INTERNAL ASSESSMENT OF ORGANIZATIONAL
MANAGEMENT PRACTICES FOR SMALL TO MEDIUM
SIZE GENERAL CONTRACTORS IN ATLANTIC CANADA

by

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Abstract

Benchmarking and organizational assessment in the Canadian construction industry are relatively well known concepts but are not applied as often as they should be. When applied at the organizational level, these principles can provide valuable insight into the state of management practices within an enterprise. Once key practices are assessed, results can be further analyzed and deficient areas can be reviewed for impact on organizational performance. The end objective in this process is for companies to determine which practices are most important and to focus on improving these practices moving forward. The barrier in this process is that organizations currently lack the ability to assess and in turn evaluate the results in a meaningful manner. This report demonstrates how a defined assessment tool can be used to collect data. Once collected this information can be used to evaluate management practices and can further be used to determine risk exposure given a set of project parameters. To demonstrate the suggested concepts, a sample organization is surveyed and a case study project is presented. The results demonstrate that any firm can use a defined assessment tool and apply basic risk management principles to facilitate overall organizational improvement.
Dedication

The author would like to dedicate this work to his family and colleagues who have provided inspiration, motivation, teaching and support throughout his academic and professional career.
Acknowledgments

The author would like to offer a special thanks to the study organization for participating in the data collection process, and for giving the author permission to use this information to conduct a full scale, organizational assessment.

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1.0 Introduction

1.1 Project Motivation

It is suggested by the author of this report that for every organization within the Canadian, and potentially international construction industry, an opportunity exists to improve its internal project management processes. Regardless of how advanced an organization is, there is always an opportunity to introduce efficiencies, streamline processes, and implement new systems where gaps may exist. The overall objective for any general contractor or construction manager is to deliver projects in the most proficient manner possible (in terms of safety, quality, cost, etc.), and in turn generate profit. In striving to meet this objective, the first step is to understand where opportunities can be realized within the organization.

It is also commonly accepted that any particular project, regardless of size, scope, or value, faces risks which are unexpected and outside of human control. In addition to these uncontrollable risks, an organization that has a poorly defined and/or executed set of project management practices and procedures also subjects itself to further potential risks. These risks can negatively impact the overall success of the organization and are the focus of this report.

The author of this paper further suggests that because organizations are failing to properly implement and execute suggested practices and procedures, which are considered “best”, they face lower than expected project performance, and potentially higher risk when executing construction projects. The organization’s inability to offer
consistent, and defined practices, results in greater risk exposure, and a higher potential for project failure.

Organizations need to have measures in place that will facilitate a simple, yet effective self-assessment of internal project management practices. Once assessed, upper management needs to be able to interpret these results, and understand where opportunities for improvement can be sought. It is suggested that generally, there is a lack of direction once a firm understands its problem areas (i.e. management understands the problem(s) but doesn't know what corrective actions are required). For many firms, this is where the improvement cycle breaks down. Based on this, firms need to have means of evaluating their processes, the ability to highlight and rank areas for improvement from a risk exposure perspective, and to implement corrective measures on an ongoing basis.

1.2 Problem Statement

With growing project complexity, there is a growing need for the organization to have advanced management processes and procedures to handle the challenges presented by each project. As an example, increasing time demands require more sophisticated tools to schedule project milestones and forecast completion dates. Alternatively, leaner and more complex project budgets require increasingly accurate cost control measures and precise tracking tools to ensure overall financial success; these are just a couple of examples the author can offer based on his experience to demonstrate the ongoing need for continuous improvement and advancement of internal processes and procedures.

The problem is not just at an organizational level but also is present at the industry level. As well, the development of a benchmarking and metrics program in Canada, capable of measuring and improving performance of the construction industry in
Canada as a whole has started later than many of the other developed countries of the world (Nasir, Haas, Rankin, Fayek, Forgues, Ruwanpura, 2012). Benchmarking and productivity improvement programs are scattered and not consistent across the country (Nasir et al., 2012). Few surveys have been conducted with Canadian companies (individually, provincially or nationally) to assess and to better understand management practices in the general contracting sector. Even if such data were collected and available, there is very little research describing how results could be analyzed and interpreted in a practical manner for the sole purpose of improving project delivery within a company.

Maloney (1990) highlights the importance of management’s response to evidence of poor performance, but reminds us of the reasons why this is a problem for many firms. Because of the competitive nature of construction, contractors generally take a minimalist approach to project management often using skeleton crews to complete hundreds of thousands of dollars’ worth of work. As a result, the management team is often overwhelmed with work, and is too busy taking care of project matters, instead of focusing on process improvement. Secondly, construction projects are generally short, with durations measured in weeks or months as opposed to years or decades. Consequently, the timeline to assess, plan, implement, and check is extremely short, making process improvement a moving target.

Based on the above, the primary hypothesis of this report is:

"Provided with an assessment of management practices, an organization’s risk exposure on any given project can be determined and can further be analyzed to highlight key practices requiring improvement. Using this information, management can more precisely make decisions on project selection and execution"
1.3 Goals and Objectives

The goal of this report is to develop a method that could be used by a typical small to medium-sized general contractor to assess management practices and in turn react to gaps in current processes. As will be demonstrated, gaps represent risk which needs to be assessed and properly managed. To demonstrate this overall process, a sample medium-sized company that is representative of a typical organization found in industry will be examined. The scope of this report is outlined in the following objectives:

1. To conduct a brief literature review to obtain literature on the topic of benchmarking, risk management and process improvement. Best management practices are considered with respect to the practice areas found in the defined assessment method discussed in objective 2.

2. To complete a review of current management practices at a medium-size general contractor using a defined assessment method targeting the assessment of management practices for typical general contractors.

3. To discuss in general the results obtained using the defined assessment method with the objective of developing an understanding of their current risk exposure within the various management practice areas. Furthermore, the results obtained will be compared with the findings from surveys conducted with similar sized firms in the Atlantic Provinces as well as across Canada.

4. To assess in detail, two key management practice areas as selected by the author. This assessment will serve as a means to demonstrate the suggested
technique of identifying and reacting to improvement opportunities using common risk management principles.

5. To present and explain the concept of altering the scope of management practices based on project complexity and size. The goal is to demonstrate that practice optimization is a balance between project requirements and available resources.

6. To discuss the importance of process improvement applied to the method presented in the above objectives.

1.4 Organization and Author's Background

The sample organization has been in business for over 60 years, with a target market focused in Atlantic Canada. This firm specializes in providing a combination of construction management and design-build type construction services. The organization is part of a construction conglomerate (group of related companies), and works within a number of industries ranging from light commercial (small tenant fit ups, office building type renovations), heavy commercial/institutional (multi storey new buildings, recreational facilities, institutional facilities) and heavy industrial (oil refining, mining and pulp and paper mill projects). Total project budgets could range from $5000 to upwards of $100 million. Typical project schedules could range from a few weeks to several years. Based on these market characteristics and the portfolio of projects that the organization has completed, it is assumed the firm has relatively mature project management practices, and therefore a relatively low exposure to internal risks.

The organization has a very well defined hierarchy (Figure 1), which has been well established in terms of managing projects, as well as day to day business strategy. In
terms of a management structure, direction comes from the top down with the General manager/vice-president making key decisions given input from the division manager and/or other divisions within the group. A well defined company policy dictates how tasks such as contract preparation/release, and purchasing are handled, with increasing purchasing authority moving up the chain; again based on the hierarchy. Key decisions, which have a significant impact on project objectives (financial, schedule, quality, etc.) always receive the approval by either the division manager or general manager.

Employees within the organization generally have many years of experience and have been with the company for an extended period of time (see figure 2). Turnover rates are fairly low in the operations (project execution) side of the company indicating that the organization has been able to obtain experienced individuals, and has been able to retain
them for long periods of time. From a management maturity perspective, having long serving employees who understand the company’s procedures is a significant advantage in terms of boosting project performance.

![Employee Years of Experience](image)

**Figure 2 - Employee Years of Experience**

Note: only personnel involved in the direct execution of projects were considered. Administration and support staff are not considered to have a significant impact on the outcome of a project in terms of the financial, time, quality and safety aspects of a project.

### 1.5 Significance of Report

This report is significant for a couple of reasons. First, for the host organization it represents the first time a detailed analysis has been conducted by an independent individual that is not part of the organization’s upper management structure. Instead, it comes from a project manager’s perspective based on data obtained from the general manager and another senior project manager within the company. It will provide the host
organization with an excellent opportunity to assess both strength and weakness areas and perhaps offer a glimpse at where potential improvements could be sought given a case study example. The end goal for the organization would be to balance the cost (time, financial, personnel) with the benefit (reduction in risk exposure) for any given project through optimizing their current internal processes and management practices.

From an industry perspective, this report will demonstrate a method for assessment and improvement of management practices that can be used by any typical general contractor executing projects within the Canadian Construction industry. Based on the literature reviewed in section 2.2 of this report, carrying out a risk analysis of an organization’s own internal processes is uncommon and therefore represents a unique opportunity for companies to seek improvements in this area.
2.0 Literature Review

2.1 Performance Analysis and Assessment

The concept of performance analysis is a well-researched topic in construction engineering and management. Korde and Mingen (2005) reviewed over (120) journal articles highlighting various tools and techniques for performance assessment focused at the project, project participant level, and activity level. They concluded, based on their research, that there is no definitive method used to predict or explain performance. Furthermore, they concluded that many of the models were strictly research based, as opposed to practice orientated.

Maloney (1990) considered organizational performance as multi-dimensional, consisting of characteristics such as efficiency, productivity innovation and profitability. He suggests that overall organization performance is a combination of several factors which the author of this paper suggests simplifying into individual (employee) performance versus management performance. Maloney (1990) found that one common problem is that management often struggles to identify poor performance, and secondly, they don’t always recognize the benefits or value in improving this lack of performance (thereby reducing cost, duration etc. of a project). Although this research focused more specifically on employee performance, the concepts suggested with regards to organization performance as a whole are valuable.

Rankin and Willis (2012) provided a brief overview of relevant literature discussing measurement of project performance using a combination of project performance measures such as cost, time, quality, safety etc. commonly referred to as project performance benchmarking. They identified the need for a measurement
framework that uses a combination of both leading and lagging indicators as a means of improving overall performance at an industry level (which in turn could be applied at an organizational or project level as well). The principles of the Construction Industry Macro Maturity Model (CIM3) will be applied in a similar fashion to the results of this report.

Nasir et. al (2012) in their report, found that a national benchmarking program in Canada is feasible and sustainable based on the implementation and results of the labour productivity and project performance benchmarking program. They demonstrated how data can be collected and analyzed. They further highlight the challenges with rolling out a benchmarking program that is robust in nature, which is an important consideration for a survey such as the DTAPP discussed next in this report. Nasir et. al (2012) also provided valuable feedback in terms of lessons learned which are important to consider when implementing a benchmarking program. Some examples of challenges highlighted were differing opinions between management and practitioners or the fact that owners are more willing to participate than contractors.

The Organizational Project Management Maturity Model (OPM3) detailed by the Project Management Institute (2003) also provides an extremely detailed framework for assessing current maturity (i.e. degree of implementation) of management practices against a comprehensive set of best practices. The OPM3 is well recognized within the industry, and covers a broad spectrum of management practices. It is both a tool for assessment, as well as an improvement tool. The OPM3 model’s cycle of knowledge-assessment-improvement (overall continuous cycle) is consistent with the target of the research and case study covered in this report. Where OPM3 looks to prioritize
improvements based on increasing maturity, this report looks at focusing on improvements based on reducing overall risk to the organization.

2.2 Principles of Risk Management

2.2.1 Risks Facing Construction Projects

Understanding where organizational performance is benchmarking is critical to understanding where risk exposure is on projects. Conducting an internal assessment is critical to understanding where there are opportunities for improvement and where your firm may be exposed to risk on a particular project. Singer and Erger (2008) stated that where there is design and construction, there are resulting claims and there is no definite or sure way to avoid such claims. Furthermore a difficult client can become dissatisfied, a good or bad contractor can make a mistake or other elements such as luck, karma and physics can take a good project and turn it into a disaster (Singer et al., 2008).

There are many different approaches and methods to categorize and sort risk. Abdou (1996) stated that generally there are three kinds of construction risks which surface in two phases (considered from the owner’s perspective). These risks are cost, time and design and can become apparent in either the pre-construction or construction phase.

Internal risks, in most circumstances, are preventable through efficient and well implemented systems. PMBOK refers to internal risks as “things that the project team can control or influence…” (PMBOK, 1996). These risks should be identifiable, with potential impacts known well in advance of an actual event. Standardized and well-developed processes can help to minimize exposure to such risks. Standardized processes
also offer more opportunities for continuous improvement because they are documented, and practiced by all individuals within the organization giving everyone an opportunity to provide relevant feedback. This is not possible in a scenario where multiple practitioners have implemented ad-hoc systems which are inconsistent across the organization.

2.2.2 Analyzing and Measuring Risk Exposure

The topic of risk management is a well-researched and explored topic in the engineering and construction management field. Risk management can be applied to various aspects of a project such as examining internal risk (those risks generated by the organization itself), external risks (outside of the organizations control – weather, subcontractors etc.) and outside factors such as political or economic factors that are very often completely outside of the organizations control but are an important consideration. Risk management is considered proactive while crisis management is reactive (Choudry, Iqbal, 2013). It is generally accepted in the construction industry that the risk management process consists of four basic but very essential steps – identification, analysis, response and control as described in most of the models reviewed later in this section. These steps have been expanded further by some practitioners to include review (post mortem project review) and continuous learning through knowledge sharing (Zou, Chen and Chan 2009). Others (Zhou and Zhang 2010) included the use of data bases to assist with the organization of more standardized risk events common to larger projects. A further review of relevant research is highlighted below.

Project Risk Analysis and Management (PRAM) is one of the earlier models developed and accepted by the industry as a comprehensive risk assessment model.
(Chapman, 1997). PRAM focused on nine distinct stages: Define, Focus, Identify, Structure, Ownership, Estimate, Evaluate, Plan and Manage. PRAM is iterative and it is suggested, and shown, that multiple passes are required at the various stages of a project. Like the concept of benchmarking, the results of an analysis will consistently be changing. Chapman also comments that it is important to maintain simplicity in a risk management process, regardless of the complexity of the project. Value from complexity is merely perceived.

The Project Uncertainty Management model (PUMA) is presented by del Cano and de la Cruz. (2002) which is described as a hierarchically structured, flexible and structured, generic project risk management tool. Although developed from an owner perspective, it can be easily adapted to a general contracting scenario. del Cano et al. took a traditional generic Project Risk Management (PRM) strategy (PRAM, others) and tailored it based on organizational risk management maturity and project complexity. Furthermore techniques used for analysis and the application of organization resources are also dependent on the project being undertaken.

The Risk Management Maturity Model (RM3), is a risk management maturity model based on five key attributes by Zou et al. (2009). Their attributes consisted of management, culture, risk identification, risk analysis and systematic risk management. Their model was tested and feedback/attributes of Australian construction industry were discussed. They suggested (4) levels of maturity ranging from ad-hoc to optimized.

Hallowell, Molenaar and Fortunato (2013) discussed the advantages of Enterprise Risk Management (ERM) and explain the extent and advantages of an ERM program in U.S. state DOT departments. Their general conclusion is that ERM can be very beneficial
but that it is not widely used. They conclude by stating that those DOT departments that have implemented such programs have been very successful – this provides an opportunity for other departments to achieve similar success. The development of an ERM program is extensive, requires a commitment from upper management, resources and time.

Zhou et. al (2010) presented a dynamic risk management system for large construction projects in China. The proposed system consisted of six parts which included risk and event data base, standard risk management components of identification, assessment, control and also tracking. The article demonstrated the software used to implement this risk management strategy which could serve as useful on larger projects.

A decision support system for modeling and management of project risks and risk interactions was suggested by Fang and Marle (2011). In their research the authors use classical risk management models but expand to consider risk interrelationship. The authors explain how loop relationships and chain reactions can impact the assessment of risk on a particular project.

2.3 Application of Literature

Although many projects are successful in the end, it is the author’s experiences that the path to project completion is full of surprises, foreseen problems and even known risks that always seem to exceed initial expectations. Risk is present in every aspect of construction and the best companies recognize this and are prepared to handle it to the best of their abilities.
From a construction manager’s perspective, most risk can almost always be traced back to a cost or schedule impact regardless of how seemingly unrelated that risk could seem. For example, a breakdown on the environmental management area could mean a hazardous spill which is not only a serious environmental problem, but will almost definitely impact the cost and schedule of the project - through clean-up costs, fines and delays.

The author of this report further highlights that based on research reviewed, there are two primary categories of risk facing any organization which is actively involved with the management of construction projects. Internal risks are those which are a direct result of poorly executed processes and principles. An example could be a poorly executed accounting system that in turn results in mismanagement of funds (financial risk) or a poor shop drawing process that results in delays in ordering of materials (schedule risk). External risks on the other hand are beyond the control of the company and are often the result of unforeseen factors and circumstances. These risks typically put direct pressure on the organization and cause management and personnel to react and develop mitigation strategies to address the problems. An example of this could be poor weather (schedule risk) or substandard soil conditions (cost and schedule risk). Due to the focus of this report, the author is primarily focused on the internal risks resulting from poor practice areas.

As briefly discussed at the beginning of Section 2.3, the concept of loop relationships and chain reactions in risk management is an important concept worth noting. Although the concepts suggested in some risk models are highly specialized and technical (not practical for a typical general contractor) the theory is valuable for even
small to medium-sized construction firms. Recognizing the basic principle that risks can be interrelated is important particularly when conducting an analysis of multiple management areas.

To assist with meeting the objectives of this report, the author is interested in applying basic risk management principles and theory as discussed in section 2.2 to assist with linking risk exposure and lacking internal management processes. These lacking processes and procedures are identified using a defined assessment method. Based on this approach, the PRAM flow chart presented by Chapman (1997) has been adapted to show the phases to be completed as part of this report. Because we are only interested in assessing internal risk exposure, some of the processes are relaxed and have been generalized in figure 3 below.
Figure 3 - Risk Analysis Process Adapted from Chapman

In the initial stages of define, focus, identify, structure and ownership, the organization needs to focus on two areas: assessment of the project and review of internal practices. Management and employees alike need to understand the project specific requirements, key deliverables, timelines and other relevant information. Understanding this information will be key to the risk assessment later. At this point, internal practices also need to be reviewed and assessed to understand where there is potential for risk exposure on a given project. Once the assessment is complete the organization should be able to begin developing an initial understanding of how well-suited they are to handle the potential project.
The next steps comprise the assessment which will aim to connect deficient and non-deficient practices with risks by using a risk score card. Once relationships are determined, practitioners can assess risks in terms of probability and impact to assist with highlighting which ones are of greatest importance. Once the process is completed, management should be better prepared to make key project decisions such as whether or not to proceed with the project, whether immediate actions are required to correct areas or perhaps to proceed without further action.

The final stage of the process, the management stage, is focused on monitoring the corrective measures that have taken place, and following up with subsequent internal assessments and overall implementing the continuous improvement cycle. In a similar manner to the management phase of a PRM plan, the technique developed in this paper requires follow up on through weekly, monthly or quarterly reviews and tracking.
2.4 Risk Indicators – Score Card Development

Once the internal assessment is performed, we need to be able to connect best practices and their degree of usage to potential risks on a project. One could argue that a company only needs to review each of the management practices and question whether or not it has been implemented to determine where the risks are for the company. The author suggests that the process is slightly more complicated than this because of distinct differences between organizational practices and the application of project practices.

Research has shown that various tools can be used to assist in the identification of project specific risks. Turnbaugh (2005), when considering risk management on large capital projects, recommended the use of a risk indicator score card. The list of risk sources should be comprehensive and should include all potential risks that could be encountered. If the risk indicator (an extension of a management practice) is not in place, the probability of an issue is greatly increased. As an example, if a cost management and control platform is not in place, cost control and monitoring will be nearly impossible. In this situation if a client or owner has certain expectations from the contractor or construction manager, and the proper tools are not present to provide results, confidence will be lost and there will be a greater risk of a problem.

Although different literature may lead to additional risk indicators or adjustment of the indicators presented, for the purpose of conducting and demonstrating the method suggested within this report, the list developed by Turnbaugh (2005) is assumed to be competent. These risk indicators will now be applied in conjunction with the detailed data obtained from the administered survey.
3.0 Research Methodology – Organizational Assessment

To understand the internal functions of an organization and how projects are executed we need to be able to collect data and information from individuals within the organization. There are various methods which could be employed to collect such information including personal interviews, long response surveys, group discussions, and so forth. Although each method may offer a host of advantages and/or disadvantages, the data collected needs to be concise and focused on providing a snapshot of management practice implementation.

3.1 Survey Design

The survey used for data collection was prepared for a research project entitled “Enhancing the Performance and Productivity of the New Brunswick Construction Industry through Appropriate Digital Technology Adoption”. This research initiative was completed as part of the Digital Technology Adoption Pilot Program (DTAPP) which aims to increase the productivity, and growth, of small and medium-sized enterprises across Canada, through the adoption of digital technologies (UNB CEM, 2012).

The DTAPP survey was developed to provide a comprehensive assessment of construction organizations’ operational processes and capacity, with respect to digital technologies, and to identify areas with the potential to improve firm performance and productivity through successful adoption. The overall survey is structured to provide feedback in key assessment areas which will be reviewed and discussed in detail within this report.

The survey was adapted and applied to the sample organization, introduced previously in this report for two reasons. First, the organization served as a pilot for the
administration and assessment of the questionnaire, and gave the principal and assistant researchers an opportunity to validate the effectiveness of the questionnaire. Secondly, the survey provided valuable feedback for the purpose of assessing and benchmarking key management practices employed in the delivery of construction projects. Once all data is aggregated this will give the sample organization an opportunity to review how they are benchmarking against other organizations surveyed across Canada. Furthermore, results should highlight which areas are lagging behind the other companies in industry and also offer insight into those areas in which the sample organization is leading the industry.

3.2 Data Collection

Data collection was conducted through face to face interviews with key individuals within the organization as identified by the author with input by the DTAPP principle researcher. These interviews/survey sessions ranged in duration from 1 ½ to 2 hours. Each question was typically reviewed and discussed as required prior to selecting a response. All responses were based on a five point Likert scale. Responses ranged from never (1) to always (5).

The intent of the survey was to collect data from individuals within the organization offering diverse experience, background and managerial power. This information would in turn provide feedback in terms of the usage of key management practices from differing perspectives. A total of (3) employees participated in the survey. These employees represented the vice president/general manager, senior project manager and a junior project manager.
The primary data collected is presented in Appendix B. An overview of employee responses and corresponding data obtained from these responses is presented in Section 3.4, with results segmented into the nine general practice areas which are further described in Section 3.3.

3.3 Overview of Management Practices

The management practices identified within the DTAPP survey are based on the PMI PMBOK with some categories cross referenced with closely linked practice areas (as an example - procurement is grouped with cost management). Each management area is loosely broken down into either a planning or a control grouping. As an example, the practice area of schedule management includes schedule development and analysis as a planning grouping, and schedule control as a control grouping. A general description of each management area assessed by the DTAPP survey is explained further below (including what would be considered “optimal practice” for each management area).

3.3.1 Time Management

Time management practices include the development of project schedules, duration estimates, tracking, monitoring and control of activities based on actual progress. Organizations that effectively implement time management understand the overall duration of a project, can track progress and understand and monitor resource requirements.

3.3.2 Cost Management

Cost management includes cost development (estimating), estimate analysis and lastly cost controls. Firms that understand the principles of cost management use well
defined estimating tools and techniques. They analyze project costs throughout the project life cycle and evaluate project costs on an ongoing basis to understand the financial status of a particular project.

3.3.3 Quality Management

Quality management focuses on the planning of quality management programs with the objective of controlling the quality of work performed in the field and assuring that quality is continuously monitored and improved upon, on an ongoing basis. Key quality management practices include the use of inspection and test plans, documenting nonconformance work, and internal auditing.

3.3.4 Scope Management

Effective scope management is based on the principles of clearly understanding the firms contractual obligations prior to entering and also during a project, being able to plan and manage unknowns through effective risk management, effectively managing changes in scope and lastly, effectively managing the contract closeout. Organizations that effectively implement scope management understand the initial scope of a project and are able to effectively deal with changes raised during project execution.

3.3.5 Health and Safety Management

Health and Safety management, unlike the other management practices is legislated and therefore best management practices are a combination of legislative practices as well as general practices. Key practices include the development and use of safety related policies and procedures, task specific planning that considers proper equipment, materials and resources.
3.3.6 Human Resources Management

Human Resource management aims to effectively link resources with projects. Key practices include development of a staffing plan, selecting project participants based on key skills, and assessing performance of project personnel through interviews and/or surveys. Firms that employ effective human resource practices ensure that the right people are assigned to any given project and that their progress is continuously monitored and assessed on an ongoing basis.

3.3.7 Materials Management

Materials management practices are focused on the effective ordering, delivery, handling and control of project specific materials. Best practices include the development of a material management plan, material tracking (i.e. during delivery and upon arrival at site), and coordinating materials through schedules and procurement plans. Organizations that properly implement material management understand every item required to complete the job, know when to order and how long it will take to receive, and effectively handle the materials once they arrive on site.

3.3.8 Information and Communication Management

Information and communication management deals with the receipt and distribution of project specific information. These management practices include having processes in place for storing project records, distribution of information to project participants and being able to access historical information. Firms that effectively perform information and communication management are also able to assess the flow of
information, and to control this information through reviews for efficiency, and effectiveness.

3.3.9 Environmental and Waste Management

Similar to safety management, environmental and waste management also has a legislated component. Environmental and waste management includes the reduction of impacts on surrounding environments and project waste, analysis of tools and techniques available to reduce waste and training project personnel with the overall objective of becoming more environmentally friendly. Firms that top the industry in these areas have well defined environmental and waste management programs and consistently look for improvements and opportunities for improvement.

3.4 Survey Results by Management Discipline

Based on the completed surveys and knowledge gained through practitioner interviews as described in section 3.2, the following information is available for each of the nine practice areas.

Figure 4 below graphically shows the results for the sample organization. Based on the graph it can be noted that there are opportunities for improvement across all management practice areas based on the survey results obtained. To assist with understanding what the survey results mean for the sample organization in terms of risk exposure, we can consider the relevant concepts of risk management and apply them to each management area based on project specific needs.
3.4.1 Time Management

The surveyed organization scored very well in terms of the development and implementation of project scheduling. Schedules generally follow a standard format and are developed by those directly responsible for managing the project. Best, probably and worst case scenarios are not typically reviewed which could be seen as a potential improvement. Instead, probable timelines are primarily used for schedule development. Senior staff generally conduct a high level review of the schedule for projects of greater significance. High level constraints and challenges identified at the design or procurement stage are analyzed, and impacts are allotted for within the project schedule. Resources in the form of personnel are assigned to projects early in the estimating stage with general conditions adjusted accordingly. Resource allocation appears to be ad-hoc with personnel changes tending to follow the demand of the specific project. Lower
results in this area are an indication that the right resource may not always be assigned to the project and instead the most available resource is used.

Another area with lower results was schedule control. Lack of schedule control can be characterized by instances of failing to recognize that a work task is falling behind until it is too late, or failing to understand the chain reaction of a single change or delay. The organization appears to do a decent job of capturing schedule changes and re-forecasting, although there does appear to be room for improvement.

Survey results indicate that there is a general consensus that there is a standard policy in place for schedule development, however, there is no indication of a consistent continuous improvement cycle. This hints that perhaps developing a more elaborate scheduling system, standard techniques, and a review process to analyze opportunities for improvement could be one recommendation.

3.4.2 Cost Management

Cost estimating appears to be well-executed within the organization based on the results analyzed. Estimates are developed using a standard chart of accounts and historical cost estimates are consulted when determining the overall project budget. There appears to be a good review process in place which includes project participants and upper management and focuses on a review of subcontractor quotations and the project estimate. As well, schedule and the impact on the overall estimate are considered with costs adjusted accordingly.

From an estimate analysis perspective, the organization performed well in the optimization of costs through alternative construction techniques and developing
procurement strategies. There is a standard procurement procedure in place with larger projects, each having their own procurement strategy that details budget, number of bidders, and tender release/closing dates. Cash flow analysis is rarely conducted at the project level based on the organization’s financial stability, however sometimes project specific cash flows are generated based on subcontractor invoicing and client requests. Return on investment is rarely analyzed in any great detail with the exception of confirming the project met targets at project completion. Financial performance of the organization is analyzed at the upper management level as opposed to on a project by project basis. Project uncertainties are often accounted for at the estimating stage but are not necessarily monitored or tracked closely during the project execution stage. Mitigation is the most common technique with budget dollars added to assist with transferring the risk to another party.

Project cost control techniques appear to only be partially employed within the organization. Project cost controls typically include cost reports broken down by the construction divisions which indicate actual, committed, and estimated to complete costs. Although actual versus projected costs are continually monitored, trends are only sometimes analyzed. Earned value is not typically used to update project status and data collected through forums such as post mortems are only sometimes utilized. The proper people do not always see the results which hinders the ability for future improvements. There tends to be greater variance in terms of the degree of sophistication of the techniques based on the individual(s) managing the project.

There was general agreement that more organizationally mature practices are not always employed with respect to cost management; however the overall policies and
procedures are defined and utilized. Furthermore, survey results showed that participants were only neutral when questioned whether cost management practices were continually improved upon.

3.4.3 Quality Management Practice

The organization scored marginally from a quality management perspective. The author also points out that the organization is currently in the process of developing a quality management manual, which when implemented should further improve the current practices in place at the organization.

Quality planning is implemented on most projects undertaken by the organization. Project specific quality plans along with inspection and test plans are typically informally completed with initial quality control measures identified early in the project.

Quality control is an important part of all projects as identified by survey results. Project specifications and contracts identify the quality requirements for a given scope of work. Work components that fail to meet these requirements are always documented by members of the project team and are brought to the attention of those responsible. Rework or completed work in general is reviewed through deficiency inspections and final acceptance is made by the project management team. Statistical figures however, are not specifically reviewed for deficient work.

Quality assurance is less of a focus within the organization compared to quality control. Quality performance is rarely examined and compared to any internal or external metrics. Little adjustment is made to any project processes and instead quality processes are more driven by the project specific practitioners and the organization as a whole. The definition of quality has been developed and taught within the organization more so than
recorded and handed to specific individuals. Furthermore, management monitors quality on all projects closely. Likely due to this reason, and because of the absence of a formal quality plan, opportunities for improvement are more difficult to identify.

3.4.4 Scope Management Practice

Scope planning is well conducted within the organization. Management strategic goals and objectives are considered on each project that is pursued (typically at the General and division manager level). The organization has the ability to pursue projects that are in the best interest of the organization and is rarely forced to take on any project because of financial or personnel commitments. Contract documents and project administration are always considered, although constructability on average is only sometimes reviewed.

An important consideration for the purpose of this project is the organization’s specific approach to risk management. Project risks are only sometimes identified based on common risk categories and contract provisions. Risks are sometimes but often rarely analyzed for their potential impact on the organization and the likelihood that they will occur. Finally risk responses are rarely developed based on those risks considered a priority. Based on these results there are many opportunities for improvement to be discussed later following the remainder of the organization assessment.

The organization generally performs well in terms of scope control during the project. Request for information and change order processes are fairly standard and normally utilized on all projects. Estimates are completed for out-of-scope work and backup documentation is provided to support each change order request. Claims prevention
strategies are rarely used and project risks are rarely re-evaluated throughout the project execution stage.

Finally, defined close-out procedures are often used on projects with procedures such as deficiency lists and close out documents used by most practitioners. As-built drawings and maintenance manuals are prepared by site personnel and provided to the owner for each project. In general, the policies and procedures are defined and where possible it is generally agreed that those procedures are improved upon.

3.4.5 Health and Safety Management practice

Health and safety management practices are very well defined within the organization and are very well practiced on all construction sites. The company has a well-defined safety policy and set of procedures which all employees are knowledgeable of and are expected to take part in. Health and safety training functions in a continuous improvement cycle with employees continually updating their training to ensure compliance. Health and safety statistics for the organization are recorded on a company wide basis and in some instances are also recorded at the project level depending upon the size and type of project.

Safety materials, equipment and resources are sometimes considered during project planning with complexity of the task as the major determinant for how much attention is warranted. Employees are always expected to use the proper tool for the task, to operate the tool using proper procedures, and inspections as regulated are continuously carried out. Safety materials, equipment and resources are generally continuously monitored and replaced as required.
Site inspections / hazard management occurs often on projects. Hazard inspections are always completed, documented with participants actively involved in the process. Statistics are commonly recorded and often this data is used to look for trends and areas for opportunity.

3.4.6 Human Resource Management Practice

Human resource practices are not site-specific but are set instead for the organization as a whole. Staff planning is always completed for each project to determine who will work in which role and for what period of time. Each project has a well-defined team structure and practitioners are matched with project expertise and past experience by the management team.

Human resources are analyzed often with skill assessments and performance evaluations conducted on a regular basis through the corporate side of the group (highlighted in the hierarchy as “other division of organization”). Team development is rarely to never used, with professional development and training sometimes used to support project personnel as required. A formal reward program is often used to recognize personal performance on a project but generally post mortem reviews are not conducted very often. As a result lessons learned opportunities for future projects are missing. In more recent months and on the last few larger project the company is taking steps to improve in this area.

3.4.7 Materials Management Practice

Materials management practice is probably one of the weakest performance areas for the organization based on the survey results obtained. Materials management plans
are sometimes used and often take the form of a series of tasks and durations located at the beginning of the schedule. Little attention is given to the impact of different suppliers and only sometimes are the links established between changes such as re-design and the impact on materials.

Materials are not often controlled on the company’s project sites. Disciplines such as tracking or lay down areas, are rarely utilized simply for the reason that projects are not large enough to warrant detailed analysis. In certain circumstances, material control is considered in terms of overall site planning but little attention is given beyond this. Deliveries to site are not always well-documented or controlled, occasionally resulting in misplaced materials or delays.

Materials are better coordinated than they are “controlled” on project sites. The degree of coordination appears to vary depending on perhaps size and location of project. Traditionally on larger projects procurement plans are utilized along with a material tracking schedule incorporated into the overall larger project schedule. On smaller projects it is not practical to use these measures simply due to the labour requirements to maintain and update these tools. Materials never have an inspection process and rarely have a process to confirm they meet to specifications (aside from the shop drawing process conducted prior to final procurement). Overall there is disagreement amongst the individuals surveyed that projects have policies and procedures for the management of materials.

3.4.8 Information and Communications Management Practice

The methods for distributing, collecting and storing project information are fairly well used within the organization. The company has a standard approach to setting up
and saving project files so that data can easily be accessed by various employees for differing purposes. This makes accessing historical information simpler for project managers. Training is not well utilized by the organization to inform how folders should be used and therefore there are opportunities for improvement in this area.

Information and communication control is not well executed. Projects are only sometimes benchmarked across the organization and lessons learned are not well captured as previously mentioned. Project metrics are used to rate overall project performance with cost and schedule considered the most critical elements or most often reviewed.

3.4.9 Environmental Waste Management Practice

Environmental and waste management planning is only sometimes implemented on projects with the actual process being very site specific (i.e. if a LEED project is being executed then it plays an important part of the overall process). If the organization is going to be rated for environmental performance or needs to meet specific environmental targets, there is a greater chance that the organization will strive to meet them.

Projects are only sometimes analyzed to determine if there are opportunities to reduce waste, and the quantities of materials are rarely analyzed for potential improvements. In the author’s experience waste reduction is often driven due to cost reductions and not necessarily for environmental improvement. Furthermore, audits (environmental) are only sometimes conducted on a project so feedback is limited. Individuals rarely receive specific training related to waste reduction or the environmental impact of construction. Overall as an organization, the survey indicated that the organization does not have policies and procedures defined for the environmental
and waste management on project; this represents good opportunities for further improvement. It should be considered that the organization has employed an environmental manager and has taken recent steps to reduce the group’s overall environmental footprint.

3.5 Summary of Survey Results

A graphical summary of the computed survey data is presented in Figure 5 below. In this figure, results are compared next to the Survey results obtained by the UNB Construction Engineering and Management Group (UNB CEM) to provide a reference for where the sample organization is trending relative to the firms sampled across Canada. A total of (33) organizations were surveyed using the DTAPP survey (UNB CEM, 2014).

Based on the numerical results, it can be noted that Health and Safety practices for the sample organization scored the highest out of all management practice areas and in fact was higher than the average of all companies surveyed. This result is consistent with the UNB CEM group’s conclusion that health and safety was the highest scoring management area. The primary driver behind this is the fact that Health and Safety practices are legislated in Canada.

Low scoring categories were materials, and environmental and waste management practices which again, is consistent with the other surveyed organizations. Quality, human resources and information and communication scored lower than the average of the other organizations while scope ranked approximately the same. Time and cost management practices, which will be examined in more detail later, both scored below the other organizations. Based on the survey results it can be concluded that the sample
organization is ranked slightly below average with the other firms. This is useful when determining the applicability of the framework presented later to the other organizations. Also due to the fact that many of the organizations show opportunities for improvement, it is reassuring knowing that each could potentially benefit from the use of tools aimed at practice improvement.

Figure 5 - Company A Survey Results vs. Aggregated Results of Other Organizations
4.0 Detailed Analysis of Results

The DTAPP survey serves as an acceptable initial indicator of management areas where potential short falls could result in the greatest risk exposure. Based on the survey results and the average scoring of the sample organization presented in Figure 6, we can look more closely at areas for improvement. For the sample organization, material and environmental/waste management were two areas with the overall lowest scores, a common trend found in the survey results collected nationally in Canada. As an example, Figure 6 below shows the theoretical risk exposure of the sample organization based on the data collected. In theory, this exposure will vary depending on project specific factors which will be discussed in more detail later in this report but in a general sense it is representative of risk exposure due to lacking management.

![Material Management Theoretical Risk Exposure](image)

Figure 6 – Material Management Theoretical Risk Exposure
A detailed risk analysis can be completed on any one of these project management areas to better understand the opportunities for improvement. Abdou (1996) stated the importance of matching risks with organizational capabilities and understanding the relationships in each scenario. In this situation, we are interested in knowing which lagging management practices are going to result in risk. For the purpose of this report two management areas will be considered in terms of overall risk exposure – cost and time management. Despite the fact that all management areas are critical to the overall success of a project, it is the author’s experience that cost and time are typically the most impacted factors in almost every project completed. Firms looking to perform a similar type analysis in future should consider the project specific variables and the initial benchmarking data obtained, to decide which if any management areas require further assessment.

4.1 Cost Management Detailed Analysis Sample

In the author’s experience, cost management is the single most analyzed project parameter on most, if not all construction projects he has worked on because it can both influence as well as be impacted by almost every other management area. For example, initial cost may dictate whether or not a project proceeds beyond the design stage, cost overruns during a project could cause a contractor to cut corners and negatively impact quality and so forth. Results are presented below based on the data collected using the DTAPP survey. Results are broken down into (3) main areas: Cost Estimating (planning), Estimate Analysis (planning) and Cost Control (controlling).

Based on the initial assessment (Figure 7) we can see that the organization scores quite well on Cost Estimating (4.45), lower on Estimate Analysis (3.20) and lower again
on Cost Control (2.83). These results indicate that the organization does a very good job at developing the estimate, but is lacking in terms of analyzing and controlling costs throughout the project. For this particular organization, the lack of analysis and control could represent a sizeable risk given a demanding project. As suggested by Turnbaugh (2005), cost management does not end with a sound baseline but continues with a program to monitor job progress and to accurately trend and forecast project costs.

![Cost Management Diagram](image)

**Figure 7 - Cost Management Detailed Analysis**

Within each of the sub-practice areas we can look even more closely at the lower scoring categories to better understand the specific practice areas that are potentially problematic for the organization. In this analysis, a low scoring category was assumed to be 3.0 or lower. Each area and the corresponding survey question are indicated below in Table 1 and Table 2, along with the average score for each.
Table 1 - Estimate Analysis Low Scoring Practices

<table>
<thead>
<tr>
<th>Practice</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Uncertainty in project estimates is explicitly defined and accounted for (e.g. addition of cost contingencies, additional resource assignment)</td>
<td>3.33</td>
</tr>
<tr>
<td>6.2 Projects are analyzed to determine the cash flow requirements throughout the duration of the project.</td>
<td>2.0</td>
</tr>
<tr>
<td>6.3 Projects are analyzed to determine the return on investment of capital and/or human resources.</td>
<td>2.66</td>
</tr>
</tbody>
</table>

Table 2 - Cost Control Low Scoring Practices

<table>
<thead>
<tr>
<th>Practice</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 Project cost control techniques include the analysis of trends over the completion of the project.</td>
<td>2.66</td>
</tr>
<tr>
<td>7.2 Earned value analysis is used to determine the time and cost status of projects.</td>
<td>2.66</td>
</tr>
<tr>
<td>7.3 Actual project costs are captured with supporting information so that they can be re-used to develop future estimates.</td>
<td>2.30</td>
</tr>
</tbody>
</table>

By examining the practices in detail we can develop a better understanding of where the root causes may be for deficient practice areas. This detailed review of results is essential to developing initial discussions within the organization and is the first step in making improvements. Next we need to link management practices to corresponding risk indicators.

Project specific risk indicators requiring consideration at the project level from a Cost Management Perspective as adapted from Turnbaugh (2005) are located below in Table 3. For the purpose of assessing the potential risk resulting from the low scoring
management practice areas, the chart below was developed by the author which links potential risk indicators with the low scoring practice areas. For example, DTAPP survey practice 6.2 “Projects are analyzed to determine the cash flow requirements throughout the duration of the project” is potentially connected to a number of risks indicators (indicators 1, 2, 3, and 6). Not unlike external project risks, we can see that a single short fall can impact different aspects of a project. In this situation, if the sample organization is failing to properly assess cash flow requirements throughout the project it could result in inaccurate forecasts, a break down in project financing or failure to meet the clients’ needs/demands by providing accurate cash flow reports.
Table 3 - Cost Management Risk Indicators

<table>
<thead>
<tr>
<th>Risk Indicator</th>
<th>Required Degree of Implementation (1-3)*</th>
<th>Low Scoring Practice Area</th>
<th>Potential Impact(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Project or program budget in place showing original budget, changes, current budget, forecast to complete and current expenditures</td>
<td></td>
<td>6.1, 6.2, 7.1, 7.2</td>
<td></td>
</tr>
<tr>
<td>2. Project budget shows all project elements e.g. design, permitting, construction, testing, and financing etc.</td>
<td></td>
<td></td>
<td>6.1, 6.2, 7.2</td>
</tr>
<tr>
<td>3. Cash flow profiles showing plan, actual and forecast in place</td>
<td></td>
<td></td>
<td>6.1, 6.2, 7.2</td>
</tr>
<tr>
<td>4. Complete file of all initial and revised budget information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Basis and assumptions for the budget</td>
<td></td>
<td></td>
<td>6.1</td>
</tr>
<tr>
<td>6. Standard and frequent updating of project budget, cash flow, and cost to complete estimate.</td>
<td></td>
<td></td>
<td>6.1, 6.2</td>
</tr>
<tr>
<td>7. Process for identifying, documenting and approving changes in place</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. RFI Log in place and operating</td>
<td></td>
<td></td>
<td>7.3</td>
</tr>
<tr>
<td>9. Logs in place for change requests, change notices, and change orders/authorizations</td>
<td></td>
<td></td>
<td>7.3</td>
</tr>
<tr>
<td>10. Reason and type of change being tracked</td>
<td></td>
<td></td>
<td>7.3</td>
</tr>
<tr>
<td>11. Contract time impacts being addressed on all changes</td>
<td></td>
<td></td>
<td>7.3</td>
</tr>
<tr>
<td>12. Change order pricing consistent with contract terms and conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Logs to include status of any necessary approvals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Log of outstanding disputes/claims and their disposition (supported by documentation for each)</td>
<td></td>
<td></td>
<td>7.3</td>
</tr>
<tr>
<td>15. Potential change log in place</td>
<td></td>
<td></td>
<td>6.1</td>
</tr>
</tbody>
</table>

*degree of implementation scale – 1 low implementation, 3 high implementation
Each risk indicator will not always be applicable given a specific project. For this reason a "Required Degree of Implementation" scale has been added to the risk indicator check list. For example, indicator No. 1 may have a score of (1) on a very small project where cost reporting is simplified or not a rigid requirement as opposed to a score of (3) on a large project which would likely require detailed cost reporting, change order tracking and cash flow forecasting. Probability and impact are the traditional tools to assess risk (Fang et. al, 2011) and in a similar manner we are using degree of implementation (probability) and a discussion of potential impacts in this analysis for the purpose of ranking risk items. There are also differing opinions within literature as to when a qualitative versus a quantitative approach should be taken when applying the concepts of probability, impact etc. during risk management. Chapman (1997) commented that there is a time and a place for both approaches but in the end it becomes a decision based on the purpose of the assessment and the available resources. Therefore, given this higher level approach, the author suggests a qualitative approach.

The assessment of impact will also depend on the characteristics of a specific project. The author of this report suggests assigning a qualitative value based on a cost, schedule, quality etc. range. In most cases the consequence of a risk becoming reality is often in the end a cost (i.e. schedule delay results in cost, quality issue results in cost etc.). Upper management always understands the consequence of a risk if it is highlighted as a cost as opposed to a qualitative assessment. For example, a delay resulting in staff having to work an additional two days on site may or may not catch the attention of management but the same delay expressed as a staff cost overrun of $5000 might.
At this stage, and without project specific data it is not possible to determine the applicability of the specific indicator and what the potential probability and resulting impact would be, should the organization fail to implement a particular practice area. Project requirements and resulting probabilities and impacts will be discussed in more detail in Section 4.3 of this report through application to a case study project.

4.2 Schedule Management

Often regarded as important to project cost, is project schedule. It is the author's experience, that in heavy industrial environments, where large pieces of process equipment are shut down to complete maintenance or to expand facilities, the project schedule becomes a critical element with work literally broken down into hour, or even minute increments. Commercial projects are also heavily focused on schedule, with leases and new building openings scheduled on fixed dates that are sometimes fixed contractually. Technology being employed on new projects is becoming increasingly more advanced, budgets are getting tighter and project schedules are becoming more demanding as clients and owners seek to maximize the returns from their investments through fast tracking in an attempt to obtain the end product faster.

Organization results for the schedule portion of the questionnaire are explained below. The schedule portion of the survey is broken down into (4) areas: Schedule development (planning), Resource management (planning), Schedule analysis (planning), Schedule control (control). Based on the results (Figure 8) it can be determined that the company scored very well on schedule development (4.33), low on resource management (3.35), low on Schedule Analysis (3.35), and acceptable on schedule control (3.50).
In the same manner as the cost management practices we can look more closely at
the low scoring schedule management areas in Table 4 and Table 5:
Table 4 - Resource Mgmt. Low Scoring Practices

<table>
<thead>
<tr>
<th>Practice</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1 Project resources (labour and equipment) are planned and assigned on</td>
<td>3.00</td>
</tr>
<tr>
<td>an activity/task basis (resource allocation)</td>
<td></td>
</tr>
<tr>
<td>8.2 Project schedules are adjusted to account for changes in the level</td>
<td>3.00</td>
</tr>
<tr>
<td>of resources required throughout the project (resource levelling)</td>
<td></td>
</tr>
</tbody>
</table>

Table 5 - Schedule Analysis Low Scoring Practices

<table>
<thead>
<tr>
<th>Practice</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1 During the development of project schedule, details of project</td>
<td>3.33</td>
</tr>
<tr>
<td>specific constraints and assumptions are defined.</td>
<td></td>
</tr>
<tr>
<td>9.2 Uncertainty in the project schedule is accounted for and explicitly</td>
<td>3.33</td>
</tr>
<tr>
<td>defined (e.g. addition of time contingencies, additional resource</td>
<td></td>
</tr>
<tr>
<td>assignment)</td>
<td></td>
</tr>
<tr>
<td>9.3 Project schedules are examined for the potential of decreasing</td>
<td>3.33</td>
</tr>
<tr>
<td>overall project costs through reduction in project time (e.g. time-cost</td>
<td></td>
</tr>
<tr>
<td>trade off analysis)</td>
<td></td>
</tr>
</tbody>
</table>

Further questions (Risk Indicators) requiring consideration at the project level from a Schedule Management Perspective are presented below. In this example if we consider risk indicator (7) in Table 6, it is linked to low scoring practice area (8.2). In this situation if resources are not adjusted and the project schedule is not being adjusted accordingly, monthly progress reports will be inaccurate and could mislead the client. Monthly reports often contain project worker hour counts, forecasts both of which are linked to cost; obviously, if information is not correct than the value of these reports will be diminished.
### Table 6 - Schedule Management Risk Analysis

<table>
<thead>
<tr>
<th>Risk Indicator</th>
<th>Required Degree of Implementation (1-3)*</th>
<th>Low Scoring Practice Area</th>
<th>Potential Impact(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cradle to grave project schedule</td>
<td></td>
<td></td>
<td>9.1, 9.2</td>
</tr>
<tr>
<td>2. Electronic schedule tool implemented (i.e. Primavera, MS Project)</td>
<td></td>
<td></td>
<td>9.1, 9.2</td>
</tr>
<tr>
<td>3. Schedule review process defined and implemented</td>
<td></td>
<td></td>
<td>9.3</td>
</tr>
<tr>
<td>4. Frequent and regular progress schedule submittals occurring with review/comments formalized</td>
<td></td>
<td></td>
<td>8.2</td>
</tr>
<tr>
<td>5. Formal response to all time extension issues/comments.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Verification process for work reported as actual in place.</td>
<td></td>
<td></td>
<td>9.3</td>
</tr>
<tr>
<td>7. Monthly progress report being prepared and issued.</td>
<td></td>
<td></td>
<td>8.2</td>
</tr>
<tr>
<td>8. Certain key tracking reports/analyses being done:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Planned vs. actual progress</td>
<td></td>
<td></td>
<td>9.3</td>
</tr>
<tr>
<td>b. Planned vs. actual construction work force</td>
<td></td>
<td></td>
<td>8.1, 9.3</td>
</tr>
<tr>
<td>c. Contractor performance tracking</td>
<td></td>
<td></td>
<td>8.1, 9.3</td>
</tr>
<tr>
<td>9. Daily reports tracking critical information</td>
<td></td>
<td></td>
<td>8.1, 8.2</td>
</tr>
</tbody>
</table>

*degree of implementation scale – 1 low implementation, 2 high implementation

### 4.3 Sample Project

#### 4.3.1 Background

To demonstrate some of the concepts discussed above, consider ‘Project A’. This project is a 3500 sqft, specialized commercial tenant fit up, within an existing building, in a large Atlantic Canadian city. Total project budget is $1 million dollars, of which $750k
is comprised of typical construction activities (interior finishes, mechanical, electrical), while the remainder of funds are committed to furniture, equipment and tenant related expenditures. This particular project has a (12) week duration, with the owner subjected to a significant financial penalty billed monthly if the new tenant space is not operational at the end of the (12) week construction phase. In terms of cost management, this project is more complex because the financials are split into several smaller projects therefore requiring multiple cost reports and tracking. As well, the owner has expressed concerns with cost over-runs due to a marginal expected return on the end lease agreement. The contractor-owner relationship in this situation is also unique since both parties share a common owner. As a result of this relationship, some of the risk indicators are relaxed to some degree as explained below.

Project staff consists of a project manager, superintendent and contract administrator. The Cost Management – Risk Exposure analysis portion of this project is presented below.

4.3.2 Analysis

Based on the classification approach tool identified above, this project would initially carry an intermediate risk based on the schedule and cost estimate to complete the project. Based on the current benchmarking assessment of the organization it would be safe to assume that the organization could complete this project with minimal difficulties. Based on the project specific characteristics provided in the case study introduction, we can now review the risk indicator table for the cost management practices.
Table 7 - Project 'A' Cost Management Risk Analysis

<table>
<thead>
<tr>
<th>Risk Indicator</th>
<th>Required Degree of Implementation (1-3)*</th>
<th>Low Scoring Practice Area</th>
<th>Potential Impact(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Project or program budget in place showing original budget, changes, current budget, forecast to complete and current expenditures</td>
<td>3</td>
<td>6.1, 6.2, 7.1, 7.2</td>
<td>Financial Error(s), Misinformation to client</td>
</tr>
<tr>
<td>2. Project budget shows all project elements e.g. design, permitting, construction, testing, and financing etc.</td>
<td>2</td>
<td>6.1, 6.2, 7.2</td>
<td>Financial error(s),</td>
</tr>
<tr>
<td>3. Cash flow profiles showing plan, actual and forecast in place</td>
<td>1</td>
<td>6.1, 6.2, 7.2</td>
<td>Insufficient company cash flow, Financial error(s)</td>
</tr>
<tr>
<td>4. Complete file of all initial and revised budget information</td>
<td>2</td>
<td>N/A</td>
<td>Cost overruns</td>
</tr>
<tr>
<td>5. Basis and assumptions for the budget</td>
<td>2</td>
<td>6.1</td>
<td>Cost overruns</td>
</tr>
<tr>
<td>6. Standard and frequent updating of project budget, cash flow, and cost to complete estimate.</td>
<td>1</td>
<td>6.1, 6.2</td>
<td>Financial error(s), Cost overruns</td>
</tr>
<tr>
<td>7. Process for identifying, documenting and approving changes in place</td>
<td>3</td>
<td>N/A</td>
<td>Financial error(s), Cost Overruns, Client Misinformation</td>
</tr>
<tr>
<td>8. RFI Log in place and operating</td>
<td>1</td>
<td>7.3</td>
<td>Financial Tracking</td>
</tr>
<tr>
<td>9. Logs in place for change requests, change notices, and change orders/authorizations</td>
<td>1</td>
<td>7.3</td>
<td>Financial Tracking</td>
</tr>
<tr>
<td>10. Reason and type of change being tracked</td>
<td>1</td>
<td>7.3</td>
<td>Client Misinformation</td>
</tr>
<tr>
<td>11. Contract time impacts being addressed on all changes</td>
<td>2</td>
<td>7.3</td>
<td>Schedule overruns</td>
</tr>
<tr>
<td>12. Change order pricing consistent with contract terms and conditions</td>
<td>1</td>
<td>N/A</td>
<td>Financial error(s), Contractual disputes</td>
</tr>
<tr>
<td>13. Logs to include status of any necessary approvals</td>
<td>1</td>
<td>N/A</td>
<td>Financial Tracking, Financial error(s)</td>
</tr>
<tr>
<td>14. Log of outstanding disputes/claims and their disposition (supported by documentation for each)</td>
<td>1</td>
<td>7.3</td>
<td>Financial Tracking</td>
</tr>
<tr>
<td>15. Potential change log in place</td>
<td>1</td>
<td>6.1</td>
<td>Financial Tracking</td>
</tr>
</tbody>
</table>
Based on the results presented in Table 7, a number of comments can be made. The first objective is to review the risk indicators requiring the highest degree of implementation. For this project indicators (1) and (7) had a ranking of (3) meaning those indicators require full implementation on this particular project. Full implementation is required in this situation because this project requires detailed cost reporting as requested by the owner. Indicators (2), (4), (5), and (11) all had a score of (2) indicating they will require moderate implementation which would be expected given a project of this size and duration. It can be noted that several of the other key risk indicators all carried a score of (1) or low implementation despite the fact the project would be considered a “level 2” as per Figure 9 discussed in Section 4.4.

Next we can look at the risk indicators and highlight where the potential impact could be. Indicators (1) and (7) both require a high degree of implementation on this project. If the organization is lagging in these areas the result could be financial errors, misinformation to the client and potential cost overruns on the project. Management needs to discuss each of these impact areas in detail before proceeding. If we consider indicator (1) more closely, it is linked to low scoring practice areas (6.1), (6.2), (7.1) and (7.2) and stands out as one of the areas requiring immediate attention. If we consider a practice area such as (7.3), it is not as concerning as it is mostly linked to indicators with a require a lower degree of implementation.

Taking the analysis one step further, the organization should look at each practice area highlighted above. For example practice 6.1 “Uncertainty in project estimates is explicitly defined and accounted for (e.g. addition of cost contingencies, additional
resource assignment). Given this particular project the firm may want to review in detail how they will assess cost contingencies, what tools and techniques have been utilized, is historical data available and what lessons can be learned from it etc. Given the importance of understanding uncertainty and the potential on the highlighted risk indicator, the organization may want to implement changes in this area to lower potential risks going forward.

We can consider (2) other general scenarios from this case study. First if the organization was benchmarking significantly lower than its current level, the number of low scoring practices would be greater and the significance of having a high degree of implementation with a greater impact would be heightened. From another perspective if the project value was higher and the duration of the project was longer most of the indicators would have higher degrees of implementation based on the suggested project variation approach, and the resulting impact would be higher. In this situation it would be recommended that the sample organization spend significantly more time reviewing the low scoring practice areas since the resulting risk exposure would likely exceed the organization’s risk tolerance. Or in this scenario another option might be to seek alternative projects that are more in alignment with their current practice levels.

4.4 Practice Application based on Project Parameters

The concept of varying the degree of effort or practice implementation given a project’s specific characteristics is a common theme in the literature reviewed. del Cano et. al (2002) suggested altering the project risk management approach given project complexity and characteristics, Rankin et al. (2014) further suggested that project management practices vary with the complexity of an organizations projects. In this
report, and based on the information obtained from the sample organization, the author suggests considering project cost and budget as a means for determining how practice implementation can vary. See Figure 9 below.

Figure 9 - Project Classification Tool

In theory, if an organization has established a current benchmark (refer to figure 4 – sample organization DTAPP results) then they can quickly identify where their current risk exposures are from a high level perspective. In turn, using a method similar to the one completed for the cost and schedule management practices above, they can identify which practice areas are the most concerning. An organization that mostly works on projects that are in the basic risk category as highlighted in Figure 9, might deem it acceptable that they are benchmarking lower than other firms simply because their target market does not demand higher expectations, or perhaps they are comfortable with the risk exposure given their portfolio of projects. From an organization’s perspective, the
cost-benefit trade-off to improve the organization's practices might not make sound business sense.

From another perspective, if an organization is working primarily on projects that would be considered intermediate risk, but they are benchmarking lower than the industry average, they will likely want to take steps to mitigate their risk exposure. In this scenario, the level of exposure (expressed as a potential financial loss, schedule delay, threat to reputation etc.) would arguably exceed the cost trade-off to improve the organization's practices. In this situation it would make sense for the organization to invest in improving its practices.

There are also considerations with respect to the classification approach and risk exposure even if a firm scores extremely high on the benchmarking scale. The question then becomes is the organization effectively using resources to suit the client or project needs given the project parameters? In some instances, an organization may be using a general approach to project management which could result in misallocation of resources, loss of profitability and missed opportunities on other projects.

Understanding project requirements, the organizations abilities and risk exposure on a given project are instrumental in tailoring an approach for any given project. Without understanding the specific requirements of any given project, the only possible approach taken by a firm is a general one which is not efficient. The underlying objective of the project classification approach is that projects get reviewed in detail and that firms consider potential risks before a project starts.
5.0 Conclusions and Recommendations

5.1 Limitations and Caveats

Applicability of process improvement will vary based on organizational structure, markets and organizational maturity. A broad brush approach cannot be assumed and one set of recommendations will not be suitable for every organization. Therefore the recommendations of this report need to be considered on an organization by organization basis.

The data collection was limited to a single organization, assumed to be representative of a typical medium-sized general contractor offering construction management, lump sum, design-build type services in Atlantic Canada. Data collection was limited to only (3) surveys and therefore conclusions can only be drawn with regards to the processes discussed in this report and not based on the statistical significance of the data. The individuals surveyed represented the general manager, a senior project manager and project manager from the sample organization. If a similar type study was to be conducted within an organization for the purpose of making actual improvements, the number of individuals surveyed and their positions should be considered further. For example, if an organization consisting of (50) individuals (all assumed positions focused on project management practice areas) was studied compared to an organization consisting of (100) individuals the approach might vary significantly. The data collection stage needs to be focused on obtaining data from key individuals within the organization who represent both upper management, field personnel and positions in between. As demonstrated in this report, positions should also range in level of authority with a proper mix of office and field personnel. The objective of the data collection should be to seek
the best possible data using the most appropriate methodologies. The data collection techniques and means of obtaining could vary greatly or be altered to best suit the organization being studied.

A discussion is also warranted in terms of the survey results obtained and the handling of "outlier" scores. For the purpose of this report all data was considered and outlier scores were not removed from the data set. In a quantitative statistical analysis, this would not normally be the case. However, because the data in this report is considered from a qualitative perspective these outliers provide useful discussion points. Outliers are sources of disagreement, areas where potentially upper and lower management have different perspectives or where field and office personnel share different views. Acknowledging differences is important but there is more value in the discussion of these differences as a group or organization. Therefore, it is recommended that in future trials a discussion, or even assessment, of the results be conducted in a group format as opposed to individually. This would give participants an opportunity to express their candid views more openly and to provide evidence to support survey responses given.

The DTAPP survey has been utilized in this report as the sole means of collecting and organizing data related to the various project management practice areas. Although the author of this report feels that the DTAPP survey is extensive and successfully implemented across Canada, there are always alternative means of obtaining results and differing opinions within literature. The volume of available literature is broad and academics and industry professionals will continue to share differing views and perspectives.
Using management practice survey results, this report demonstrates how risk management principles can be applied to assist firms in determining which management areas are of greatest importance given a set of project parameters. Although the concept has been demonstrated for two practice areas, the remaining practice areas have not been discussed in detail from a risk analysis perspective and risk score cards have not been developed. Prior to conducting a fully analysis, a practitioner would need to develop a complete risk score card which encompasses all areas discussed in the survey.

Once priorities have been assigned to management practice areas, the organization needs to develop a strategy to facilitate improvements. This report aims to assign priorities based on level of risk exposure but does demonstrate how companies can improve practice areas. The literature base on practice improvement is broad and next steps will vary greatly based on organizational factors (size, structure, markets etc.).

5.2 Conclusion

Overall, the construction industry in general needs to spend more time assessing project management practices. The consensus is that minimal time has been spent developing a standardized benchmarking program, and that few firms in the Canadian construction industry actively assess the use and effectiveness of their practices on a regular and ongoing basis. Once assessed, and improvement areas are highlighted, there is a lack of guidance in terms of which practice areas to focus on and what steps should be taken to react.

In this report a brief literature review was conducted to obtain pertinent literature on the topic of benchmarking, risk management and process improvement. Best management practices were considered with respect to the practice areas found in the
defined assessment method discussed in objective 3. It is concluded that there is a significant amount of available research on the topic of risk management, improvement and benchmarking. Relevant concepts have been applied in this report where appropriate to develop and test the proposed model.

An overview of current management practices at a medium-size general contractor was completed using a defined assessment method. It was found that this general contractor was similar in terms of management practice to the research obtained from the cross Canada survey. This validated the survey organization as an acceptable sample organization to demonstrate the analysis.

Survey results were discussed for the purpose of developing an understanding of the organization’s current risk exposure within the various management practice areas. Numerical results obtained were further compared to the DTAPP survey results to demonstrate how the sample organization is benchmarking against (33) others firms across Canada. Health and Safety practices along with Scope management practices were the highest scoring areas for the sample organization. Environmental and Materials management practices were the lowest scoring areas which was consistent with the DTAPP results of other firms. Overall the sample organization had similar results to the surveyed firms in the Atlantic Provinces and across Canada.

Two key management practice areas, selected as cost, and schedule management were assessed in detail, to demonstrate how risk management principles could be applied following an initial benchmarking exercise to determine organizational risk exposure. A case study project was presented and it was demonstrated how project specific factors can
impact the importance of certain management practice areas thereby impacting the organization.

Based on developing an understanding of the organization's degree of risk exposure, the concept of adjusting the degree of implementation management practices, based on project complexity and size, is proposed. It is suggested that optimizing project management practice is a balance between project requirements and available resources. Optimizing profit and organization effectiveness involves understanding project requirements and developing a project execution plan accordingly. Project requirements are constantly changing which results in organizations consistently having to re-assess and alter their project management strategy moving forward.

Overall this report provides an acceptable option for organizations looking to assess management practices from a risk exposure perspective. It is recognized that further refinements of this concept are required, including the expansion of the risk score card, before it could be fully applied. With an expansion of the concepts applied in this report, the assessment method presented can provide small to medium size general contracts valuable feedback.

5.3 Recommendations

5.3.1 Industry Practice

As suggested in this report, it is widely accepted that there is a lack of data collection and benchmarking across the Canadian construction industry. If the industry strives to improve, practitioners need to understand where to look for improvements. The following are the contributions this report has made to the construction industry and how the industry can improve in future work.
1. A basic assessment tool has been developed that can be used by organizations to understand their current internal risk exposure. Members of industry need to begin actively engaging in the practice of benchmarking to begin to understand their internal processes if they wish to make improvements. This begins with a commitment by upper management but extends to front line practitioners.

2. It is suggested that the concepts presented within this report, be applied to small to medium size general contractors within industry that are looking to develop a better understanding of their internal process and the potential impact on the outcome of a project. The basic steps of assessment, review, risk analysis and continuous improvement can be applied to virtually any organizational setting regardless of size or technical expertise.

3. It is suggested that organizations that have completed the initial assessment begin focusing on one or two key practice areas highlighted using the risk assessment method proposed. Recognizing that firms have limited resources to work with it is critical to consider resources when planning for improvements. Once measurable improvements are made, firms can re-assess to determine if further work needs to be completed or if other practice areas should be examined based on their current project portfolio.

5.3.2 Continuous Improvement Cycle

All research reviewed, whether based on risk management principles, or benchmarking, stresses the need for an iterative process that continually updates data and offers potential improvements. The concepts of benchmarking, and the ensuing risk exposure analysis are meant to be ongoing. Firms need to continually check to see which
areas are improving or falling behind and they must constantly be looking for opportunities for future improvements.

The continuous improvement cycle shown in Figure 10 includes three key steps: knowledge, assessment and improvement. Initially knowledge is the base of information contained within the organization or could be considered as the degree of practice implementation. For most organizations it would be unclear what this base is because it has never been assessed. Using a tool such as the DTAPP we can assess and categorize results, and benchmark against other firms.

![Continuous Improvement Cycle](image)

**Figure 10 - Continuous Improvement Cycle**

Once assessed, the results can be evaluated in detail and improvements sought. The addition of improvements will in most cases mean added resources, time and most often cost. The principle of course is that improvement is an investment and that the
benefits will far exceed the initial investment over the life of the firm. Following the improvements, follow up will be required by management to review and monitor the results. Ultimately this will lead to follow up assessments and the cycle continues. Cycle time will vary based on the firm, the portfolio of projects worked on just to name a few factors. As an example, a small firm that consistently works on low risk projects might only perform this cycle on a yearly basis. A large firm with multiple high risk exposure projects on the books could benefit from performing this cycle more frequently. In this situation management practice improvements made based on feedback on one project could positively impact a closely related project starting in the near future.

Bearing in mind the progressive management approach discussed earlier, and the continuous improvement cycle highlighted above, an important concept to consider is that one performance measure may be more important than others at any given time. Maloney (1990) suggested that based on a certain project or portfolio of projects a higher degree of importance may be place on, for example, time or quality management. Although it is acceptable and often likely that an organization will favor certain performance areas over another, it is important not to neglect less important ones. Eventually neglected areas can become significant issues resulting in loss of profitability, turn over or reputation damage (Maloney, 1990).

5.3.3 Future Research

There is a significant opportunity for future research in the areas of benchmarking, process improvement:

1. How to make benchmarking practices and collected data more accessible for small to medium-size general contractors across Atlantic (and potentially the rest
of Canada. The goal is to provide a snapshot of where the industry is practice-wise and to provide an opportunity for comparison to industry players. Data collection should be conducted on an annual, or bi-annual, basis, and results made available to organizations to review.

2. Examine in greater detail each of the management practice areas, and refine the assessment tool developed in this report. The objective would be to expand the assessment from an initial risk assessment tool to a detailed review of risk exposures on a given project. This would be particularly important for larger organizations that are focused on executing larger projects. To achieve this, the DTAPP assessment tool could be expanded in scope (i.e. development of additional questions) to focus on more specific practices within a particular management practice area.

3. Consider in more detail the risk indicators, highlighted in section 2.2.3 and demonstrated in the analysis sections, and consider broadening the list of indicators based on further research. The expanded risk indicators may or may not be applicable to a particular project, but by expanding them and making them more specific, it translates into more meaningful results for the organization.

4. Determine the feasibility of implementing the continuous improvement cycle in a sample organization through a case study analysis. It is suggested that this be conducted by first carrying out an initial assessment, analysis and improvement cycle with subsequent follow-ups to determine if the overall process has improved practices within the organization. Feasibility should be measured in terms of time,
cost, and technical expertise requirements needed to implement the continuous improvement cycle within an organization.

5. Conduct research on the feasibility of using electronic means as a tool of collecting, organizing and analyzing data obtained from research participants at the organizational level. Several research articles reviewed discussed the use of risk registers and risk analysis using electronic tools and the author suggests there are future opportunities in this area.
References


Appendix A – DTAPP Survey

Construction Project Management Practices Assessment

Each category of management practices is a synthesis of numerous sources of commonly employed best practices within the construction industry. The following notes are to describe the scope and context of the practices being assessed:

1. Practices are intended within the scope of a design-bid-build type project versus any form of design-build-operation project (e.g., less emphasis on financial management)
2. Practices being examined are common to general contractors in commercial, institutional and infrastructure projects (e.g., equipment management is excluded as it is considered heavy civil specific).
3. Although some practices are normally performed in a home-office scenario (i.e., planning practices), the emphasis is project (site) level practices.
4. The order of questions within each subsection of a management area is provided randomly as not to imply a progression of capability (increasing maturity of management practices).
5. The assessment of practices is to be followed by a comprehensive Technology Capacity Assessment.

There are nine practice areas:

1. Time Management
2. Cost Management
3. Quality Management
4. Scope Management
5. Health and Safety Management
6. Human Resource Management
7. Materials Management
8. Information and Communication Management
9. Environmental and Waste Management
The practices within an area are grouped and each practice is assessed for its level of implementation on a typical project:

**Practice group**

1. Practice 1 implementation  
   (Likert scale 1-5) never to always

2. Practice 2 implementation  
   (Likert scale 1-5) never to always

... etc.

The extend of the definition, documentation and review of practices within each practice area are assessed with two general questions:

1. Policy and procedures extent  
   (Likert scale 1-5) disagree to agree

2. Reviewed and improved extent  
   (Likert scale 1-5) disagree to agree

An open-ended question solicits information on additional practices in each practice area:

1. Are there project management practices in the area of ... that you do not feel are captured in the statements provided?
1. **Time Management Practices**

Time management includes practices that are generally accepted to contribute to the effective management of projects in the construction industry. Time management practices include: the development of schedules and estimation of durations; the allocation and management of project resources; the analysis of project schedules; and the subsequent monitoring and control of project time.

*For the following statements of management practices please indicate the level of implementation for a typical project performed by your organization on scale of: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always).*

**Schedule development**

1. A standard work breakdown structure (e.g., CSI MasterFormat) is used to define the activities/tasks for project schedules.
   - never
   - rarely
   - sometimes
   - often
   - always

2. Those with expertise in managing and performing the project work are involved in the development of project schedules.
   - never
   - rarely
   - sometimes
   - often
   - always

3. Estimates of best, worst, and most likely durations are developed when defining the activities/tasks for project schedules.
   - never
   - rarely
   - sometimes
   - often
   - always

4. The assumptions used to sequenced activities/tasks are captured during the development of project schedules (e.g., precedence relationships between activities).
   - never
   - rarely
   - sometimes
   - often
   - always

5. Project schedules are communicated with the support of a graphical representation (e.g., bar charts, network diagrams).
   - never
   - rarely
   - sometimes
   - often
   - always
Resource management

1. Project resources (labour and equipment) are planned and assigned on an activity/task basis (resource allocation).
   ○ never ○ rarely ○ sometimes ○ often ○ always
2. Project schedules are adjusted to account for changes in the level of resources required throughout the project (resource levelling).
   ○ never ○ rarely ○ sometimes ○ often ○ always
3. Variations in resource capabilities and production rates are accounted for during the development of project schedules.
   ○ never ○ rarely ○ sometimes ○ often ○ always

Schedule analysis

1. During the development of a project schedule, details of project specific constraints and assumptions are defined.
   ○ never ○ rarely ○ sometimes ○ often ○ always
2. Uncertainty in the project schedule is accounted for and explicitly defined (e.g., addition of time contingencies, additional resource assignment).
   ○ never ○ rarely ○ sometimes ○ often ○ always
3. Project schedules are examined for the potential of decreasing overall project costs through reductions in project time (e.g., time-cost trade-off analysis).
   ○ never ○ rarely ○ sometimes ○ often ○ always

Time (schedule) control

1. Project schedules are updated with actual information on a timely basis during the project.
   ○ never ○ rarely ○ sometimes ○ often ○ always
2. Short-term (look ahead) schedules are developed for projects on a timely basis.
   ○ never ○ rarely ○ sometimes ○ often ○ always
3. Progress against the project schedule is analyzed (e.g., progress curves) as a project performance measure.
   ○ never ○ rarely ○ sometimes ○ often ○ always
4. Project schedules are adjusted (e.g., new forecasts developed) throughout the project based on progress and performance.
   ○ never ○ rarely ○ sometimes ○ often ○ always
General questions

1. The organization has policies and procedures defined for the time management of projects?
   - strongly disagree
   - disagree
   - neutral
   - agree
   - strongly agree

2. The policies and procedures for the time management of projects are reviewed and improved on a timely basis?
   - strongly disagree
   - disagree
   - neutral
   - agree
   - strongly agree

3. Are there project management practices in the area of time management that you do not feel are captured in the statements provided?
2. Cost Management Practices

Cost management includes practices that are generally accepted to contribute to the
effective management of projects in the construction industry. Cost Management
practices include: the planning of costs through estimating development and analysis; and
cost control techniques.

For the following statements of management practices please indicate the level of
implementation for a typical project performed by your organization on scale of: 1
(never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always).

Cost estimating

1. Estimates of project costs are developed with the use of historical costing information (whether in-
house, industry indices, or a combination).
   - never
   - rarely
   - sometimes
   - often
   - always

2. A standard chart of accounts is used to develop and structure project cost estimates.
   - never
   - rarely
   - sometimes
   - often
   - always

3. Cost estimates are developed to reflect the details of explicitly defined construction methods (work
definition) selected for completion of the project.
   - never
   - rarely
   - sometimes
   - often
   - always

4. Those with expertise in managing and performing the project work are involved in the development of
   project cost estimates.
   - never
   - rarely
   - sometimes
   - often
   - always

5. Project estimates (developed in-house and received from subcontractors) are peer-reviewed internally.
   - never
   - rarely
   - sometimes
   - often
   - always

6. Estimated project costs are integrated with project schedule activities (integration with time) to form
   project budgets.
   - never
   - rarely
   - sometimes
   - often
   - always
Estimate analysis

1. Alternative construction methods are examined for projects to optimize total project costs.
   - never  - rarely  - sometimes  - often  - always

2. Uncertainty in project estimates is explicitly defined and accounted for (e.g., addition of cost contingencies, additional resource assignment).
   - never  - rarely  - sometimes  - often  - always

3. Subcontracting and procurement strategies are developed and used during the analysis of project costs.
   - never  - rarely  - sometimes  - often  - always

4. Projects are analyzed to determine the cash flow requirements throughout the duration of the project.
   - never  - rarely  - sometimes  - often  - always

5. Projects are analyzed to determine the return on investment of capital and/or human resources.
   - never  - rarely  - sometimes  - often  - always

Cost control

1. Project cost control techniques include variance analysis of actual versus estimated costs.
   - never  - rarely  - sometimes  - often  - always

2. Project cost control techniques include the analysis of trends over the completion of the project.
   - never  - rarely  - sometimes  - often  - always

3. Earned value analysis is used to determine the time and costs status of projects.
   - never  - rarely  - sometimes  - often  - always

4. Actual project costs are captured with supporting information so that they can be re-used to develop future estimates.
   - never  - rarely  - sometimes  - often  - always

General questions

1. The organization has policies and procedures defined for the cost management of projects?
   - strongly disagree  - disagree  - neutral  - agree  - strongly agree

2. The policies and procedures for the cost management of projects are reviewed and improved on a timely basis?
   - strongly disagree  - disagree  - neutral  - agree  - strongly agree

3. Are there project management practices in the area of cost management that you do not feel are captured in the statements provided?
3. Quality Management Practices

Quality management includes practices that are generally accepted to contribute to the effective management of projects in the construction industry. Quality management practices include: the development of quality plans and specific tests and inspections; the control of non-conforming work; and assurance of project performance through measurement and corrective actions.

For the following statements of management practices please indicate the level of implementation for a typical project performed by your organization on scale of: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always).

Quality planning

1. Overall quality management plans are developed for each project.
   ○ never ○ rarely ○ sometimes ○ often ○ always
2. Inspection and test plans are developed for a given scope of work where required.
   ○ never ○ rarely ○ sometimes ○ often ○ always

Quality control

1. Inspection and testing is performed where specified in the project specifications and applicable work standards or as detailed in an inspection and test plan.
   ○ never ○ rarely ○ sometimes ○ often ○ always
2. Non-conformances of work items are captured, documented and managed on each project.
   ○ never ○ rarely ○ sometimes ○ often ○ always
3. The details of rework required as a result of non-conformances are documented on each project.
   ○ never ○ rarely ○ sometimes ○ often ○ always
4. An acceptance process is used for work items on a project.
   ○ never ○ rarely ○ sometimes ○ often ○ always
5. Numerical analysis tools (e.g., statistical) are used to support the quality control of work items on a project.
   ○ never ○ rarely ○ sometimes ○ often ○ always
Quality assurance

1. Project performance is assessed independently through an internal auditing process.
   - never  - rarely  - sometimes  - often  - always

2. When required, adjustments are made to project processes through a corrective action procedure.
   - never  - rarely  - sometimes  - often  - always

3. Project performance is benchmarked against a variety of internal and external metrics.
   - never  - rarely  - sometimes  - often  - always

General questions

1. The organization has policies and procedures defined for the quality management of projects?
   - strongly disagree  - disagree  - neutral  - agree  - strongly agree

2. The policies and procedures for the quality management of projects are reviewed and improved on a timely basis?
   - strongly disagree  - disagree  - neutral  - agree  - strongly agree

3. Are there project management practices in the area of quality management that you do not feel are captured in the statements provided?
4. **Scope Management Practices**

Scope management includes practices that are generally accepted to contribute to the effective management of projects in the construction industry. Scope management practices include: the planning and review of project scope and contractual requirements; the assessment of project risks; the control of changes in project scope; and the closing out of projects.

*For the following statements of management practices please indicate the level of implementation for a typical project performed by your organization on scale of: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always).*

**Scope planning**

1. Projects are selected (or pursued) based on organizational strategic goals and objectives.
   - never
   - rarely
   - sometimes
   - often
   - always

2. A contract requirements review is completed for each project undertaken.
   - never
   - rarely
   - sometimes
   - often
   - always

3. A contract administration plan is developed for each project.
   - never
   - rarely
   - sometimes
   - often
   - always

4. A thorough technical review of the constructability of project designs is completed for each project.
   - never
   - rarely
   - sometimes
   - often
   - always

**Risk management**

1. Project risks are identified for each project based on common risk categories and specific contract provisions.
   - never
   - rarely
   - sometimes
   - often
   - always

2. Project risks are analyzed for their potential impact on the project and the likelihood that they will occur.
   - never
   - rarely
   - sometimes
   - often
   - always

3. Risk responses are developed for risks that are considered a priority.
   - never
   - rarely
   - sometimes
   - often
   - always
Scope control

1. A defined process is in place to verify the scope of a project and document requests for information.
   ○ never ○ rarely ○ sometimes ○ often ○ always

2. A defined process is in place to manage scope changes and document change orders and change requests.
   ○ never ○ rarely ○ sometimes ○ often ○ always

3. Documentation of extra work on a project due to changes is supported with complete estimates of impacts on time and cost.
   ○ never ○ rarely ○ sometimes ○ often ○ always

4. A claims prevention strategy is defined for each project.
   ○ never ○ rarely ○ sometimes ○ often ○ always

5. Project risks are re-evaluated throughout the execution of a project and where required the risk response plan is updated.
   ○ never ○ rarely ○ sometimes ○ often ○ always

Contract closeout

1. A defined process is in place to manage the final inspection and completion of projects (e.g., punch list and close-outs).
   ○ never ○ rarely ○ sometimes ○ often ○ always

2. A defined process is in place to capture as-built project information.
   ○ never ○ rarely ○ sometimes ○ often ○ always

General questions

1. The organization has policies and procedures defined for the scope management of projects?
   ○ strongly disagree ○ disagree ○ neutral ○ agree ○ strongly agree

2. The policies and procedures for the scope management of projects are reviewed and improved on a timely basis?
   ○ strongly disagree ○ disagree ○ neutral ○ agree ○ strongly agree

3. Are there project management practices in the area of scope management that you do not feel are captured in the statements provided?
5. Health and Safety Management Practices

Health and safety management practices integrate common legislative requirements, as well as generally accepted practices that support a proactive approach to managing health and safety for construction organizations. Health and safety practices include: hazard recognition, reporting, control, and monitoring; methods of communicating health and safety; employee awareness and knowledge of health and safety; effectiveness of company health and safety policies and procedures; and work site organization, layout, and the use of equipment and handling of materials. (EMR – equipment, including personal protective equipment, materials, and resources)

For the following statements of management practices please indicate the level of implementation for a typical project performed by your organization on scale of: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always).

Health and safety planning

1. Health and safety roles and responsibilities are clearly outlined to include both work-related tasks, as well as the promotion of safe practices.
   ○ never ○ rarely ○ sometimes ○ often ○ always

2. All project participants are involved in the development of the policy and procedures they participate in (e.g., identification of job task hazards).
   ○ never ○ rarely ○ sometimes ○ often ○ always

3. All project participants are able to freely express their health and safety concerns and make suggestions for improvement.
   ○ never ○ rarely ○ sometimes ○ often ○ always

4. Reviews of all project participants’ current knowledge and understanding of health and safety are completed on a timely basis.
   ○ never ○ rarely ○ sometimes ○ often ○ always

5. All members of the organization receive regular health and safety training/education (e.g., causes of workplace injuries).
   ○ never ○ rarely ○ sometimes ○ often ○ always

6. A review of project participants’ health and safety performance is completed on a timely basis.
   ○ never ○ rarely ○ sometimes ○ often ○ always
Safety equipment, materials and resources

1. EMR health and safety requirements are considered during planning processes (e.g., risk associated with materials, safest tools).
   ○ never ○ rarely ○ sometimes ○ often ○ always

2. EMR are selected based on job specific tasks, employee training and knowledge, as well as employee comfort, and other qualitative aspects such as noise level and impact on surroundings.
   ○ never ○ rarely ○ sometimes ○ often ○ always

3. The proper use and handling of EMR on a project is strongly promoted in all situations and enforced where required.
   ○ never ○ rarely ○ sometimes ○ often ○ always

4. EMR is thoroughly inspected and checked prior to the start of any task and on a timely basis during use.
   ○ never ○ rarely ○ sometimes ○ often ○ always

5. The effectiveness of the EMR is monitored, and improvements are also actively encouraged from workers.
   ○ never ○ rarely ○ sometimes ○ often ○ always

6. Defective EMR is replaced/repaired immediately upon detection of defects and the cause for the defect is investigated to prevent it from reoccurring.
   ○ never ○ rarely ○ sometimes ○ often ○ always

Hazard management

1. Hazard management planning occurs prior to the start of a project resulting in a description of each hazard, its potential impact, and suggested control mechanisms.
   ○ never ○ rarely ○ sometimes ○ often ○ always

2. Inspections are regularly performed per legislative requirements and all project participants are expected to perform daily inspections of their work area and on a timely basis.
   ○ never ○ rarely ○ sometimes ○ often ○ always

3. All project participants are encouraged to implement hazard management controls and are recognized for their contribution when doing.
   ○ never ○ rarely ○ sometimes ○ often ○ always

4. Hazard statistics are maintained and reviewed and incident data is regularly reviewed to identify trends and to seek possible areas in need of improvement.
   ○ never ○ rarely ○ sometimes ○ often ○ always
General questions

1. The organization has policies and procedures defined for the health and safety management of projects?
   - strongly disagree
   - disagree
   - neutral
   - agree
   - strongly agree

2. The policies and procedures for the health and safety management of projects are reviewed and improved on a timely basis?
   - strongly disagree
   - disagree
   - neutral
   - agree
   - strongly agree

3. Are there project management practices in the area of health and safety management that you do not feel are captured in the statements provided?

Human Resource management includes practices that are generally accepted to contribute to the effective management of projects in the construction industry. Human resource management practices include: planning of the structure and details of project staffing; assessing and evaluating project personnel skills; and improving project personnel skills.

For the following statements of management practices please indicate the level of implementation for a typical project performed by your organization on scale of: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always).

**Human resource planning**

1. Each project establishes a set of human resource practices.
   - never
   - rarely
   - sometimes
   - often
   - always

2. Organizational planning is completed for each project resulting in a staffing plan for the duration of the project.
   - never
   - rarely
   - sometimes
   - often
   - always

3. Each project has a defined team structure, where specific roles and responsibilities are defined and assigned.
   - never
   - rarely
   - sometimes
   - often
   - always

**Human resource analysis**

1. The approach to staff acquisition is developed for each project.
   - never
   - rarely
   - sometimes
   - often
   - always

2. Skills assessments are used in the selection of project personnel.
   - never
   - rarely
   - sometimes
   - often
   - always

3. Performance evaluations are conducted for all project participants.
   - never
   - rarely
   - sometimes
   - often
   - always
Human resource control

1. Each project practices team development (e.g., conducts team building exercises) to foster teamwork and build trust among project participants.

   ○ never  ○ rarely  ○ sometimes  ○ often  ○ always

2. Project personnel are supported through personal and professional development and achievement activities (e.g., training programs).

   ○ never  ○ rarely  ○ sometimes  ○ often  ○ always

3. A formal rewards and recognition program is in place for project personnel.

   ○ never  ○ rarely  ○ sometimes  ○ often  ○ always

4. Project performance from a human resource perspective is captured at completion (e.g., exit interviews).

   ○ never  ○ rarely  ○ sometimes  ○ often  ○ always

General questions

4. The organization has policies and procedures defined for the human resource management of projects?

   ○ strongly disagree  ○ disagree  ○ neutral  ○ agree  ○ strongly agree

5. The policies and procedures for the human resource management of projects are reviewed and improved on a timely basis?

   ○ strongly disagree  ○ disagree  ○ neutral  ○ agree  ○ strongly agree

6. Are there project management practices in the area of human resource management that you do not feel are captured in the statements provided?
7. Materials Management Practices

Materials management includes practices that are generally accepted to contribute to the effective management of projects in the construction industry. Materials management practices include: developing comprehensive materials management plans; implementing tracking tools for control; coordinating materials with the project schedule; and inspecting and maintaining materials before use.

For the following statements of management practices please indicate the level of implementation for a typical project performed by your organization on scale of: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always).

**Materials planning**

1. Each project has a comprehensive written materials management plan.
   ○ never ○ rarely ○ sometimes ○ often ○ always
2. Projects have a separate materials management organizational group or a single person responsible for it.
   ○ never ○ rarely ○ sometimes ○ often ○ always
3. Project materials management plans address the effects of change orders on site materials management.
   ○ never ○ rarely ○ sometimes ○ often ○ always
4. Project materials management plans examine the impact of alternatives of materials and suppliers.
   ○ never ○ rarely ○ sometimes ○ often ○ always
Materials control

1. There is a formal system available to track project materials’ status (materials control system).
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
2. The materials control system is integrated internally with other project control systems.
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
3. The materials control system is available for use by all project participants and is it integrated throughout the supply chain.
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
4. Project lay-down areas for materials received are defined and their locations are recorded and updated on a timely basis.
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
5. Each project uses automated data collection technologies (e.g., barcodes, RFID tags, GPS systems) for automated on-site location tracking.
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always

Materials coordination

1. Projects have a documented materials delivery schedule.
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
2. Projects have a documented procurement plan for materials and equipment.
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
3. Project procurement schedules are integrated with the construction schedule.
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
4. There is a mechanism to identify long-lead procurement items.
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
5. Projects have a list of authorized suppliers.
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
6. Does the project purchasing system have the capability of allowing field purchases of consumables?
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
7. Project procurement schedules are updated on a timely basis to coordinate with short-term (look-ahead) planning.
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
8. Projects have a process that separates materials into stages of the receipt process (e.g. awaiting inspection, storage area restocking, scrap, and/or awaiting shipment).
   ○ never    ○ rarely    ○ sometimes    ○ often    ○ always
Materials inspection and maintenance

1. Projects have a documented materials inspection process for costly items (or for all materials) delivered to the site.
   ○ never ○ rarely ○ sometimes ○ often ○ always

2. Projects have a process to verify that the materials confirm to project specifications.
   ○ never ○ rarely ○ sometimes ○ often ○ always

3. Projects have a post receipt preservation and maintenance process in place for materials.
   ○ never ○ rarely ○ sometimes ○ often ○ always

General questions

1. The organization has policies and procedures defined for the materials management of projects?
   ○ strongly disagree ○ disagree ○ neutral ○ agree ○ strongly agree

2. The policies and procedures for the materials management of projects are reviewed and improved on a timely basis?
   ○ strongly disagree ○ disagree ○ neutral ○ agree ○ strongly agree

3. Are there project management practices in the area of materials management that you do not feel are captured in the statements provided?
Information and Communication Management Practices

Information and communication management includes practices that are generally accepted to contribute to the effective management of projects in the construction industry. Information and communication management practices include: planning for the collection, distribution and storage of project information; reviewing the effectiveness of project communication; and assessment of performance.

For the following statements of management practices please indicate the level of implementation for a typical project performed by your organization on scale of: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always).

**Information and communication planning**

1. Projects have a plan in place for the efficient distribution of project information to all project participants.
   - ○ never ○ rarely ○ sometimes ○ often ○ always

2. Projects have a system in place for the collection of project information generated throughout their execution.
   - ○ never ○ rarely ○ sometimes ○ often ○ always

3. Projects have a standard structure in place for the storage of project records.
   - ○ never ○ rarely ○ sometimes ○ often ○ always

4. Project participants receive training to enhance their information management and communication skills.
   - ○ never ○ rarely ○ sometimes ○ often ○ always

5. Project participants have ready access to historical project information for reuse on current projects.
   - ○ never ○ rarely ○ sometimes ○ often ○ always
Information and communication analysis

1. Project information and communication is reviewed on a timely basis to determine its effectiveness (e.g., accuracy, timeliness, accessibility).
   - never
   - rarely
   - sometimes
   - often
   - always

Information and communication control

1. The performance of projects is measured through a standard set of metrics (e.g., cost, time, production, quality, safety).
   - never
   - rarely
   - sometimes
   - often
   - always

2. Project performance is compared (benchmarked) across projects.
   - never
   - rarely
   - sometimes
   - often
   - always

3. Lessons learned throughout a project are captured and quantified based on other project objectives.
   - never
   - rarely
   - sometimes
   - often
   - always

General questions

1. The organization has policies and procedures defined for the information and communication management of projects?
   - strongly disagree
   - disagree
   - neutral
   - agree
   - strongly agree

2. The policies and procedures for the information and communication management of projects are reviewed and improved on a timely basis?
   - strongly disagree
   - disagree
   - neutral
   - agree
   - strongly agree

3. Are there project management practices in the area of information and communication management that you do not feel are captured in the statements provided?
8. Environmental and Waste Management Practices

Environmental and waste management includes practices that are generally accepted to contribute to the effective management of projects in the construction industry.

Environmental and waste management practices include: planning to address legislative requirements and the impact on the surrounding environment; analyzing to identify mitigating solutions; and implementing measures to control environmental impacts.

For the following statements of management practices please indicate the level of implementation for a typical project performed by your organization on scale of: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (always).

**Environmental and waste planning**

1. Environmental plans are develop for projects to account for legislative requirements and best practices.
   - never  ○ rarely  ○ sometimes  ○ often  ○ always
2. Plans are in place for projects to optimize the reduction of the impacts on the surrounding environment (e.g., noise, dust, traffic).
   - never  ○ rarely  ○ sometimes  ○ often  ○ always
3. Waste management plans are developed for projects to account for reuse, recycling and reduction opportunities.
   - never  ○ rarely  ○ sometimes  ○ often  ○ always

**Environmental and waste analysis**

1. Projects are analyzed to identify opportunities to reduce waste in construction processes (e.g., work improvement).
   - never  ○ rarely  ○ sometimes  ○ often  ○ always
2. The quantity of waste materials produced on projects is examined and compared to expected values.
   - never  ○ rarely  ○ sometimes  ○ often  ○ always
Environmental and waste control

1. Audits of the environmental impacts of projects are conducted on a timely basis.
   - never  - rarely  - sometimes  - often  - always

2. Project participants receive training on waste reduction practices.
   - never  - rarely  - sometimes  - often  - always

3. Project participants receive awareness training surrounding environmental impacts of construction.
   - never  - rarely  - sometimes  - often  - always

4. Environmental control measures are implemented to reduce the impact on the surrounding environment.
   - never  - rarely  - sometimes  - often  - always

5. Waste control measures are implemented to minimize waste generation and maximize reuse of materials.
   - never  - rarely  - sometimes  - often  - always

General questions

1. The organization has policies and procedures defined for the environmental and waste management of projects?
   - strongly disagree  - disagree  - neutral  - agree  - strongly agree

2. The policies and procedures for the environmental and waste management of projects are reviewed and improved on a timely basis?
   - strongly disagree  - disagree  - neutral  - agree  - strongly agree

3. Are there project management practices in the area of environmental and waste management that you do not feel are captured in the statements provided?
## Appendix B – Primary Survey Data

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### 9. Environmental and Waste Management

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Curriculum Vitae

Candidate’s full name: William Jude Gerard Woodhouse

Universities attended: The University of New Brunswick, Bachelor of Science in Civil Engineering, 2009