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PRINCIPLES, CHARACTERISTICS, AND METHODOLOGY TO DEVELOP A PROJECT MANAGEMENT ASSESSMENT TOOL AT THE CONSTRUCTION PROJECT LEVEL

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Abstract: This paper describes the principles, characteristics, and methodology to develop a conceptual approach and a preliminary project management assessment tool based on an integrated framework of international project management (PM) standards and construction projects success factors. Previous PM assessment tools have been designed to measure organizations' PM practices, and individuals' knowledge of PM. After completing these assessment tools, individuals or organizations would identify their strengths, weaknesses and training needs. These tools, though powerful, do not assess what is actually implemented on a specific project. The intention is to develop an assessment tool that diagnoses an organization and an individual project manager by what was actually implemented in a specific project. By assessing what was actually implemented in a project and comparing this with the project results, it could be possible determine the strengths, weaknesses, and value of PM in a construction organization, as well as to benchmark PM best practices. Three types of questions will be used: context questions, PM implementation questions, and project results questions. Each question will have a reference to one or more of the international PM standards. Each question will evaluate the quality or the frequency of the PM implementation, which could be a competence, knowledge, tool, technique, process, or practice. This paper discusses the question design methodology for developing the tool using the resource management knowledge area as an example. Finally, the assessment tool is tested with 18 construction projects executed by different organizations.

INTRODUCTION

Over several decades, project management (PM) communities of practice have put substantial effort into defining good project practice, and these practices are codified in a number of PM standards. The ability to assess the PM practices of a project organization with respect to these best practices would provide a valuable tool for improving PM performance and benchmarking PM best practices. Furthermore, a comparison of the assessed PM levels with assessed project success can provide insight into the quantitative value that PM brings to construction projects.

The goal of this research is to develop a PM assessment tool that can benchmark PM best practices, as well as to diagnose the strengths and weaknesses of an organization's PM implementation, assess levels of project success, and explore the relationship between PM practices and project success in order to evaluate the PM value. A feature that differentiates this research from previous work is the focus on assessing PM practices at the level of individual projects, rather than assessing practices at the level of a company or of an individual manager. This paper will focus on the principles, characteristics, and methodology to develop the PM assessment tool using the resource management area as an example. In

order to design the questions of the assessment tool, it is important to determine the methodological process, which includes a planning, preparation, and testing phase.

The planning phase consists of developing an integrated framework of global standards and a ranking of critical construction success factors. The preparation phase consists of structuring and elaborating each question of the assessment tool. The questions will be based on specific PM standards and/or project success factors. The questions are intended to determine the strengths, weaknesses, and value of PM implementation. Each of the PM implementations defined in the PM standards does not contribute equally to project success. Therefore, some weighting technique should be applied to aggregate the PM assessment results into higher-level, overall PM scores. The weighting scale will be based on an average of the number of citations of the success factors in management journals and the number of projects involved in the empirical data collected either from surveys or case studies in the literature review.

Finally, this paper will test the questions included in the resource management area with 18 construction projects from different organizations and determine the correlation coefficients between the resource management implementation and project results.

1 EXISTING PROJECT MANAGEMENT ASSESSMENT TOOLS

Previous PM assessment tools have been designed to measure organizations' PM practices, and individuals' knowledge of PM. The Boston University Corporate Education Center (BUCEC, bucec.com), the Atlantic Management Center Inc. (AMCI, amciweb.com), the Business Improvement Architects (BIA, bia.ca), the Enterprise Information (EII, eiicorp.com), Harold Kerzner's PM maturity model, and the PM/ROI Assessment by Ibbs Consulting are assessment tools designed to measure PM technical competencies, personal competencies, leadership and business competencies, or PM maturity levels. After completing these assessment tools, individuals or organizations would identify their strengths, weaknesses and training needs. These tools, although very powerful and reputable sources of organizational PM and individual knowledge assessment, do not assess what is actually implemented on a specific project.

The intention is to develop an assessment tool that diagnoses an organization and an individual project manager by what was actually implemented in a specific project. By assessing what was actually implemented on a specific project and comparing this with the project results, it may be possible to determine the strengths and weaknesses of the PM in a construction organization, as well as to explore the value of PM.

2 PROJECT MANAGEMENT STANDARDS

There are many standards for PM practices: A Guide to the Project Management Body of Knowledge by the Project Management Institute, the Capability Maturity Model, Prince2, ISO 9000, the standards by the International Project Management Association (ICB), the Project and Program Management (P2M) by the Engineering Advancement Association of Japan, and the C-PMBOK by the Chinese project management conference among others. This study will use an integrated framework from four international PM standards: A Guide to the Project Management Body of Knowledge (PMBOK) from the Project Management Institute, the International Project Management Association Competence Baseline Version 3.0 (ICB), PRINCE2 by the Government of UK, and the ISO 9000 family of standards. It is important to note that PRINCE2 is a methodology but it has all the components of a standard. Mapping these four global standards gives validity to the process of developing the PM assessment tool.

3 PROJECT SUCCESS FACTORS

Project success factors were identified to provide a source for the weighting scale of the questions of the assessment tool. Project success factors from previous research also give validity to the initial PM assessment tool questions.

Projects are considered successful when they meet stakeholders' needs and expectations. Most of the time, the stakeholder's needs and expectations are met when the project is on time, on budget and within the scope and quality planned. However, project success criteria are subjective, and most of the time, are determined by the stakeholders. There is a clear difference between project success and PM success (Wit, 1998).

In a recent study, a set of metrics were used to try to determine the link between PM practices and project success. The outcome of this study was that the better the PM practices, the better the project results, "the results suggest that the PM practices that make a difference may not be the most frequently used" (Papke-Shields, Beise, & Quan, 2010).

For the purpose of this study, critical success factors has been selected from construction projects only. So far, there has been identified 60 research papers from different scientific journals stating the number of construction projects and the critical success factors identified. Table 1 provides an example of these success factors, listing just the top ten ranked factors, based on the number of reference that identified the factor and the total number of project cases studied in identifying the factor. Each of these success factors, as well as the PM standards, will be related to one or more of the questions of the initial PM assessment tool.

Table 1 Example of Critical Success Factors in Construction Projects.

Rank	Critical Success Factor Identified in Construction Projects	No. of Citations	Case Studies
1	Multidisciplinary/competent project team	10	661
2	Clear objectives and scope	9	542
3	Time performance (project schedule/plans)	8	860
4	Formal & Structured Selection of Contractor/subcontractors	8	648
5	Competent project manager	7	565
6	Clear information and communications channels	6	619
7	Project team commitment	6	454
8	Power and Politics	5	932
9	Client's competencies	5	539
10	Continuous involvement of stakeholders in the project	5	528

4 ASSESSMENT TOOL METHODOLOGY

In order to design the questions of the PM assessment tool, it is important to determine the methodological process, as well as some principles and assessment tool characteristics. The process of developing the PM assessment tool includes a planning phase, a preparation phase, and a testing phase.

The planning phase consists of developing an integrated framework of global standards and the project success factors literature. The preparation phase consists of structuring and elaborating each question of the assessment tool. The questions will be based on specific PM standards and/or project success factors. This link between the questions of the assessment tool and the PM standards and success factors will give face validity to the PM assessment tool. The questions are intended to determine

strengths, weaknesses, and the value of PM, as well as to benchmark PM best practices. Thus, the questions are divided in three categories; one set of questions related to the project context, another set of questions related to the actual PM implementation in reference to one finished project, and a third set of questions related to the project results.

The testing phase consists of using a preliminary PM assessment tool to test the reliability and validity of the PM assessment tool on several pilot cases. After pilot testing and refinement, the PM assessment tool will be ready for a full scale survey.

5 DEVELOPING AN INTEGRATED FRAMEWORK OF INTERNATIONAL PROJECT MANAGEMENT STANDARDS

This study developed an integrated framework from four international PM standards: A Guide to the Project Management Body of Knowledge (PMBOK) by the Project Management Institute (PMI), the International Project Management Association Competence Baseline Version 3.0 (ICB3), PRINCE2 by the Government of UK, and the ISO 9001:2008 standard.

This framework is organized around the same structure of the PMBOK, but it consists of 11 management areas and 5 process groups. All four international standards include the following PM knowledge areas in different forms or wording: integration, scope, time, cost, quality, human resources, communication and information, risk, and procurement. For the purpose of this study and to adapt the framework to construction projects, the following two PM areas have been added: context, and safety and environmental management. Project context, and safety and environmental management are missing in the PMBOK, or included in a different set of standards. However, these management areas are specifically included in the ICB3 as contextual competences. The five process groups are clearly identified in the PMBOK and PRINCE2: initiating, planning, executing, monitoring and controlling, and closing.

The most comprehensive and elaborated standard is the PMBOK by the PMI, so some knowledge management areas such as cost, risk and procurement contain processes that are taken from the PMBOK as is. The other international standards mention these and other knowledge management areas and process groups in general term and definitions, so mappings to these standards have been made. For instance, project human resource management is also called Resources in ICB3 and Organization in PRINCE2, Table 2.

6 DESIGN OF QUESTIONS USING THE RESOURCE MANAGEMENT KNOWLEDGE AREA

The four global standards emphasize the process of planning, selecting, training, and managing the project team. Table 2 shows a mapping of the four global standards for the resource management area.

Project human resource management for the PMBOK standard is the process of organizing, managing, and leading the project team to achieve a goal. This process includes planning human resources, acquiring the project team, developing the project team, and managing the project team. The human resource plan includes the identification of roles and responsibilities, the required skills, reporting relationships and the creation of the staffing management plan. It is the most elaborated standard in the matter of human resource management, but also it misses other project resources, behavioural competences, the work environment, and the organization executing the project.

The PRINCE2 methodology defines roles and responsibilities as one of its principles, which relates directly to one of the PRINCE2 themes, the organization. The organization is defined in different levels, from project level to corporate level. The definition of roles and responsibilities in item 5.4 of this standard are very broad and more toward the internal corporate organization, as well as the definitions on the PM team, PRINCE2, item 5.3.2. However, this standard states clearly the importance of training the project team if needed. In this standard or methodology, the team plans (section 7.2.6) is the closest parallel to the human resource plan and is also vaguely defined.

Table 1. Mapping of the Four PM Standards for the Management Area of "Project Human Resource Management" (or "Resources" in ICB and "Organization" in Prince2). Each column represents on of the five PM process groups. Items marked "*" are from the ICB3 standard, those marked with a "+" are from PRINCE2, "#" from ISO9001, and the rest are from PMBOK.

Initiating * Start up + Starting up & initiating	Planning + Plans	Executing + Directing	Monitoring & controlling * Control + Progress # Measuring, analysis, & improvement	Closing * Close-out + Closing
	1. H.R plan + Responsibilities	1. Acquire project team		
# 1. Ensuring availability of resources	* 2. Project Organisation	2. Develop project team + Training Needs	# 1. Competence of personnel	
	* 3. Teamwork	3. Manage project team	# 2. Work environment	
	+ 4. Team Plans, Project Management Team	* 3. Behavioural competences		
	# 5. Defining responsibility & authority	# 4. Acquire, deploy, maintain, & dispose resources		

The international standard ICB-3 states and defines resource management, resource competence (section 1.12), as the planning, allocation, optimization, and monitoring and controlling of humans, materials, and equipment resources. In addition, project organization competence, teamwork, and project structures competence are considered part of this management area since they are related to the project environment. In terms of the latent variables of this study, project organization, teamwork, and project structures are part of the project context. Behavioural competences are considered in this area because they are relevant to PM and the project manager. However, the PM assessment tool will not include a question for each behavioral competence element, since the tool will be more focused on technical competences. It will include leadership, creativity, consultation, and ethics as part of the leadership score.

The global standard ISO 9001:2008 mentions the need to ensure the availability of resources and defining responsibilities and authority as part of the management commitment and responsibility. However, it is item 6 of the standard that states clearly resource management, not only to continually improve the management system in place, but also to achieve the satisfaction of the stakeholders by reaching their project requirements. It is a general statement of the resource management process. It does not state or mention a plan, but it includes important elements such as definitions of competence for people executing the work, the training needs, the infrastructure and equipment required, and the work environment.

The questions in the assessment tool and in the resource management knowledge area in particular are designed to address the PM implementation in one project, the context in which the project and the

organization performed during the project life cycle, and the project results. These are called the latent variables.

In addition, there are different types of PM implementation: competence, knowledge, skills, tool, technique, process, and practice. Each question fits one or more than one of these PM implementation according to their definitions (see table 3). Each question has been elaborated based on the best PM practices according to four global PM standards and construction success factors. Each question has a reference to one or more standard (see table 3), or one or more construction success factors (see ranking of construction success factors in table 1).

Finally, each question is designed to evaluate the quality of the PM implementation or the frequency of the PM implementation during the project life cycle, or both of them.

One of the key questions to assess the quality of the resource management process is the presence of the human resource plan. If the plan exists, there may be different levels of implementations from informal to a very formal process. Thus, the question of the assessment tool would be formulated towards how well the human resource plan was implemented in terms of its component elements or processes.

Table 2. Resource Management Area Questions, Latent Variables, Type of PM Implementation, Standard Reference, and Quality & Frequency Characteristics.

Question #	Question	"Latent Variable"	PM Implementation							Standard				Characteristic	
			Competence	Knowledge	Skills	Tool	Technique	Process	Practice	PMBOK	ICB-3	PRINCE2	ISO9001	How Well/	Frequency
55	HR plan: identified roles/responsabilities/sk	Implementation	Technical					YES		9.1 to 9.4	1.06, 1.07	7.2.6, 5.3	4.1d, 6.2	YES	
56	PM of client experience in years?	Implementation	Technical	YES	YES					9.1.3.1	1.2	2.2	6.2		
57	Developer/owner organization experience?	Implementation	Technical	YES	YES					9.1.3.1	1.2	2.2	6.2		
58	Constructor organization experience?	Implementation	Technical	YES	YES					9.1.3.1	1.2	2.2	6.2		
59	PM of constructor experience in years?	Implementation	Technical	YES	YES					9.1.3.1	1.2	2.2	6.2		
60	PM highest level of education?	Implementation	Technical	YES						1.7.1, 9.1	1.2		6.2.1		
61	How do you rate your leadership skills?	Implementation	Behavioural		YES					9.4.2.4	2.01 to 2.07		6.2	YES	
62	Did you exploded into anger?	Implementation	Behavioural		YES					9.4.2.4	2.01 to 2.07		6.2	YES	YES
63	Requested input from team member affecte	Implementation	Behavioural		YES					9.4.2.4	2.01 to 2.07		6.2	YES	YES
64	Spent time thinking how to improve things	Implementation	Behavioural		YES					9.4.2.4	2.01 to 2.07		6.2	YES	YES
65	Hypothetical situation/conflict of interest (Et	Implementation	Behavioural						YES		2.15		6.2	YES	
66	Extrovert or introvert?, Sensing or intuitive?,	Implementation			YES					9.1.3.1, A.X3		5.3.3.1			
67	Hours of work per day?	Results							YES	9.2.3.1				YES	
68	Managing more than one project?	Results							YES	9.2.3.1				YES	
69	Recognition and reward system?	Implementation					YES			9.3.2.6				YES	
70	How many project managers?	Results	Contextual					YES		9.3.3.1	3.08				
71	Acquired the necessary project team?	Implementation						YES		9.2		5.3.2	6.2	YES	YES
72	Performance assessment during project life?	Implementation						YES		9.3.3			6.2.2c		YES

The next four questions on the resource management area are related to construction experience (owner/client organization, developer manager, construction organization, and construction manager). The PMBOK and ICB standard do not mention specifically this element within their standards. PRINCE2 states it in the standard 5.3.2.1 which is referring more towards the PM team structure than to the experience itself. ISO 9001-2008 6.2.1 states the importance of experience in the general definition of human resources, table 3. However, experience is what makes a competent project manager, which is ranked at the top five on critical construction success factors by the number of citation in journal articles. Seven citations with a total of 565 project cases concluded that the project manager competence is key to project success. Table 1 shows the ranking of the construction success factors. The type of answer for these questions are open ended.

The next question of the assessment tool in the resource management area is the level of education of the project manager of the construction organization. This question is related to the project manager knowledge. It is referred in the PMBOK standard on item 1.7.1 and 9.1.3.1 as knowledge and competence. ICB3 refers to the knowledge and the professional PM in item 1.2. The only standard that refers to the competence on the basis of the appropriate education is ISO 9001:2008, 6.2.1, see Table 3. In addition, the top construction success factor according to number of citations from journals and 661 case studies within those citations is multidisciplinary, competent project team, table 1.

The next nine questions in the resource management area are related to the leadership skills and personality types. It is difficult to fully assess the leadership and personality type of a project manager. These two interpersonal skills could easily be two separate assessment tools themselves. The leadership skills is assessed based on five questions. One is a self-assessment of the leadership by the tool user, how would you rate your leadership skills from excellent to poor. The other ones are based on the very definition of the leadership skills by the PMBOK "Leadership is the ability to get things done through others by establishing and maintaining the vision, strategy, and communication; fostering trust and team building; influencing, mentoring, and monitoring; and evaluating the performance of the team and the project." Table 3 shows the references to their specific standards on questions 61 to 65.

The personality type is based on the Myers and Briggs type indicator assessment. It is a summary of the Myers and Briggs assessment. The first question is related to the individual preference for energy (introvert or extrovert), the second is related to the individual preference for information gathering (sensing or intuitive), the third one is about the individual preference for decision making (thinking or feeling), and the last one is related to the individual preference for lifestyle (judging or perceiving). The PMBOK standard mentions personality types on the required skills as part of the human resource plan, 9.1.3.1 and appendix X3 (interpersonal skills). PRINCE2 methodology states personality types in 5.3.3.1. Research suggest that a large majority of all managers have personality either Introvert-Sensing-Thinking-Judging or Extrovert-Sensing-Thinking-Judging, Noe et al.2003. Table 3 shows the references to their specific standards on questions 66a to 66d.

The last six questions in the resource management area are related to acquiring and developing the project team. The questions are intended to triangulate or corroborate the existence of the necessary project team, question 71. So, if there is an adequate project team then the hours of work should be around the normal working hours (question 67), working in one project most of the time (question 68), with a performance, recognition and reward system (questions 69 and 72) that allows the organization to reduce the employees' turnovers. See table 3 for the questions with reference to their specific standards, their PM implementation types, and their quality of frequency characteristics. Acquiring the project team could also be extended to the proper selection of the subcontractors, which is ranked as the fourth construction success factor; formal and structured selection of subcontractors, table 1.

7 SCORING CRITERIA

After elaborating the questions, the next step is the scoring criteria for each question. There were several calibration processes in order to weight the score of each question; from assigning 1 point for each question to separating the questions according to the latent variables in the following groups: context questions, PM implementation questions, and project results questions. Finally, a scoring criteria based on the construction success factors was chosen. Questions within the top ranking of construction success factors were given more weight. For instance, resource management questions related to roles and responsibilities, the staffing management plan, experience, leadership, knowledge related to construction, acquiring the necessary project team, performance assessment plan are being scored with 10 points, as these questions are closely related to the following construction success factors: multidisciplinary project team(1), formal structured selection of subcontractors (4), competent project manager (5), project team commitment (7), client competencies (9), leadership (26), employee enhancement (38), and availability of resources (52).

The total scoring for resource management area on the planning group is 132 points in PM implementation, for the executing process group is 13 points for PM implementation and 14 for project results, and finally the monitoring and controlling process group has a maximum score of 4 points for PM implementation. In total, the resource management area account for 149 points out of 591 (25.2%) of the total possible PM implementation, as well as 14 points out of 220 (6.3%) of the total possible project results. The low percentage in project results in this area can be explained in the sense that this management area can be considered more of an input than a project result, and also because the project results are measured and located more in other management areas such as the project time, cost, scope, and quality.

8 TESTING PHASE AND ANALYSIS

The assessment tool has been tested with 18 construction projects from different organizations, with different types of projects, sizes, and context. In order to test and analyze the results in the resource management area, the projects are separated according to these differences. At the end, the results are compared among all projects to draw some general conclusions.

8.1 Residential Projects from the Same Organization

The first selection are high-rise residential projects from the same organization. The projects range from $19 million to $70 million, with an average of $44 million canadian dollars. All these project are located and built in lower mainland BC. The project managers taking the assesment tool rated these project with complexity level 3 or 4, where 5 is very complex (e.g. demanding stakeholders, complex design, etc.) and 1 is very simple project (e.g. similar to previous type of project). Table 4 shows the resource management implementation for the specific project in HR column, the total PM implementation in all management areas, and the total project results.

Table 4. High-Rise residential projects from the same organization

Project ID	Human Resource Management Score	Overall PM Score	Project Result Score
CR1	128	452	180
CR2	87	348	157
CR3	85	297	136
CR4	99	442	149

The correlation coefficient is 0.878 between human resource management implementation and project results. The correlation coefficient is 0.812 between human resource management implementation and total PM implementation. Finally, the correlation coefficient is 0.704 between PM implementation and total project results. Although these coefficients are lower than the critical values of the Pearson correlation coefficient for n=4, r = 0.95, the results show that there is a strong association between the three data sets. The better the resource management implementation, the better the project results in terms of time, cost, quality, and customer satisfaction. In addition, the better the resource management area implementation, the better the overall project PM implementation.

8.2 Institutional Projects from the Same Organization

The second selection consists of 11 institutional projects from the same organization. The projects range from $3 million to $20 million, with an average of $7 million. All project are located in different islands of British Columbia. Most projects are new schools or additions to existing schools for different First Nation communities. The project level complexity range from 3 to 5. For these projects, the correlation coefficient is 0.012 between resource management implementation and project results. The correlation coefficient is -0.013 between resource management implementation and total PM implementation. These two correlation coefficients show that there is no correlation between the two data sets. Interestingly, there is a statistical correlation between PM implementation and total project results for n= 11 and the Pearson correlation coefficient r = 0.602. The correlation coefficient is 0.739 between PM implementation and total project results.

8.3 All Projects Combined

The remaining three project are a $1.6 billion highway, a $32.5-million high-rise residential, and a $4.4-million institutional, all of them from different organizations. In this particular situation, n=18, the Pearson correlation coefficient is r = 0.468. There is a coefficient correlation of 0.280 between reource management and total project results, so there is no statistical correlation. There is a coefficient correlation of 0.167 between resource management area and the total PM implementation including all

management areas, so there is no statistical correlation between these two data set as well. Figure 1 shows the trend line, the equation that relates the two variables, and the R-squared value.

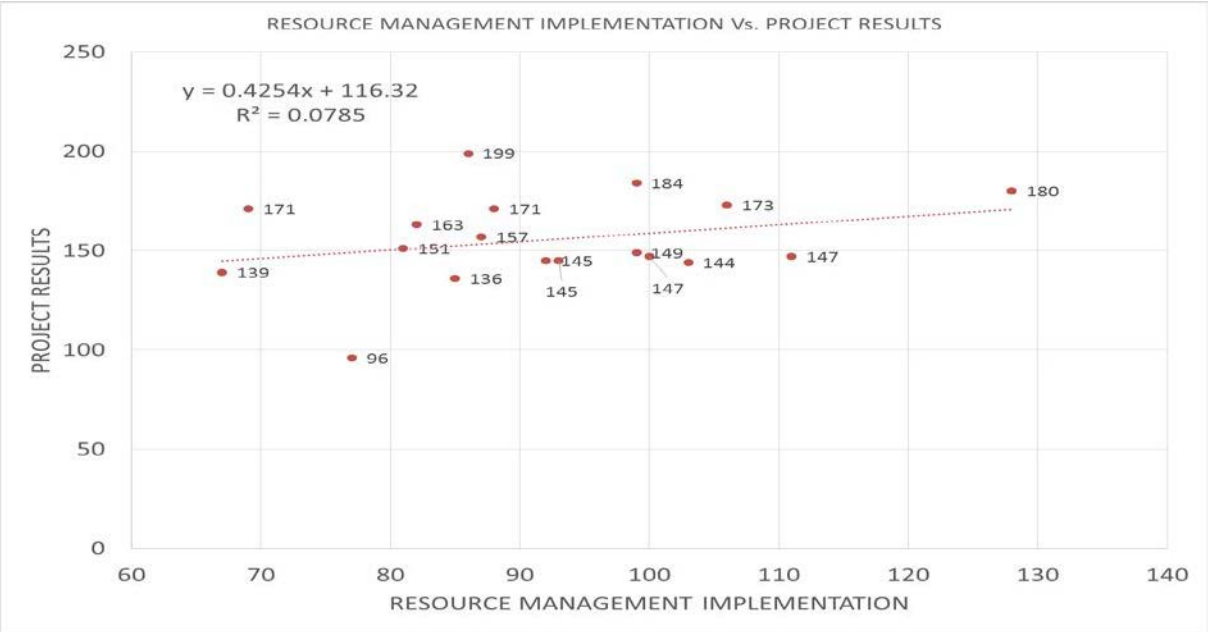

Figure 1. Resource Management Implementation vs. Project Results

9 CONCLUSIONS

This paper explains the process, principles, and methodology to build the assessment tool using the resource management area as a demonstration. The questions are divided in three groups: context, implementation, and results, which are the latent variables. The questions are based on a finished project and are oriented to test the quality or frequency of the PM implementation, which could be a competence, knowledge, skill, tool, technique, process or practice. Some of these PM implementation may involve more than one of these elements.

The PM assessment tool was tested with 18 construction projects. For analysis purpose, the cases were separated based on the type of project and the organization. At the end the cases are combined to analyze the overall statistical correlation between the variables and data set in question.

The results and analysis show that there is a strong association between resource management implementation and project results for the four high-rise residential projects. The better the resource management implementation, the better the overall PM implementation and project results. Furthermore, the results for the eleven institutional projects shows that although there is no correlation between resource management and project results, there is a strong statistical correlation between the overall PM implementation and project results. Finally, when all eighteen cases are combined, there is no statistical correlation between resource management implementation and project results.

In conjunction with the other management knowledge areas and process groups as well as using an integrated framework among four global PM standards, a PM assessment tool may be used to determine the strengths, weaknesses, and the value of PM. It can also be used to benchmark PM best practices.

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