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An exploratory study of project success with tools, software and methods

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Abstract

Purpose – The purpose of this paper is to examine the relationships between project delivery success factors, project management tools, software, and methods.

Design/methodology/approach – A statistical analysis was undertaken using data from a survey from a purposive sample of 150 participants across three countries (Australia, Canada and the UK). The findings were used to consider the relationships between project success factors, project management tools, software, and methods.

Findings – The findings reveal certain insights in the use of tools and methodologies. Of all the variables measured, the number of project management tools used and the number of risk tools used showed the highest direct correlation. It was therefore surmised that the use of tools from one of these categories is often coincident with the use of tools from the other category. Also, the use of project management tools exhibited less variability as compared to use of information communication technology support tools and risk management tools. In addition, use of formal project management methods exhibited less variability than use of formal decision-making methods. Therefore, it is suggested that use of project management tools and methods is more consistent across the organizations studied, as compared to other tools and methods.

Originality/value – This paper extends the survey findings of an international 2011 study and sheds light on the use of project management and related tools and methods.

Keywords Project management, Risk management, Project success, Computer software, Techniques and tools, Control, Methods, Australia, Canada, United Kingdom

Paper type Research paper

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1. Introduction

It has long been accepted (Cooke-Davies, 2002; de Wit, 1988), that success in projects has two different aspects. Project success, is concerned with judgments about the outcomes of a project, and project management (PM) success is about the successful delivery of a project. However, judgments about the success of an individual project are not necessarily the same across both aspects. A project regarded as well-managed may fail to deliver the intended outcomes and a poorly-managed project can still be capable of delivering success, though almost always at a price. It is also the case that different project stakeholders may have varying (even polar) views on levels of success and that their impressions of success may change over time. This is no surprise given judgements about success and failure incorporate objective and subjective performance components and encompass specific and vague outcomes (Nogeste, 2004; Nogeste and Walker, 2008).

Valuable research work has been undertaken from a socio-technical perspective (Crawford and Pollack, 2004) and a reflective practitioner perspective (Schön, 1983; Cicmil, 2003; Cicmil and Hodgson, 2006) to underpin the concepts of project success antecedents (Steinfort and Walker, 2011). However, research in these traditions tends to stress the application of tools, methods and approaches within an experiential and purposeful context rather than their use by project managers on a day-to-day basis.

In this study we are concerned with a focus on the tools and PM methods themselves and our emphasis is upon project delivery success and not project success in general. More specifically, the research question this paper addresses is:

RQ1. What are the relationships between project success factors, project management tools, software, and methods?

The findings of two prior studies (White and Fortune, 2002; Fortune *et al.*, 2011) will be extended to explore descriptive and correlational statistical behaviors and associated relationships between project success factors, PM tools, PM software, and PM methods in the belief that knowing more about PM methods, techniques and tools can help organizations be more successful in project delivery. We acknowledge that these are preliminary statistical findings because the original survey addressed different aspects of the relationships between success factors and tools, software and methods. Additionally, the small sample size limits the researchers from conducting multivariate analyses.

We begin with a literature review on project success, methods, tools, and techniques, as well as cooperation and control practices. Then we outline our statistical analysis approach as applied to the Fortune *et al.*, data set (2011) to extend those survey findings of "real world" experiences of practitioners in PM.

2. Underpinning literature

PM is institutionally seen as a set of processes that encompasses the tools, techniques, and knowledge-based practices applied to projects, to achieve organizational goals and deliver products or services (Project Management Institute, 2008). Projects have a lifecycle based on the initiation, planning, execution, and closeout phases (Project Management Institute, 2008). Projects are reliant upon a temporary organization (Lundin and Söderholm, 1995) that draws upon skills and tools as well as the people who use these resources to deliver projects. Project managers require a multitude of technical and interpersonal competences as they balance project knowledge areas, critical success factors, stakeholders, and other demands throughout the project lifecycle.

Whereas in the 1990s the PM literature discussed the optimization school and critical success factors (Packendorff, 1995; Söderlund, 2002), more recent literature indicates that there are upwards of nine schools of thought in PM and project success continues to be one of the schools (Turner, 2010).

Considerable literature has been published on the topic of success including in depth reviews on PM success (Müller and Jugdev, 2012; Jugdev and Müller, 2005). Müller and Jugdev (2012) examined literature on project success by using keywords and identified publications, each with over 200 citations in Google Scholar. The top publications were by Pinto and Slevin (1988a, b), followed by Baccarini (1999), Shenhar *et al.* (1997, 2001) and Munns and Bjeirmi (1996).

The literature typically divides project success into two components (Morris and Hough, 1987; Turner, 1999; Wateridge, 1998) whereby project success factors are analogous to independent variables that contribute to the likelihood of success and project success criteria are measures used to determine if a project was successful or a failure. In the latter case, the success criteria are like the dependent variables (Müller and Jugdev, 2012). In relation to this paper the various methods, tools, and techniques can be viewed of as independent variables and as outlined in the methodology section, the positive and negative project success factor counts are the dependent variables.

As we reviewed the relevant literature, we were struck by the insight that "it is better to do the right things wrong than the wrong things right" (Ackoff, 1995, p. 43). From a systems thinking perspective, this pertains very clearly to PM where use of tools, techniques, and methods is often made on a piece-meal basis rather than seeing how they can be used in combination to manage the whole. If the individual PM software tools, methods, and techniques do not work as a whole, how well can the entire system work? This question is very important in terms of PM delivery success.

2.1 PM delivery success

Shenhar *et al.* (2001, p. 699) take a holistic view of project success stating that there are "four major distinct success dimensions: (1) project efficiency (2) impact on the customer (3) direct business and organizational success, and (4) preparing for the future". The first dimension relates to the successful delivery of a project. The second is about the project outcome in terms of immediate stakeholders as customers. The third and fourth dimensions are a little ambiguous. The third dimension relates to an outcome that enhances the business that could be the client or the PM delivery organization. The fourth dimension also could refer to both the project client and the project delivery organization. Most project managers are not particularly strategically-minded as their focus is directed to the first dimension, project efficiency. Major competency studies undertaken stress that PM delivery skills are fundamental to success but must be exercised alongside an ability to reflect on experience and the project contexts (Crawford *et al.*, 2006) and on the interaction of several forms of intelligence (i.e. managerial, emotional and technical) that marshal the application tools and techniques according to context (Turner *et al.*, 2009). Previous studies that have looked at PM processes and project delivery success are relevant to this topic as they focus upon what tools and methods project managers deploy and the relative popularity of use of these processes (Zwikael, 2008a, b; Zwikael and Globerson, 2006). These studies also focused on the role of executives in software project success as well as success factors and success processes. The work undertaken by Zwikael is particularly important because it places a focus on PM process as being linked to successful project delivery.

In addition to addressing the technical knowledge areas and managerial aspects, project managers also pay attention to critical success factors. A classic study identified project mission, management support, project schedule/plan, and client consultation as prioritized project critical success factors (Pinto and Slevin, 1987). A more recent empirical study appeared to support this list, identifying top project success factors to be: clear goals; support from senior management; and adequate resources (White and Fortune, 2002). However, a note of caution needs to be sounded. When looking across 63 publications setting out critical success factors, Fortune and White (2006) found there was only limited agreement among authors about what the factors are.

2.2 Methods, tools, and techniques

Another stream of PM research spans topics on the methods, tools, and techniques used within the discipline. One analysis of two time periods (1987-1991 and 1992-1996) found that the literature focused on tools (concentrated on schedule, costs and quality), industry sector, and the nature of projects (Ulri and Ulri, 2000). Thereafter, another study examining the current state of research in PM determined that the literature between the 1970s and 1990s predominantly focused on technical aspects of PM (i.e. software, costing, scheduling) (Kloppenborg and Opfer, 2002). More recently, research addressed the breadth of use of tools and techniques in relation to project success emerged (Besner and Hobbs, 2002, 2004, 2006; Floyd *et al.*, 2003; Patanakul *et al.*, 2010; White and Fortune, 2002; Fortune *et al.*, 2011).

PM tools, and techniques are intended to help practitioners do their job and to execute processes (Besner and Hobbs, 2004) whilst methods provide guidelines and checklists to ensure that practices are being followed properly and that the right outcomes are attained. Control practices involve applying the technical aspects of PM and using methods, tools, and techniques to ensure that project metrics are within acceptable trend limits. Typically, projects are controlled for time, cost, and scope variables. Control systems are uni-dimensional (e.g. scope control, quality control, financial control), or multi-dimensional (e.g. earned value and the theory of constraints) (Rozenes *et al.*, 2006).

The various methods, software, tools, and techniques of PM can be categorized as follows (Fortune *et al.*, 2011):

- PM methods: for example, the Project Management Institute's Body of Knowledge Guide (PMBOK® Guide which reflects standards used primarily in North America), the British Association of Project Management's PRojects IN Controlled Environments (PRINCE®, PRINCE 2®), Structured System Analysis and Design Method (SSADM), Agile PM. For more on Agile PM refer to Leybourne (2009) and Highsmith (2004).
- PM software such as Microsoft Project, Primavera and Excel.
- PM tools including Gantt charts, work breakdown structures, critical path method, program evaluation and review technique (PERT), strengths, weaknesses, opportunities and threats (SWOT).
- Decision making (DM) methods including cost benefit analysis, decision analysis, sensitivity analysis, decision trees.

- Risk assessment tools including probability analysis, life-cycle cost analysis, reliability analysis.
- Information communication technology (ICT) support tools: such as integrated groupware (email, collaborative tools, shared access to web portals), video conferencing, virtual environments and voice over internet protocol.

Because this paper is extending work reported previously (White and Fortune, 2002; Fortune *et al.*, 2011), it does not include socio-cultural (interpersonal) methods, tools and techniques such as human resources tools used for team development and assessment, and those used for quality management purposes such as Six Sigma that some people now associate with PM. The methods, tools and techniques that are covered are those reported as being used by respondents at the time the data was gathered.

Besner and Hobbs (2006) undertook a study of over 70 project controls tools, and techniques ($n = 753$ practitioners) to investigate the extent of use and potential contribution to project success (performance). They defined intrinsic value "by adding the present extent of use to the potential contribution to project performance of more or better use" (p. 41). Their analysis revealed the following:

- The four super tools found to be both extensively used and with high intrinsic value (to improve project success) were software for task scheduling, scope statements, requirements analysis, and lessons learned/post-mortems.
- Tools and practices that received high scores for use but that lacked the potential to improve project success included progress reports, kick off meetings, Gantt charts, and change requests. Besner and Hobbs interpreted this as an indication that these tools and practices were frequently used and had reached their full potential.
- Discredited tools and practices (i.e. those that were rarely used and those with the least intrinsic value to enhance project success) included Monte Carlo, decision tree analyses, Pareto diagrams, and cause and effect diagrams.
- Whereas some tools and practices were deemed to have a low intrinsic value to improve project success and were under used, the ones deemed to have potential to improve project success included software for simulations, critical chain methods, value analyses, and quality function deployment.
- Under-utilized tools with a high potential of enhancing project success included databases for lessons learned, historical data, risk, cost estimates, and contracts, multi project scheduling software, and cost monitoring software.

White and Fortune's (2002) survey examined the breadth of methods, tools, and techniques used in the UK as well as critical success factors ($n = 236$). Nearly a decade later, Fortune *et al.* (2011) study expanded the geographical boundaries to examine the use of methods, tools, and techniques in Australia, Canada, and the UK ($n = 150$). Overall, they found that the breadth of methods, tools, and techniques used between the three countries was comparable. Their study included methods but the Besner and Hobbs paper (2006) did not. It is White and Fortune (2002) and Fortune *et al.* (2011) surveys that provide the foundations of this paper. For now, it is worth noting a few highlights from them. Whereas 41 percent of the participants indicated that their projects were completely successful in 2002, the 2011 study found that only 16 percent deemed their projects to be completely successful. Whereas 41 percent of the participants indicated that their projects were completely successful in 2002, the 2011 study found that only 16 percent deemed their projects to be completely successful. The top three success criteria in the 2002 study were also the top three criteria in the 2011 study (i.e. client requirements, schedule, and budget). However, quality/safety emerged as the fourth most widely cited success criterion.

Based on six categories, the most widely used methods, tools and techniques in Fortune *et al.* (2011) were:

(1) *PM methods.* In house approaches, PRINCE®, PRINCE 2®, SSADM.

(2) *PM tools.* Software, Gantt charts, work breakdown structures.

(3) *DM techniques.* Cost benefit analyses, expressed preferences, sensitivity analyses.

(4) *Risk assessment tools.* Probability analysis, life cycle cost analysis, in house risk assessment tools.

(5) *Computer models/databases/indexes.* Lessons learned files, in house models/databases/indexes, expert systems.

(6) *Computer simulations.* Monte Carlo.

In this paper, we shall build on the contribution to the field by Fortune *et al.* (2011) in order to gain greater insight into the relationships between project success factors, PM tools, PM software and PM methods but please refer to their original paper for a detailed explanation of the methodology and findings upon which this subsequent analysis is based.

3. Methodology

The methodology undertaken for the extended analysis was to apply selected statistical techniques to the data from the Fortune *et al.* study as it extended the geographical and industry sector sample range from previous studies such as the one by White and Fortune (2002). The study involved a survey of 150 PM practitioners equally distributed from the UK, Canada and Australia across a wide range of industries. (For details about the sample, questions asked and sample frame see Fortune *et al.* (2011).

A seven-point scale from complete failure to complete success was used to represent judgements about project outcome in the extended analysis. As listed, new variables were also created to represent the total counts of the various project success factors, PM tools, PM software, and PM methods:

- Positive project success factors count (total count of these factors).
- Negative project success factors count (total count of these factors).
- PM tools count: Gantt charts, work breakdown structures, critical path method.
- PERT and SWOT.
- Risk assessment tools count: probability analysis, life-cycle cost analysis, reliability analysis.
- ICT support tools count: integrated groupware (email, collaborative tools, shared access to web portals), video conferencing, virtual environments, voice over internet protocol.
- PM software count: for example Microsoft Project and Primavera.

- PM methods count: for example, PMBOK® Guide, PRINCE®, PRINCE 2®, and SSADM, and Agile.
- DM methods count: cost benefit analysis, decision analysis, sensitivity analysis, decision trees.

Addinsoft XLSTAT (Version 2011) was used to conduct the analysis. Descriptive statistical analyses were performed on the above variables, followed by correlation analyses. In order to gain greater insight into the relationships, additional correlation analyses were performed using those variables that showed the highest correlation whilst controlling for certain other variables.

4. Results

4.1 Summary statistics

Table I shows the summary descriptive statistics for each of the variables. Because of the comparatively different ranges between the variables, the percent coefficient of variation, i.e. %CV = (standard deviation/mean) *100, was calculated to gain insight into a variable's variation with respect to its mean and therefore provides a notion of its stability of meaning. Coefficient of variation is useful for comparing dispersion in variables with differing means.

The following summarizes the notable descriptive statistical results found in this study, with a specific focus on %CV:

- Project outcome showed the lowest %CV overall.
- Risk tools count had the highest %CV overall.
- Regarding the success factors, negative project success factors count had a higher %CV than positive project success factors.
- Regarding the three tools variables, (PM tools count, risk tools count and ICT tools) Risk tools had the highest %CV and PM tools had the lowest %CV.
- PM software's %CV was slightly higher than the PM tools' %CV.
- Regarding the two methods, DM methods had a higher %CV than PM methods.

Variable	Minimum	Maximum	Range	Mean	SD	%CV
Project outcome						
Project outcome	2.00	7.00	5.00	5.49	1.16	21.02
Project success factors						
Positive project success factors count	0.00	21.00	21.00	9.52	4.82	50.45
Negative project success factors count	0.00	19.00	19.00	4.39	3.32	75.21
Project tools, software, and methods						
PM tools count	0.00	11.00	11.00	3.40	2.12	62.16
Risk tools count	0.00	11.00	11.00	1.19	1.56	130.07
ICT tools count	0.00	6.00	6.00	1.99	1.44	72.00
PM software count	0.00	6.00	6.00	1.30	1.00	77.31
PM methods count	0.00	3.00	3.00	1.31	0.67	50.72
DM methods count	0.00	7.00	7.00	1.26	1.32	104.26

Notes: $n = 150$; for project outcome, 1 – complete failure, 7 – complete success

Table I.
Summary descriptive statistics

4.2 Correlations

Table II shows the correlations between the respective variables.

We used Cohen (1988) as a guide to interpreting the Pearson correlations:

- 0 to ± 0.10 indicates no correlation;
- ± 0.10 to ± 0.29 indicates a low correlation;
- ± 0.30 to ± 0.49 indicates a medium correlation; and
- ± 0.50 to ± 1.00 indicates a high correlation.

The highest direct correlation was between PM tools count and risk tools count ($r = 0.62$), and this relationship was statistically significant ($\alpha = 0.01$).

PM software count showed comparatively medium direct correlations with each of the tools variables. These relationships were statistically significant ($\alpha = 0.01$) and showed medium correlation. Specifically, the correlation between PM software count

Variables	Project outcome	Positive project success factors count	Negative project success factors count	PM tools count	Risk tools count	ICT tools count	PM software count	PM methods count	DM methods count
Project outcome	1	−0.09	−0.13	0.09	0.15	0.04	0.03	−0.10	0.01
Positive project success factors count	–	1	0.07	−0.01	−0.05	−0.05	−0.12	*0.27* (*0.001*)	*0.39* (< *0.0001*)
Negative project success factors count	–	–	1	0.02	−0.00	0.04	0.04	0.11	*0.19* (*0.019*)
PM tools count	–	–	–	1	*0.62* (*0.0001*)	*0.27* (*0.001*)	*0.47* (*0.0001*)	0.04	0.04
Risk tools count	–	–	–	–	1	*0.31* (*0.0001*)	*0.39* (*0.0001*)	−0.01	−0.03
ICT tools count	–	–	–	–	–	1	*0.33* (*0.0001*)	0.02	0.00
PM software count	–	–	–	–	–	–	1	−0.12	−0.12
PM methods count	–	–	–	–	–	–		1	*0.34* (*0.0001*)
DM methods count	–	–	–	–	–	–		–	1

Notes: Values in italics are different from 0 with a significance level $\alpha = 0.05$; p-values are shown in parentheses; for project outcome, 1 – complete failure; 7 – complete success

Table II. Pearson correlation matrix and PM tools count was 0.47; the correlation between PM software count and risk tools count was 0.39; the correlation between PM software count and ICT tools count was 0.33.

Medium direct correlations were also found between other variables. These relationships were statistically significant ($\alpha = 0.05$). Specifically, a medium direct correlation was found between positive project success factors count and DM methods count ($r = 0.39$). Regarding tools, medium direct correlations were found between risk tools count and ICT tools count ($r = 0.31$). PM methods count and DM methods count also showed a medium direct correlation ($r = 0.34$).

Comparatively lower direct correlations were found between several variables. These relationships were statistically significant ($\alpha = 0.01$). Specifically, low direct correlations were found between positive project success factors count and PM methods count ($r = 0.27$), PM tools count and ICT tools count ($r = 0.27$), and negative project success factors count and DM methods count ($r = 0.19$ with statistical significance of $\alpha = 0.05$).

No direct or indirect correlations between project outcome and any other variable were found. No noteworthy indirect correlations between any variable were found.

Tables III-VI depict coefficients of determination and other correlations.

Table III shows coefficients of determination. The relationship with the highest R^2 was between PM tools count and risk tools count ($R^2 = 0.39$). This relationship indicates that the variation of one of the variables is associated with 39 percent variation of the other variable. Using Cohen (1988) as a guide to interpreting the Pearson correlations (i.e. R-values) as previously discussed, we view the relationship between PM tools count and risk tools count as high (i.e. since $R = 0.62 =$ square root of 0.39). In an attempt to gain greater insight into the relationship between PM tools count and risk tools count, several additional correlations were performed while controlling for certain variables. Table IV shows the correlations when controlled for the PM professional (PMP®) and/or PRINCE2® qualifications. The highest correlation occurs for those respondents who did not indicate holding a PMP® and/or PRINCE2® professional credential. Table V shows the correlations when controlled for whom that the project was conducted (i.e. client or internal). The correlations between PM tools count and risk tools count are relatively the same. Table VI depicts the correlations between project duration and PM tools count, and project duration and risk tools count. The highest correlation occurs between project duration and PM tools count.

5. Discussion

The survey data and the subsequent analyses appear to show that the progress is being made by project managers towards "doing the right things right" (Ackoff, 1995, p. 43) in terms of their use of PM software tools, methods, and techniques. However, there are still indications that there is more work to be done in order to achieve an integrated, systems approach to PM that extends across the entire suite of practices used.

5.1 PM tools and PM methods

As evident from Table I:

- There is wider variability in risk tool use, compared to the other tools, indicating that risk tools use is less predictable and that there is greater disparity in risk tools use in organizations, as compared to the use of PM tools and ICT tools.
- PM tools are more widely used as compared to the other tools and methods, with an average of 3.4 PM tools used. In relation to the other tools and methods,

Variables	Project outcome	Positive project success factors count	Negative project success factors count	PM tools count	Risk tools count	ICT tools count	PM software count	PM methods count	DM methods count
Project outcome	1	0.01	0.02	0.01	0.02	0.00	0.00	0.01	0.00
Positive project success factors count		1	0.00	0.00	0.00	0.00	0.01	0.07	0.15
Negative project success factors count			1	0.00	0.00	0.00	0.00	0.01	0.04
PM tools count				1	*0.39*	0.07	0.22	0.00	0.00
Risk tools count					1	0.10	0.15	0.00	0.00
ICT tools count						1	0.11	0.00	0.00
PM software count							1	0.01	0.01
PM methods count								1	0.11
DM methods count									1

Note: The highest R^2-value is *italics faced*

Table III. Coefficients of determination (R^2)

Variables	PMP® and/or PRINCE2®	Pearson correlation (p-value)	R^2
PM tools count and risk tools count	Yes	*0.58* (*<0.0001*)	0.34
PM tools count and risk tools count	No	*0.68* (*<0.0001*)	0.46

Notes: For Pearson correlation, values in italics are different from 0 with a significance level $\alpha = 0.05$; p-values are shown in parentheses

Table IV. Pearson correlation between PM tools count and risk tools count when controlled for "PMP® and/or PRINCE2®" qualifications

PM tool use exhibits less variation indicating a certain degree of comparative stability in the use of PM tools.

- The most widely use reported tool was Gantt charts, followed by work breakdown structures, and then critical path methods.
- There is wider variability in DM methods use, compared to the PM methods use.

The general theme is that PM tools use and PM methods use show less variation. Historically, PM tools and PM methods were adopted earlier in certain industrial sectors such as defense and construction but are now showing wider acceptance and more predictable behavior in terms of their use. It is also clear from this is that many of the DM methods are not exclusive to PM. As the use of PM continues to evolve, project team members represent various business departments. Interestingly, the most widely used tools appear to be those used in relation to schedule development.

5.2 PM tools and risk tools relationship

As Table II shows, PM tool and risk tool use had the highest correlation ($r = 0.62$). A key implication here is that these tools are embraced (or not embraced) concurrently. One reason might be that now there is a tighter integration of PM tools and risk tools, e.g. a scheduling tool purchase such as "Microsoft Project" may also lead to a concurrent risk tool purchase such as "@Risk for Project", thus making the simultaneous adoption of both tools a practical reality in project organizations.

As evident from Table IV, use of PM tools and risk tools showed a higher correlation for those who do not hold the "PMP® and/or PRINCE2®" credential, as compared to those who hold the "PMP® and/or PRINCE2®" credential. The PMP® and/or PRINCE2® certifications are based on combinations of competences, assessments, and exams. Given that these certifications also span the PM body of knowledge which includes tools and techniques, we may surmise that those who achieved this designation were less inclined to concurrently use multiple PM tools and risk tools because they were familiar with the rationale behind these tools from the certifications and were more familiar with what the purpose of each tool was. Another interesting way to interpret this finding is by reference to the project manager's maturity level. Using a categorization of the type developed by Benner (1984), Cicmil (2003, 2006) and Cicmil and Hodgson (2006) identifies five levels of competency: novice; advanced beginner; competent performer; proficient performer; and expert or virtuoso. "Novices" tend to rely on the rigid application of formulae, rules, standards and industry or professional standards (in a sense, these

Table V. Pearson correlation between PM tools count and risk tools count when controlled for "project carried out for a client" vs "project carried out within own organization"

Variables	Project carried out [...]	Pearson correlation (p-value)	R^2
PM tools count and risk tools count	[...] for a client	*0.65* (*<0.0001*)	0.42
PM tools count and risk tools count	[...] within own organization	*0.61* (*<0.0001*)	0.37

Notes: For Pearson correlation, values in italics are different from 0 with a significance level $\alpha = 0.05$; p-values are shown in parentheses

Table VI. Pearson correlation between project duration (months) and PM tools count and risk tools count

Variables	Pearson correlation (p-value)	R^2
Project duration (months) and PM tools count	*0.40* (*<0.0001*)	0.16
Project duration (months) and risk tools count	*0.29* (*<0.0001*)	0.08

Note: For Pearson correlation, values in italics are different from 0 with a significance level $\alpha = 0.05$; p-values are shown in parentheses become their security blankets). Advanced beginners start to recognize the importance of context and the problems associated with applying tools/methods in inappropriate situations but have insufficient experience to apply all their theoretical knowledge. Competent performers are more confident in choosing appropriate tool/method for a given context and are able to apply them. Proficient performers have even more reflective ability and experts are very discerning about what tool/method are used, how they are used and are able to adapt and modify. A consequence of accepting Cicmil's classification is that not using various combinations of tools and methods may indicate higher levels of competence rather than ignorance.

According to the Table VI results, project duration and PM tools count show higher correlation, than project duration and risk tools count. One can infer here that the longer the project, the more intentional use of PM tools, and vice versa, perhaps because longer and more complex projects encounter more problems, and hence require more tools. Complex long projects may have periods where it is appropriate to intensively use tools that we asked about and other periods when they are not of any real value. One can imagine a range of tools being used in waves as the project progresses with emphasis that is appropriate at various periods.

5.3 PM methods and DM methods

Two key observations regarding methods use are notable from Table II. DM methods use is more closely associated to positive project success factors, as compared to PM methods use is to positive project success factors. An implication here is that a number of the DM methods are financial in nature (cost benefit analysis), and they involve consideration being given to alternative options so they help the team consider uncertainty. In contrast, the PM methods are more akin to conceptual guides and frameworks (e.g. PMBOK® Guide or PRINCE® and PRINCE 2®). Also, PM methods and DM methods showed a significant direct correlation with each other. Use of these methods, to a certain degree, may go hand-in-hand in most project organizations.

6. Comparison with other findings

This section provides a brief discussion on how the work reported here relates to the findings of Besner and Hobbs (2006). The rationale for doing so is that the Besner and Hobbs study and the Fortune *et al.* (2011) study were both studies that spanned an extensive set of tools, techniques, and methods. However, it must be acknowledged that, given that the Besner and Hobbs surveyed a different sampling frame and time frame than the survey used as the basis for our paper, the preliminary insights comparing the two sets of findings are tentative. In addition, the survey data used here was based on respondents from Canada, Australia, and the UK whereas the survey data in the Besner and Hobbs (2006) study appears to have been collected from respondents in North America.

This paper has reported that the highest direct correlation was between PM tools count and risk tools count ($r = 0.62$), and that this relationship was statistically significant ($\alpha = 0.05$). This finding seems inconsistent with Besner and Hobbs (2006). Besner and Hobbs divided use of tools/methods into four categories: super tools, adequately utilized tools, underutilized tools, and discredited tools. Within each of these four groups, traditional PM tools and risk tools do not appear together and primarily reside in different groups (PM tools primarily in super tools and adequately utilized Tools, while risk Tools primarily in discredited Tools).

Besner and Hobbs's (2006) assessment of Underutilized tools does provide a myriad of methods/tools. Table VII presents a preliminary match between the underutilized tools with the methods/tools categorizations evident from the current study. As Table VII shows, methods and tools from Besner and Hobbs can primarily be categorized as PM methods or PM software. PM methods count and PM software count showed no correlation in our analysis, thus indicating no consistency in the use of PM methods and software. Besner and Hobbs (2006) study did not reveal if PM methods and software were quantitatively correlated but Besner and Hobbs did suggest that PM methods and software were underutilized in organizations. Therefore, the non-correlation between PM methods and software finding in our study and the conclusion from Besner and Hobbs that these methods and tools were not being used to their fullest potentials raises an interesting point. Specifically, it is possible that if PM methods and software were fully utilized in organizations, it is possible that at least some consistency in the use of PM methods and software may arise. We leave this proposition to future researchers.

We also acknowledge that this paper has primarily focused upon tools and processes that are associated with PM from a "plan, monitor and control" perspective whereas emerging PM perspectives, especially in very complex and often chaotic contexts where PM is more effective in influencing, being agile and adaptive and even "muddling through" projects based on well thought through responses to unanticipated events. Guidance is evident on appropriate management processes and approaches to working in complex and chaotic contexts (Snowden and Boone, 2007; Remington, 2011) as are alternatives to the tight plan and control paradigm that is prevalent in project manager's minds who see their job as controlling rather than integrating and influencing others to ensure project delivery (Lindblom, 1959, 1979). Our study did not focus on those aspects as we were benchmarking against our previous studies and we acknowledge that the influencing and integration role of PM

Underutilized tools (Besner and Hobbs, 2006)	PM methods (current study)	PM tools (current study)	PM software tools (current study)	Risk tools (current study)
Database of lessons learned	X			
Database of historical data	X			
Database of risks				X
Database for cost estimating	X			
Database for spreadsheet of contractual commitment data	X			
PM software for multi-project scheduling/leveling			X	
PM software for monitoring of cost			X	
PM software for cost estimating			X	
PM software for resources leveling			X	
Earned value		X		
Feasibility study	X			
Stakeholders analysis	X			
Configuration review	X			
Graphic presentation of risk information				X

Table VII.
Best possible match of the underutilized tools with the methods/tools categorization in the current study

is becoming more accepted as a valid PM role. We feel that future studies should include references to tools and techniques used to address this PM role and could provide valuable insights in DM processes that determine what tools to use, how to apply them and in what perceived context.

7. Conclusion

Based primarily on correlations, this paper explored the statistical behavior and associated relationships between project success factors, PM tools, and PM methods. In doing so, the paper extended the survey findings of an international 2011 study by Fortune *et al.* (2011). The findings indicate that some tools and methods are more stable in the sense that they exhibit less variability in terms of use than others. For example, PM tools and PM methods are highly used but risk tools are less predictably used. In addition, PM tools are the most stable tools in terms of use, especially those used for scheduling. Schedules are an element of the triple constraint. DM methods tend to be financial in nature (i.e. cost is also an element of the triple constraint) and were more correlated to project success. And finally, in terms of certification, those with a PM credential showed more unpredictable concurrent usage patterns of PM tools and risk tools, as compared to those without the certification, perhaps reflecting an understanding of how certain tools are used for certain reasons and their limitations for complex and chaotic projects. For example, a person who holds a PM credential may be more aware of the specific capabilities of PM and risk tools and thus may only procure one specific type of tool. These respondents may perceive their projects to be more complex or chaotic than others in more traditional simple or complicated contexts along the simple to chaotic continuum.

In terms of limitations, correlations are useful to indicate direction, strength, and significance of relationships but they do not infer cause and effect. In addition, the sample size for this study was relatively small which meant that multivariate analyses could not be conducted. Furthermore, this study did not examine tool use by project phase. We also acknowledge that the nuances between tools and techniques could have been further clarified and that there is room for improvement regarding the practice groupings.

A further limitation is that the participants were all self-selecting as they were emailed via the PM associations and through network of contacts and invited to take part in the survey and so many that responded were most likely working in mainly traditional simple or complicated projects and were not asked if their project could be classified as complex or chaotic. This as discussed may affect the participant's sophistication of use and desire to use command and control tools and methods. If they are engaged in highly complex or chaotic projects they may believe that strict control through planning and review is not responsive enough and so answer the questions asked in a way that indicates that these tools are of little value to them. Qualitative and in-depth case studies may be better to reveal more reliable data and insights for these types of projects.

Our introduction raised the question "what are the relationships between project success factors, PM tools, software, and methods?" The main contribution of this paper is that its findings may assist companies to consider their suite of PM practices as a whole. For example, an organization that is newer to PM may want to start to use PM tools and PM methods for scheduling before it considers adding risk tools to its suite. Tools and techniques are almost never used to maximum benefit when they are introduced in a haphazard manner but in some organizations that is currently the norm.

They may also want to think about their PM practices from a certification perspective as this may enable credentialed employees to apply their newly gained knowledge to the tools and techniques used at work as well as share their new found learning with each other. Organizations could further strive to ensure that they use DM methods earlier in the project lifecycle. Our analysis indicated that in addition to the findings reported, the use of tools and methods was not significantly different between countries so that at least within an Anglo-based national culture such as the UK, Australia and Canada (Ashkanasy *et al.*, 2002) our finding appear to be consistent and perhaps able to be generalized.

To summarize, given the breadth of PM tools, software, and methods, and given how projects vary in terms of size, shape, and complexity, this study provides new insights and sheds some light on correlations between the use of the practices and also related them to project success. Future studies could extend surveys of this nature to examine tool use and the relationship to success by examining the projects by phase. There is also ample room for future studies to investigate tool use and project success by country and type of organizational setting as well as by PM maturity within a company. Additionally, future studies could focus on at least including tools and processes that are used in highly complex or chaotic projects where the paradigm of a PM role shifts from control to influencer, agile experimenter or one of muddling through albeit with strong adaptive and resilient strengths based on high level skills and experience of probing and responding effectively in unknown situations. Much work remains to be done to categorize PM tools, techniques, and methods. There is also potential for others in the field to develop a robust categorization scheme for PM practices.

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