project costs and budgets, and was (26%) of responses within the management category, and received only 3% of all responses within the four general topics.

The fourth ranking category (10%) in the topic of management was holding weekly meetings related to the project. There were no subcategories for this answer. Meeting regularly and often with the project team is reflected in this response. It highlights the need for consistent communication (e.g. asking and receiving answers, understanding challenges with subcontractors, etc.).

The fifth and lowest category within the topic of management (8%) was understanding what project managers should do to help manage a project site. Table 4-20 shows the distribution rates within this subcategory.

Table 4-20 - Subcategories in Category of "How a Project Manager Works with a Project Site"

Subcategories of How a Project Manager works with a Project Site	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Subcategory Response %	% of Total Responses
Visiting and Walking the Job-Site to Know the Project Progress	1	17%	3	50%	1	17%	1	17%	0	0%	6	46%	2%
Understanding Project Resources Required for a Project and Having them Available for the work	2	50%	1	25%	0	0%	1	25%	0	0%	4	31%	1%
Knowledge of Munciple Requirements for Projects	2	67%	0	0%	0	0%	1	33%	0	0%	3	23%	1%
Totals	5	38%	4	31%	1	8%	3	23%	0	0%	13	100%	4%

Subcategories within these responses include (1) performing job site walks, (2) knowledge of what project resources are needed or on site, and (3) working with the municipalities where the project is being built.

Taking care of the project site and what a project manager observes while on site, has an important function for helping a project move forward. However, construction professionals ranked it lowest in the category of management.

4.9.5 Scheduling Specific Responses

Table 4-21 shows the categories identified by construction professionals in the general topic of the project schedule. This topic -- project schedule -- received the second highest response rate (38%) for question #8. Five categories were identified within this general topic. They include (1) general statements about understanding how to create a schedule, (2) having the knowledge to effectively use scheduling software, (3) having a knowledge of scheduling considerations and how they affect a project schedule, (4) having a knowledge of topics required for creating a project schedule, and (5) responses reflecting tasks that should be performed during the project construction activities.

Table 4-21 - Categories in the General Topic of "Creating and Following a Project Schedule"

Categories of "Creating and Following a Project Schedule" (corresponding response % by Job Title)	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Category Response %	% of Total Responses
Responses with a general or short statement regarding "Schedule"	0	0%	2	50%	2	50%	0	0%	0	0%	4	3%	1%
Responses of understanding and using "Scheduling Software"	1	25%	1	25%	1	25%	1	25%	0	0%	4	3%	1%
Responses reflecting a "knowledge of scheduling considerations" and how they affect a project schedule	7	13%	17	31%	19	35%	9	17%	2	4%	54	43%	16%
Responses reflecting a knowledge of topics required for "creating an accurate project schedule"	11	35%	17	55%	3	10%	0	0%	0	0%	31	25%	9%
Responses reflecting tasks that should be performed "during project construction activities"	4	13%	19	59%	8	25%	1	3%	0	0%	32	26%	10%
Totals	23	18%	56	45%	33	26%	11	9%	2	2%	125	100%	38%

The category with the highest percentage of responses (43%) within the general topic of scheduling and had the highest percentage of category responses in the survey (16%), was having a knowledge of scheduling considerations and how that will affect a project schedule. In the general topic of schedule, the category with the second highest response rate (26%) and the fifth highest percentage of category responses in the four general topics was tasks that should be performed during project construction activities. The third highest response rate in this category was (25%) a knowledge of topics required for creating an accurate project schedule. The lowest response rate in this general topic were general statements of understanding how to create a schedule (3%) and understanding how to use scheduling software (also 3%).

Three of the five categories that make up the responses referring to the topic of schedule have subcategories. The category with the highest percentage (43%) of responses was having a knowledge of scheduling considerations and how they affect a project schedule. Table 4-22 shows the distribution rates of subcategories in this category.

Table 4-22 - Subcategories in Category of "Knowledge of Scheduling Considerations and How They Effect a Project Schedule"

Subcategories of responses reflecting a "knowledge of scheduling considerations" and how they effect a project schedule	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Subcategory Response %	% of Total Responses
Understanding "lead time, procurement of materials & tracking" these items	4	12%	14	41%	10	29%	6	18%	0	0%	34	63%	10%
"Consulting trades" for times and impact with the project schedule	0	0%	1	20%	2	40%	1	20%	1	20%	5	9%	2%
Understanding how to work with project "Delays"	2	40%	0	0%	3	60%	0	0%	0	0%	5	9%	2%
Understanding schedule change and "Dealing with the Realities" of project construction	1	10%	2	20%	4	40%	2	20%	1	10%	10	19%	3%
Totals	7	13%	17	31%	19	35%	9	17%	2	4%	54	100%	16%

Understanding lead-time, material procurement, and tracking those items received the highest response rate (63%) within this category and also had the highest percentage (16%) of all twenty-seven subcategories identified in this research. This result makes it the most important

consideration when creating a schedule. The important distinction with this result is, that if no materials are on site then the project schedule falls behind. Understanding schedule change and dealing with the realities of project construction was the second highest response rate (19%) in this category. The subcategories of consulting the trades for times and impact on project schedules and understanding how to work with project delays had equally low response rates of 9% each in this category and 2% each of the total survey responses.

In the general topic of scheduling, the category of tasks that project managers should perform during project construction activities received the second highest response rate (26%). The category of knowledge of topics required for creating a project schedule was the third highest category that received a slightly lower rate of responses (25%). Tables 4-23 and 4-24 show the distribution rates of subcategories within these two categories.

Table 4-23 - Subcategories in Category of "Tasks that Should Be Performed During Construction Activities"

Subcategories of tasks that should be performed "during project construction activities"	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Subcategory Response %	% of Total Responses
Responses suggesting "tracking" construction activities for comparison with the schedule	1	11%	4	44%	3	33%	1	11%	0	0%	9	28%	3%
Responses to "update" the schedule and compare project progress to the schedule	2	22%	6	67%	1	11%	0	0%	0	0%	9	28%	3%
Responses to consistently "look ahead" at project progress for planning and scheduling	1	14%	3	43%	3	43%	0	0%	0	0%	7	22%	2%
Responses for constant "schedule communication" to everyone involved with a project	0	0%	6	86%	1	14%	0	0%	0	0%	7	22%	2%
Totals	4	13%	19	59%	8	25%	1	3%	0	0%	32	100%	10%

When compared to the total percentage of survey responses, the subcategory activities described in this category did not receive very high total response rates. Responses in this category included tracking the activities of construction (28%) and 3% of total responses, updating the schedule to reflect what has been completed (28%) and 3% of total responses,

looking ahead at construction activities (22%) and 2% of total responses, and communicating the schedule to the people involved with the project (22%) and 2% of the total responses to the survey. The distinction between tracking activity and updating the schedule is minor, but important. If a project manager is aware of construction progress but fails to record the activity so that construction activities can be compared with the project schedule, then the purpose of doing these activities is lost.

Table 4-24 - Subcategories in Category of "Reflecting Knowledge of Topics Required for Creating a Project Schedule"

Subcategories reflecting knowledge of topics required for "creating a project schedule"	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Subcategory Response %	% of Total Responses
Using proper "logic" during creation of a project schedule	1	25%	2	50%	1	25%	0	0%	0	0%	4	13%	1%
Understanding "sequencing" of construction activities	2	29%	4	57%	1	14%	0	0%	0	0%	7	23%	2%
Understanding activities that make up "critical path" and how to make adjustments to it during construction	2	25%	6	75%	0	0%	0	0%	0	0%	8	26%	2%
Understanding realistic "durations" for construction activities	2	29%	4	57%	1	14%	0	0%	0	0%	7	23%	2%
Tracking project "milestones" against schedule demands	4	80%	1	20%	0	0%	0	0%	0	0%	5	16%	2%
Totals	11	35%	17	55%	3	10%	0	0%	0	0%	31	100%	9%

This category has low total survey response rates for its subcategories as well. Five subcategories were considered important to know when creating a schedule: (1) understanding critical path (26%) and 2% of total responses, (2) realistic schedule durations (23%) and 2% of total responses, (3) schedule sequencing (23%) and 2% of total responses, (4) scheduling milestones (16%) and 2% of total responses, and (5) scheduling logic (13%) and 1% of the total survey responses. These response rates are low when compared to all other subcategories. However, understanding these concepts will help create accurate schedules for a project.

4.9.6 Communication Specific Responses

The percentage of responses reflecting the general topic of communication was very low (7%) when compared to the general topics of management (50%) and scheduling (38%). No specific subcategories were identified within the category responses of this topic. Table 4-25 examines the categories identified in this topic.

Table 4-25 - Categories in the General Topic of "Communication"

Categories within the general category of Communication (corresponding response % by Job Title)	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Category Response %	% of Total Responses
Responses containing basic "Communication" as the focus	2	18%	4	36%	5	45%	0	0%	0	0%	11	46%	3%
Responses containing Communication with a "Project Superintendent"	2	100%	0	0%	0	0%	0	0%	0	0%	2	8%	1%
Responses containing Communication with project "Subcontractors"	0	0%	3	60%	0	0%	2	40%	0	0%	5	21%	2%
Responses containing Communication within the "Project Team"	1	17%	4	67%	0	0%	1	17%	0	0%	6	25%	2%
Totals	5	21%	11	46%	5	21%	3	13%	0	0%	24	100%	7%

The basic idea of communication being an important skill had the highest rate of response (46%) of the categories within this general topic, but it only received 3% of the overall responses. Communication with the project team had the second highest category response rate (25%) within this topic, communication with subcontractors was the third highest category response rate (21%) in this topic, and communication with the project superintendent had the lowest category rate of response (8%) in this general topic. Communication is a skill that is generally publicized as very important. However, the construction professionals responding to this research did not rank it as high as other skills or knowledge.

4.9.7 Subcontractor Specific Responses

Survey responses referring to the project manager working with the project subcontractors performing construction activities are shown in Table 4-26. This general topic received the lowest (5%) response rate of the four general topics in this research.

Table 4-26 - Categories in the General Topic of "Working with Project Subcontractors"

Subcategories of "working with project subcontractors" (corresponding response % by Job Title)	PX	%	PM	%	PE	%	PS	%	Other	%	Total	Category Response %	% of Total Responses
Responses with a "general statement" regarding subcontractors	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0%
Understanding subcontractor "labor Performance and availability" for a project	2	20%	3	30%	3	30%	2	20%	0	0%	10	67%	3%
Responses of getting subcontractor "Buy-In" [or commitment to] a project schedule	2	40%	0	0%	2	40%	0	0%	1	20%	5	33%	2%
Totals	4	27%	3	20%	5	33%	2	13%	1	7%	15	100%	5%

Three categories were identified in this topic, but only two of them contained data when the filter of completing projects on schedule 90% - 100% of the time was applied. Understanding how well a subcontractor performs their scope of work and their availability to do the work for the construction project represented 67% of the responses within this topic. However, this category only received 3% of the total responses from industry professionals. Getting the subcontractor to "buy in" for performance of their required scope of work represented the remaining 33% of responses in this general topic and received only 2% of the total survey responses. General statements about subcontractors was the category that did not show a response rate when the data was filtered for finishing on schedule 90% - 100 % of the time. While subcategories are part of the general topics, they only represented a small percentage of all responses given in this research. However, the consequences of a subcontractor's performance (or non-performance) can have a significant effect on whether a project is completed on schedule.

4.10 Follow-Up to Responses

To gain a more thorough understanding of the data received through the open-ended survey question, a follow-up question asked where the respondents learned (or learned to use) the skills, tools, and knowledge they recommended with the responses given for question #8. Respondents were asked to mark all answers that apply. The distribution of answers is shown in Table 4-27.

Table 4-27 - Where Were Skills, Tools and Knowledge Learned?

Where were skills, tools & knowledge learned?	No. of Responses	% of Response
Apprenticeship	8	10%
Mentor	40	52%
Work Experience	73	95%
University	33	43%
Vocational School	3	4%
Professional Association	9	12%
Other (specify)	1	1%
(Other) Training Conferences	1	1%
(Other) Listening to subs needs	1	1%

Almost all construction professionals (95%) responded that they learned the skills, tools, or knowledge recommended in question #8 through work experience. Learning from a mentor accounted for 52% of the responses and 43% of construction professionals learned skills, tools or knowledge from studying at a University.

Table 4-28 shows a distribution of how many of the learning methods the construction professionals gained their industry knowledge and experience from.

Table 4-28 - Number of Learning Methods

No. of Learning Methods	No. of Responses	% of Responses
One	22	29%
Two	31	40%
Three	15	20%
Four	7	9%
Five	2	3%
Total	77	100%

The highest percentage of people (40%) learned the skills, tools, and knowledge they reported in question #8 from two different sources. A single method of learning was the second highest percentage (29%). This single method would most likely be from work experience, since the percentage from that method of learning was so high. The third highest percentage (20%) was learning from three different sources.

5 CONCLUSION

5.1 Summary of Survey Questions

The primary purpose of this study has been to find out what construction professionals consider the most important skills, tools, and knowledge for helping project managers complete the projects they manage on schedule. Preliminary to the answers of the original research questions (see section 1.3), this research found that project managers created project schedules most often. They typically created it alone, but they consulted an average of five other people in the process of making the schedule. This scheduling process almost always included the project manager and 45% of the subcontractors working on their projects. Others included with the schedule creation, but less often, included a project executive, the project owner, and the project superintendent. A surprise in the data analysis was that project superintendents were not consulted as often as project executives and project owners, even though demographic information revealed that project superintendents have more years of experience in the construction industry and more years of experience in their current position. Additionally, the research found that Primavera – P6 was used most often when it was the only software program used to create the project schedule.

Once the project schedule is created, and construction activities are moving forward, it must be updated. The purpose of tracking construction activities and updating the schedule is to adjust construction activities as needed. This process will help the project move forward so it

will be delivered to its owner by the contracted date. This research found that half of the project schedules were updated weekly and nearly all of them were updated using the “planned percent complete” (PPC) method of tracking construction activities. Projects managed by the construction professionals responding to this research completed them on schedule an average of 96% of the time.

5.1.1 Open-Ended Answers

Open-ended answers to the question, “What are the 5 most important things (tools, skills, knowledge) a project manager should know or use to keep a project on schedule?” produced insights into what construction professionals considered important for project managers to know or understand. The general topics of “management” and “scheduling” received the highest percentage of responses from the respondents to this survey. These two general topics represent almost nine out of every ten responses.

There were seventeen categories and twenty-seven subcategories revealed in this research. Subcategories represent responses closest to the original wording of respondents. Since two of the general topics did not have subcategories (communication and subcontractors) the seven categories in these topics also represented the closest responses from respondents. The seven categories from communication and subcontractors were grouped together with the twenty-seven subcategories for analysis of response rates. These thirty-four responses represented the closest original wording from the survey respondents. Ranking these responses (7 categories and 27 subcategories) from construction professionals revealed that the most important skills, tools, and knowledge for project managers to understand are (in order of importance):

1. “Understanding lead time, procurement and tracking these items”
2. “The importance of effectively working with subcontractors”
3. “Understanding project contracts/handling and tracking submittals & RFI’s”
4. “Project manager’s knowledge or experience with construction of a project”
5. “Weekly meetings related to the project”
6. “Project manager skills and/or interpersonal skills”
7. “The importance of effectively working with owners”
8. “Responses containing basic ‘communication’ as the focus”

It is the conclusion of this research that focusing in these areas will have the greatest impact for helping project managers keep the projects they manage on schedule.

5.2 Answers to Research Questions

Do the responses from survey respondents, as mentioned in the previous section, answer the original questions this research set out to answer? (Section 1.3) Table 5-1 shows a distribution of whether the top eight answers from above involve a skill, tool, or knowledge.

Table 5-1 - Subcategories Representing a Skill, Tool or Knowledge

Ranking	% of All Responses	Subcategory Topics	SKILL	TOOL	KNOWLEDGE
1	10.30%	“Understanding lead time, procurement and tracking these items”	X	X	X
2	7.88%	“The importance of effectively working with subcontractors”	X		X
3	7.58%	“Understanding project contracts / handling and tracking submittals & RFI’s”	X	X	X
4	6.06%	“Project manager’s knowledge or experience with construction of a project”			X
5	5.15%	“Weekly meetings related to the project”		X	X
6	4.55%	“Project manager skills and/or interpersonal skills”	X		X
7	3.33%	“The importance of effectively working with owners”	X		X
8	3.33%	“Responses containing basic “communication” as the focus”	X		

Based on this research, and in answer to the question, “What tools should project managers use to help them make decisions that keep projects on schedule?” the author recommends that project managers have tools for tracking and following up with (1) long lead procurement items, (2) submittals and RFI’s, and (3) topics identified in weekly meetings related to the project.

Likewise, in answer the question, “What skills do construction professionals consider important for helping project managers keep the projects they manage on schedule?” the author recommends that project managers should have (1) the skills required to track long lead procurement items, and (2) the interpersonal and communication skills to work with subcontractors working on the project and the project owner(s).

Additionally, the question of “What knowledge should project managers have (or draw from) to keep their projects on schedule?” was part of nearly all the top subcategory answers. This research demonstrates that project managers need to (1) understand what long lead items need to be procured and the timing of each, (2) understand how to work with the different subcontractors and help them work together on the project, (3) understand how to write contracts and RFI’s so that all scopes of work are covered and required information is received and transferred to those who need it, (4) understand how to track submittals, (5) have experience with the type of project being built, (6) have experience holding effective weekly meetings as the project is being built, and (7) understand that interpersonal skills are required to work with the project owner and entire project team.

Furthermore, in answer to the final question, “Are there activities or tasks project managers perform on a regular basis that help keep projects finish on schedule?” the researcher will refer to the response category with the highest percentage of answers. This category is

having a knowledge of scheduling considerations and how they affect a project schedule. Responses in this category were task oriented and the author advises project managers to (1) understand lead time when procuring materials and track these items, (2) understand that schedules change and work to deal with the realities of what is taking place on the project, (3) consult trades for times and impact with the project schedule, and (4) work to minimize potential project delays. These answers would include activities discussed earlier in this research. They include updating the schedule at least twice a month and using the planned percent complete method of tracking construction activities to know the status of the project they are managing.

Some of the answers to each of the original research questions overlap one another. The author would conclude that the responses that repeat themselves in each of the original questions emphasizes their importance. It is the opinion of this researcher that focusing in the areas receiving the higher response rates and regularly completing the tasks reported in this research will improve the likelihood that a project manager will complete projects they manage on schedule.

5.3 Recommendations

One of the conclusions from this research is that as a project manager's abilities and competencies increase, their ability to finish projects they manage on schedule will improve and/or increase. Based on results of this research, the author would recommend that commercial construction companies:

1. Have tools for tracking long lead procurement items. Be sure project managers are trained on the methods for ordering, tracking and ensuring delivery of these items. Have processes in place that are generally followed within the company. Then if an

- individual is replaced on a project, no delays occur when the new person picks up where the other person left off.
2. Construction companies should evaluate how well their project managers work with subcontractors and provide training to help them work with and coordinate the materials and labor they provide.
 3. Project managers should also know how to effectively work with the owners of the project. Interpersonal skills and communication received the 6th and 8th highest response rates in this research.
 4. Project managers facilitate the transfer of information. Writing contracts that fully include scopes of work provided to the project and how to write RFI's that clearly communicate questions that will provide clear answers to the people who need them.
 5. Have a method for tracking submittals required by the project and train the people reviewing what is submitted. This task is sometimes given to the people with the least construction experience.
 6. Weekly meetings provide another forum for the transfer of information to occur. Team members need to be prepared to ask and answer questions about project progress and track action items that arise during these meetings.

5.4 Suggestions for Further Research

Question #3 of the survey asked a general question about what percentage of subcontractors are consulted when a project schedule is created. The researcher would suggest seeking further insight into which trades are consulted most often.

Further insights into the methods used to track activities for updating the project schedule would be of value. Who typically updates the project schedule? Do commercial construction companies employ the same method for updating project schedules, or are they different in some way?

Further research could also focus on of completing projects on schedule. When asking construction professionals what percentage of time the projects they managed finish on schedule, no consideration was given for changes (change orders, weather, etc.) to the project which might impact the schedule.

REFERENCES

- Abdalla M. O., and Hussien T. B. (2002). "Causes of Construction Delay: Traditional Contracts," *International Journal of Project Management*, 20, 67-73.
- Ahmad, I. (1997). "Projects and IT: An Optimal Pairing," *PM Network*, June, 31-34.
- Assaf, S.A., and Al-Hejji, S. (2006). "Causes of Delay in Large Construction Projects," *International Journal of Project Management* 24, 349–357.
- Bedelian, H.M. (1996). "Successful Major Projects in a Changing Industry," *Proceedings of the Institution of Civil Engineers: Civil Engineering*, 114, August, 117-123.
- Calder, E. (2017). Interview
- Ceran, T., and Dorman, A.A. (1995). "The Complete project manager," *Journal of Architectural Engineering*, 1(2), 67-72.
- Cheng, M.Y., and Huang, C.C. (2012). "Evaluating Subcontractor Performance Using Evolutionary Gaussian Process Inference Model," *Life Science Journal*, 9 (2), 527-532.
- Cleland, D.I. (1986). "Measuring success: The owner's viewpoint," *Proceedings of the 18th Annual Seminar/Symposium (Montreal, Canada)*, Upper Darby, PA: Project Management Institute, 6-12.
- Dissanayaka, S.M. and Kumaraswamy, M.M. (1999). "Comparing Contributors to Time and Cost Performance in Building Projects," *Building and Environment*, 34, 31-42.
- Edum-Fotwe, F.T., and McCaffer, R. (2000). "Developing Project Management Competency: Perspectives from the Construction Industry," *International Journal of Project Management*, 18, 111-124.
- Egan, J. (1998). "Rethinking Construction: Report of the Construction Task Force," London: HMSO.
- Enshassi, A., Mohamed, S. and Abushaban, S. (2009). "Factors Affecting the Performance of Construction Projects in the Gaza Strip," *Journal of Civil Engineering and Management*, 15 (3), 269-280.

- Faridi, A. and El-Sayegh, S. (2006). "Significant Factors Causing Delay in the UAE Construction Industry," *Construction Management and Economics*, 24 (11), 1167-1176.
- Fearne, A. and Fowler, N. (2006). "Efficiency Versus Effectiveness in Construction Supply Chains: The Dangers of "Lean" Thinking in Isolation," *Supply Chain Management: An International Journal*, 11 (4), 283–287.
- Frank, T. (2002). *The Superior Project Manager*, Marcel Dekker, New York.
- Freeman, M., and Beale, P. (1992). "Measuring Project Success," *Project Management Journal*, 23 (1), 8-17.
- Gall, G., Gall, J.P., and Borg, W. (2003). *Educational Research: An Introduction*. White Plains, NY: Longman.
- Hsieh, T. (1998). "Impact of Subcontracting on Site Productivity: Lessons Learned in Taiwan," *Journal of Construction, Engineering and Management*, 124 (2).
- Hwang, B.G. and Ng, W.J. (2013). "Project Management Knowledge and Skills for Green Construction: Overcoming Challenges," *International Journal of Project Management*, 31, 272-284.
- Kale, S. and Arditi, D. (2001). "General Contractors' Relationships with Subcontractors: A Strategic Asset", *Construction Management and Economics*, 19, 541-549.
- Kerzner, H. (1994). *Project management: A systems approach to planning, scheduling, and controlling*, 4th edition, New York: Van Nostrand Reinhold.
- Latham, M. (1994). *Constructing the Team*, HMSO Publications, Centre, London.
- Majid, M.Z.A. and McCaffer, R. (1998). "Factors of Non-Excusable Delays that Influence Contractors' Performance", *Journal of Management in Engineering*, 14, (3), 42-49.
- NEDO, (1983). "Faster Building for Industry," National Economic Development Office, London.
- Newitt, J. S. (2005). *Construction Scheduling: Principles and Practices*, Prentice Hall 2nd edition, 4.
- Odeh, A. M. and Battaineh, H.T. (2002). "Causes of Construction Delay: Traditional Contracts," *International Journal of Project Management*, 20, 67-73.

- Pinto, J.K., and Slevin, D.P. (1988). "Project Success: Definitions and Measurement Techniques," *Project Management Journal*, 19 (3), 67-73.
- Pratt, D. (2017). Interview
- Russell, J.S., Jaselski, E.J., and Lawrence, S.P. (1997). "Continuous Assessment of Project Performance," *Journal of Construction Engineering and Management*, 123(1), 64-71.
- Shenhar, A.J., Levy, O. and Dvir, D. (1997). "Mapping the Dimensions of Project Success," *Project Management Institute*, 28 (2), 5-13.
- Smith, K. (2017). Interview
- Stuckenbruck, I.C. (1986). "Who determines project success?" *Proceedings of the 18th Annual Seminar/Symposium (Montreal, Canada)*, Upper Darby, PA: Project Management Institute, 85-93.
- Sweis, R.J., Bisharat, S.M., Bisharat, L., and Sweis, G. (2014). "Factors Affecting Contractor Performance on Public Construction Projects," *Life Science Journal*, 11(4s), 28-38.
- Tam, C.M. and Harris, F. (1996). "Model for Assessing Building Contractors' Project Performance," *Engineering, Construction and Architectural Management*, 3 (3), 187-203.
- Umble, M. and Umble, E. (2000). "Manage Your Projects for Success: An Application of the Theory of Constraints," *Production and Inventory Management Journal*; Second Quarter, 41 (2), 27.
- United States Government, Census Definitions
- Wikipedia, "Wasatch Front"
- Wikipedia, "2010 Census Statistics"
- Xiao, H. and Proverbs, D. (2003). "Factors Influencing Contractor Performance: An International Investigation," *Engineering, Construction and Architectural Management*, 10 (5), 322-332.
- Yates, D. S., Moore, D. S, and Starnes, D. S. (2003). *The Practice of Statistics*, (2nd ed.). New York.

APPENDIX A. SURVEY

Email Introduction

Dear _____,

My name is Scott Davies and I am a graduate student in construction management at Brigham Young University. I am working on gather data for my thesis and Evan Bingham (my thesis committee chair) suggested I contact you.

The research for my thesis is focused on understanding what skills, tools and knowledge are most useful in helping project managers keep projects they manage on schedule. My target population is the commercial contractors along the Wasatch Front. I would like to survey employees, (at all levels within a company), involved with building projects for their company. This would include project executives, project managers, project engineers, on-site superintendents, and any other people you feel could help give insight in this area. Would you please ask the people you work with to participate in my research?

The survey should only take about 5 minutes of your time. There are 14 questions in the survey (9 research and 5 demographic). All responses to the survey are anonymous.

I would appreciate you taking a few minutes to complete the research survey and ask other people within your company to take the survey as well. Please follow the link below: (When the window pops up you may need to click “follow the link” to get to the survey)

Survey Link

In an effort to gather as much data as possible, it would be a great help if you could forward this link to a colleague, or associate not with your company, to participate in the survey as well.

If you have any concerns, please contact me.

Thank you for your time.

Scott Davies

Survey Questions

Question 1 – Who creates the schedule for the projects you manage?

1. Project Executive
2. Project Manager
3. Project Engineer
4. Company employee dedicated to making schedules
5. Project Superintendent
6. Owner
7. Other (specify)

Question 2 – While a project schedule is being created, who of the following are consulted?
(Mark all that apply)

1. Owner
2. Project Executive
3. Project Manager
4. Project Engineer
5. Sub-contractors
6. Material(s) provider(s)
7. Other (specify)
8. None

Question 3 – When a project schedule is created, what percentage of subcontractors (of all the subcontractors used for the project) are consulted to determine the duration of the work they will perform?

-- (Answers given on a sliding scale of percentages)

Question 4 – Which of the following computer software programs does your company use?
(Mark all that apply)

1. Microsoft Project
2. P6
3. Suretrak
4. Asta
5. Phoenix
6. Other
7. None

Question 5 – Which of the following best describes how often your project schedules are updated?

1. At least weekly
2. Twice a month
3. Monthly
4. Every quarter
5. Every 6 months
6. Random intervals
7. Never

Question 6 – Which of the following methods best describes how you track activities or task completion when updating your project schedule?

1. % Complete (or Planned % Complete – (PPC))
2. Earned Value Analysis
3. Billing invoices
4. Other (specify)
5. No tracking method is used

Question 7 – What percentage of time do the projects you manage finish on schedule?

--Answers given on a sliding scale of percentages

Question 8 – What are the 5 most important things (tools, skills, knowledge) a project manager should know or use to keep a project on schedule?

--This is an open-ended question which could have had from 0 – 5 answers

Question 9 – Where did you learn the skills/tools/knowledge you listed in the previous question? (Mark all that apply)

1. Apprenticeship
2. Mentor
3. Work experience
4. University
5. Vocational School
6. Professional association
7. Other (specify)

Demographic Questions

Question 1 – What is your role in the company you work for?

1. Project Executive
2. Project Manager
3. Project Engineer
4. Project Superintendent

Question 2 – How many years have you worked in the construction industry?

--Specific number of years were given as answers

Question 3 – How many years have you worked in your current position?

--Specific number of years were given as answers

Question 4 – On average, how many projects do you manage at a time?

1. 1 project
2. 2 projects
3. 3 projects
4. 4 projects
5. 5 or more projects

Question 5 – Which of the following best describes the average size (contract amount) of the projects you manage?

1. Under 1M
2. 1M-5M
3. 5M-10M
4. 10M-25M
5. 25M-50M
6. Over 50M