Project Management in the Information Systems and Information Technologies Industries

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Abstract

For many enterprises, sustainable success is closely linked to information systems (IS) and information technologies (IT). Despite significant efforts to improve software project success, many still fail. Current literature indicates that most of the software project problems are related to management, organizational, human, and cultural issues—not technical problems. This paper presents results of a survey of 36 software owners/sponsors, contractors/suppliers, and consultants on 12 projects. The empirical results address answers to questions related to success, performance metrics, and project business drivers. A lack of alignment on these critical issues emerge consistently by phase as well as across the entire project. The results of this study also are compared with others that span seven additional industry sectors. As a result, the authors have developed an approach that links project critical success factors (CSFs) to corporate strategy, and project metrics to the CSFs. An important finding of this study is the critical need to identify and manage realistic expectations of the stakeholders to achieve perceived project success.

Keywords: information systems; information technology; managing stakeholder expectations; critical success factors; software project management

2002, Vol. 33, No. 3, 5–15
8756-9728/02/$10.00 per article + $0.50 per page

Information systems (IS) and information technologies (IT) are the fastest growing industries in developed countries. Huge amounts of money continue to be invested in these industries (Abdel-Hamid & Madnick, 1990). Due to pressure of time-to-market, there is a corresponding pressure to increase productivity. To maintain a competitive edge in today's fast-changing world, an organization's success depends on effectively developing and adopting IS. Literature has discussed concern for problems related to IT/IS development and implementation.

According to Zells (1994) and other studies, approximately 85% of software projects undertaken in Europe and North America are at level one of the Software Engineering Institute's capability maturity model (CMM). Level one is the lowest level of CMM. The challenges at level one are to have project planning, project management, configuration management, and software quality assurance in place—and have them working effectively. To improve project delivery performance, a number of organizations are adopting project management approaches and setting up project management offices (Barnes, 1991; Butterfield & Edwards, 1994; King, 1995; Munns & Bjeirmi, 1996; Raz, 1993; Redmond, 1991).

Current literature on software projects shows that most of the software problems are of a management, organizational or behavioral nature, not technical (Johnston, 1995; Martin, 1994; Whitten, 1995).

A survey of high-tech firms showed that if project management improved, time and cost could be reduced by more than 25% and profits would increase by more than 5% (Fisher, 1991). This has since been validated by use of Stratigically Managed Aligned Regenerative Transitional (SMART) project management, based on internal benchmarking by the companies involved in the field trials.

Objectives of the Study

In this paper, the authors report findings on current project management practices in the IT/IS industries. The purpose of the study was to find out what practices are important to IT/IS industries in successfully accomplishing their projects. Do they use proven project management practices? Whatever the IT/IS industries regard as important for the success of their projects, do they measure it? What are the project drivers? Are these three important elements aligned with each other? The authors investigated these questions not only for various phases of a project, but also from the perspective of three major stakeholders. These stakeholders include an owner or sponsor, a major contractor or supplier, and a consultant for the same project.

In the next section, the authors review the current literature, summarizing major problems of IT/IS projects. In the fourth section, the authors discuss their research methodology. This is followed by a discussion of the results of the study and a summary of the findings. Finally, the authors propose an approach for managing projects based on the SMART framework and implemented on a number of software and other projects with markedly improved results, followed by conclusions. The authors hope that this study will help project managers in understanding the state of the art of project management in the software industry and how it might be improved.

Literature Survey

The horror stories about delay, cost overrun, and abandonment of software projects are widely reported in the literature (Bailey, 1996; Gibbs, 1994; Lucas, 1995; Martin, 1994; Ward, 1994). In other industries, causes of project failures are investigated and reports written, but in the computer industry their causes are covered up or ignored. As a result, the IT/IS industry keeps making the same mistakes over and over again (Johnston, 1995).

There are differences in the opinions of experts as to whether software project management is similar or different to project management in other industries. The authors believe that the principles are the same across industries, but the terminology and some applications are specific to each industry and sometimes to each company or physical location. But many believe that software management is very different (Otto, Dhillon, & Watkins, 1993; Raybould,1996; Roetzheim, 1993; Samuels, 1996). However, in Duncan's (1991) view, software projects are not different from other projects. In the authors' opinion there are both differences and commonalties in all types of projects, let alone software projects. Any two projects from one industry sector can be unique, and we can benefit from other industries' experiences.

In summary, the most commonly reported causes of software project failure are as follows (based on a content analysis of the cited literature):

- Misunderstood requirements (business, technical, and social) (King, 1995; Lane, Palko, & Cronan, 1994; Lavence, 1996);
- Optimistic schedules and budgets (Martin, 1994);
- Inadequate risk assessment and management (Johnston, 1995);
- Inconsistent standards and lack of training in project management (Jones, 1994; O'Conner & Reinsborough, 1992; Phan, Vogel, & Nunamaker, 1995);
- Management of resources (people more than hardware and technology) (Johnston, 1995; Martin, 1994; Ward, 1994);
- Unclear charter for a project (Lavence, 1996);
- Lack of communication (Demery, 1995; Gioia, 1996; Hartman, 2000; Walsh & Kanter, 1988).

The authors of this paper believe that these are symptoms of the disease and not the root causes of the disease.

Main Reasons for Failures of IT/IS Projects

Before looking into the main causes of project failures in the IT/IS industry, we must define critical success factors (CSFs) and review the importance of metrics. The CSFs are the elements that make a project a success. These include trust, effective communication, top management support, etc. Key result areas (KRAs) are specific results that are needed to deliver a successful project. CSF methodology has been highly successful in identifying KRAs crucial for the success of a project (Atkinson, 1999; Baccarini, 1999; Belassi & Tukel, 1996; Byers & Blume, 1994; Clarke, 1999; Cooke-Davies, 2002; Fisher & L'Abbe, 1994; Forsberg & Mooz, 1996; Fowler & Walsh, 1999; Johnston, 1995; Levene, Bentley, & Jarvis, 1995; Lim & Mohamed, 1999; Martin, 1982; Pinto & Kharbanda, 1995; Raz, 1993; Shank, Boynton, & Zmud, 1985; Tan, 1996; Wateridge, 1999; Whitten, 1995; Zahedi, 1987; Zells, 1991).

With changing business conditions, half-century-old project performance metrics are no longer effective for the monitoring and control of today's projects. Proper measurement tools and metrics are necessary for effective control of projects (Hartman & Jearges, 1996; Kiernan, 1995; Simmons, 1992; Thamhain, 1994).

Based on both consulting and earlier research, the authors found that the main reasons for most of these problems are:

- Major stakeholders generally do not have a clear idea of project success or have differing views of what success constitutes. If a clear vision exists, it is not effectively communicated or the project team does not understand it. This leads to scope creep, inappropriate measurement, churn in developments, specification changes, delays, and other issues;
- Generally there is a problem in identifying KRAs and CSFs and linking them to the stakeholders' business strategy. This leads to lack of support by senior management;
- The project team and major stakeholders are not very clear on what the performance and control metrics should be. Normally the focus is on time, cost, performance, and quality. But this focus is not consistent between stakeholders or over time. Some have recognized the importance of customer and end-user satisfaction;
- Project control and performance metrics are not linked to KRAs and CSFs. This means we measure the wrong things and distract the team from what is important to success. It looks like inadequate or ineffective project control;
- Generally, there is very little or sometimes no alignment among major stakeholders on success criteria, KRAs, CSFs, performance metrics, project drivers, and on the dynamics of change for these elements over the project life cycle. This leads to inappropriate decision-making and inconsistency in management style and focus.

Current literature also supports these views, albeit piecemeal in many cases, as the focus of many papers is on specific aspects. A number of researchers have commented on the lack of project success criteria and on a lack of proper project metrics (Adams, Sarkis, & Liles, 1995; Demery, 1995; Ingram, 1994; Jiang, Klein, & Balloun, 1996; Johnston, 1995; Peters, 1996; Pinto & Slevin, 1988; Raybould, 1996; Stevens, 1991; Turner, McLaughlin,

Thomas, & Hastings, 1994; Wateridge, 1995). Hartman and Ashrafi (1996) reported an overview on CSFs, project drivers, and metrics of various industries. Some of the results of the current study were reported in Hartman and Ashrafi (1998).

As a first step to collecting empirical evidence to test the hypotheses, the authors decided to collect data on the current state of affairs for these aspects of project management. This included but was not limited to:

- Were the criteria for success clearly defined at the beginning of the project? Were KRAs and CSFs identified?
- Was there any alignment between major stakeholders on these CFSs?
- What project metrics were used for monitoring project performance during various phases of the project?
- Was there an alignment of major stakeholders on what these metrics should be?
- Were these metrics linked to KRAs and CSFs?
- Were the project priorities set at the beginning of the project? Did the priorities change during various phases of the project life cycle?
- Were the KRAs, CSFs, metrics, and project priorities consistent with each other?
- Were the CSFs, metrics, and project priorities changed during various phases of the project?
- Was there any alignment between major stakeholders on the dynamics of such change across the various phases of the project?

The first of these aspects is to identify what KRAs would be crucial to the successful accomplishment of the project. This allows the project team to keep a focus on them and not get led astray by the everyday fire fighting on project management problems. The second aspect is to link these KRAs and CSFs to corporate strategy and to get buy-in of all the major stakeholders. This linkage validates the project and helps senior management see its relevance and, thus, provide appropriate support to the project. The third aspect is to monitor, control, and measure those elements regarded as critical for project success. In other words, once we know what is important for success, project elements that contribute to this success are the ones we should be measuring to monitor performance during implementation. The fourth aspect is to identify project business drivers. This helps make project priorities very clear to everyone. The fifth aspect is to align all major stakeholders and the project team on KRAs, CSFs, project drivers, and metrics. Finally, it is important to have an understanding of the dynamics of these elements over various phases of the project.

The authors strongly believe that if project success criteria are defined at the beginning of a project, KRAs are identified and related to corporate strategy through a clear project mission, metrics are linked to these KRAs, project priorities are made clear, and buy-in is obtained by all major project stakeholders on all these aspects, most of the problems reported in the literature could be avoided. As a result, efficiency and success of projects could be significantly improved.

Research Methodology

The authors developed a survey instrument to collect data on all the stated aspects of project management. The survey was divided into five sections. The first section collected project-related and demographic information such as industry sector, experience of project manager, project value, duration, location, completion date, purpose of the project, role of the respondent, etc. The second section provided a list of 33 items identified by the authors as potential CSFs. These CSFs were synthesized from the extensive literature on this subject. The respondents were asked to rate these factors in terms of their importance on a scale of 0 to 5 on each of the four project phases (5 = very important; 1 = not important; 0 = not applicable). These four phases were definition, planning, execution, and termination.

The third section of the survey dealt with project metrics. A list of 20 different project metrics were provided to the respondents and they were asked to rank the importance of these metrics on the scale of 0 to 5 over the four phases of a project. These metrics were drawn from standard project management texts and were guided by the Project Management Institute's *A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*) (PMI Standards Committee, 2000). In the fourth section, a list of six project priorities was given and the respondents were asked to rank the importance of these project drivers at each of the four phases. Last, several open-ended questions were asked. Was this project successful? If so, on what basis? Other relevant information the respondent wanted to add was recorded here.

Data was collected on 12 projects in Canada through personal interviews of 36 project owners/sponsors, contractors/suppliers, and consultants—three people per project. This was part of a much larger study spanning eight industry sectors and more than 100 projects. A brief summary of projects is included in Appendix A.

First, an owner/sponsor of a suitable project was contacted and interviewed. With permission of the owner/sponsor, a major contractor or a supplier and a consultant to the same project were identified and interviewed. The respondents were asked to reply in the context of actual project management practices and not in terms of company policy or their personal opinions or preferences. The sample used in the study was small and based in Calgary, Alberta, Canada. However, based on correlation with other findings and observations from the literature, the authors believe these results have broad application.

Results of Survey Analysis

One of the main goals of this study was to identify KRAs and CSFs and to find out if project metrics were linked to these KRAs and CSFs. The authors also wanted to establish project priorities during various phases of the project life cycle. In addition to these, the authors wanted to answer several questions including:

- Is there a change in the CSFs, metrics, and priorities over the life of the project?

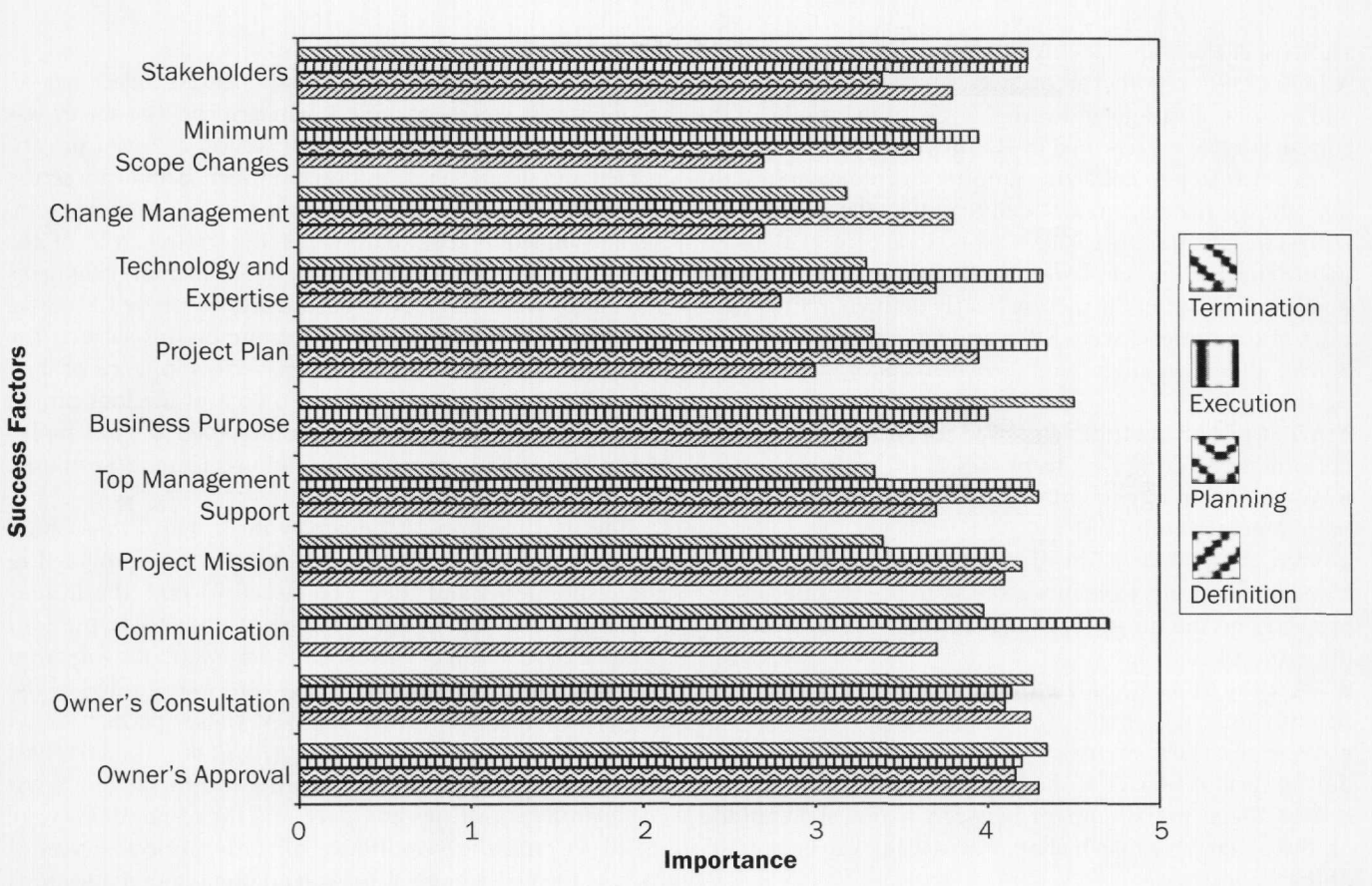

Figure 1. Project Success Factors by Phases

- How consistent are the three major stakeholders (owner, contractor, and consultant) in their perceptions of CSFs, metrics, and project priorities?
- Are the perceived CSFs consistent with the metrics used and the project priorities identified by these stakeholders?

An average of all scores of the responses in the appropriate survey groups was calculated. The most important characteristics then were defined as those that had the highest average score:

- **CSFs by Phases.** Figure 1 shows the 10 most important CSFs over the four phases of projects;
- **CSFs by Stakeholders.** The 10 most important CSFs by stakeholders group are shown in Figure 2;
- **Project Metrics by Phases.** Figure 3 shows the 10 most important project metrics for four phases of the projects investigated;
- **Project Metrics by Stakeholders.** The most important project metrics according to each of the stakeholders are shown in Figure 4;
- **Project Priority Ranking by Phase.** Figure 5 shows project priority ranking during four phases of the projects studied;
- **Project Priority Ranking by Stakeholders.** Figure 6 shows the most important project priority rankings by stakeholders.

From the results, it was concluded that the value of metrics as a predictive tool was not fully exploited by the project teams. It may have been possible to place more importance on key metrics earlier on in the project. This could have been done to ensure that things did not get out of hand by the time the execution stage rolled around because, at that point, the project has enough momentum that it becomes quite difficult to get it back on track.

Table 1 shows the most important overall CSFs and project metrics as identified by all the three stakeholder groups over four project phases. The respondents showed inconsistencies between what they identified as the project success factors and what were used as project metrics. It was observed that in some cases that respondents in the same project agreed on the importance of certain CSFs, but they did not agree on how the CSFs were measured. In other cases, respondents agreed on the importance of these factors, but they indicated that they did not have a metric established for measuring them.

It also was observed that project owners, contractors, and consultants do not have a clear understanding of the methods that are used on their projects to measure how well project goals are met. Although there is some agreement as to which factors are important to the success of the project, there also should be agreement on how to measure success. If project metrics are not clearly understood, it is difficult to determine the level of success of the project. Each individual involved in the project may have a different opinion as to how successful the project is, depending on his or her own measurement. Another important point is that success factors considered to be important to a project should be measured in some way during execution to determine ahead of time whether

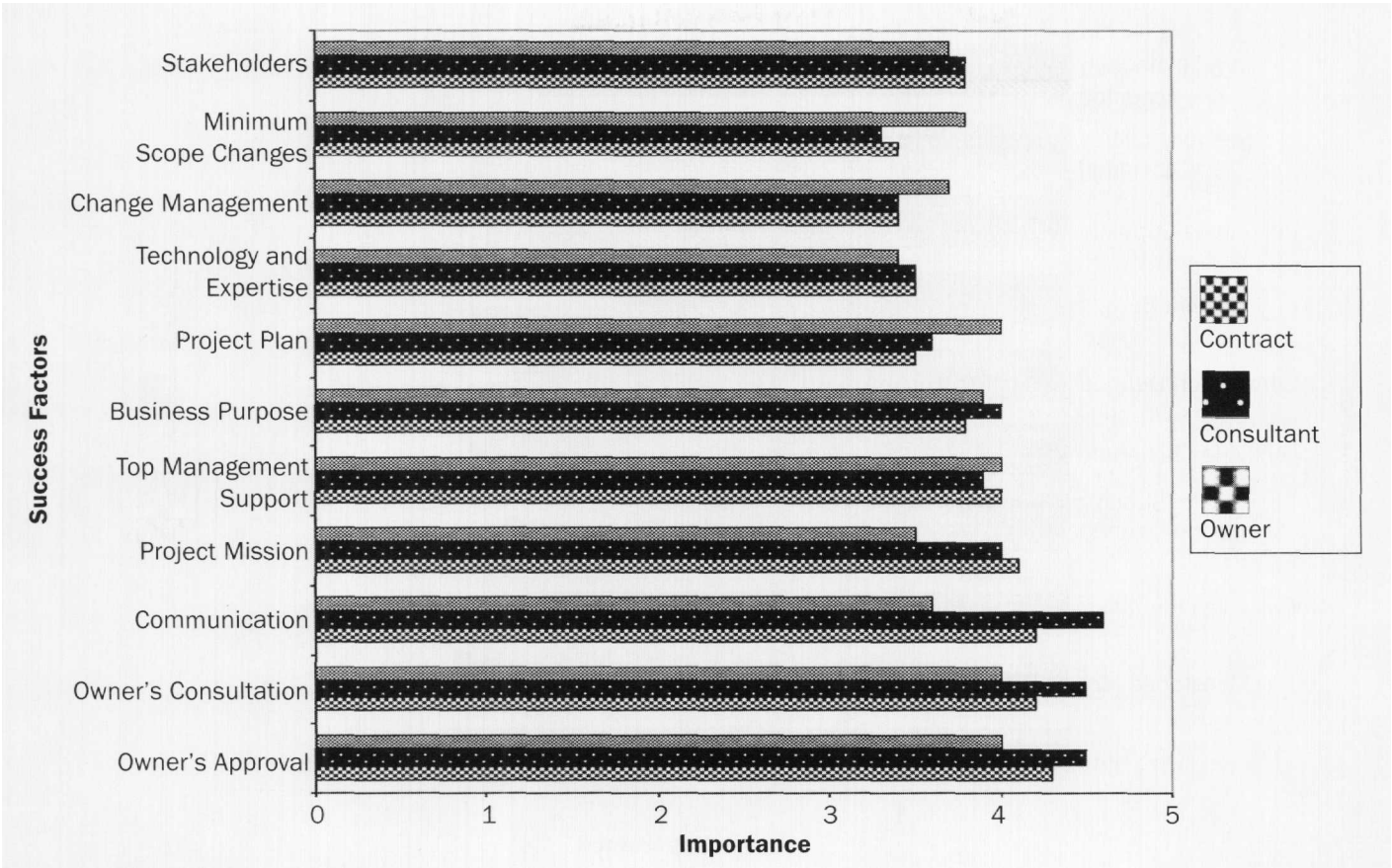

Figure 2. Success Factors by Stakeholders

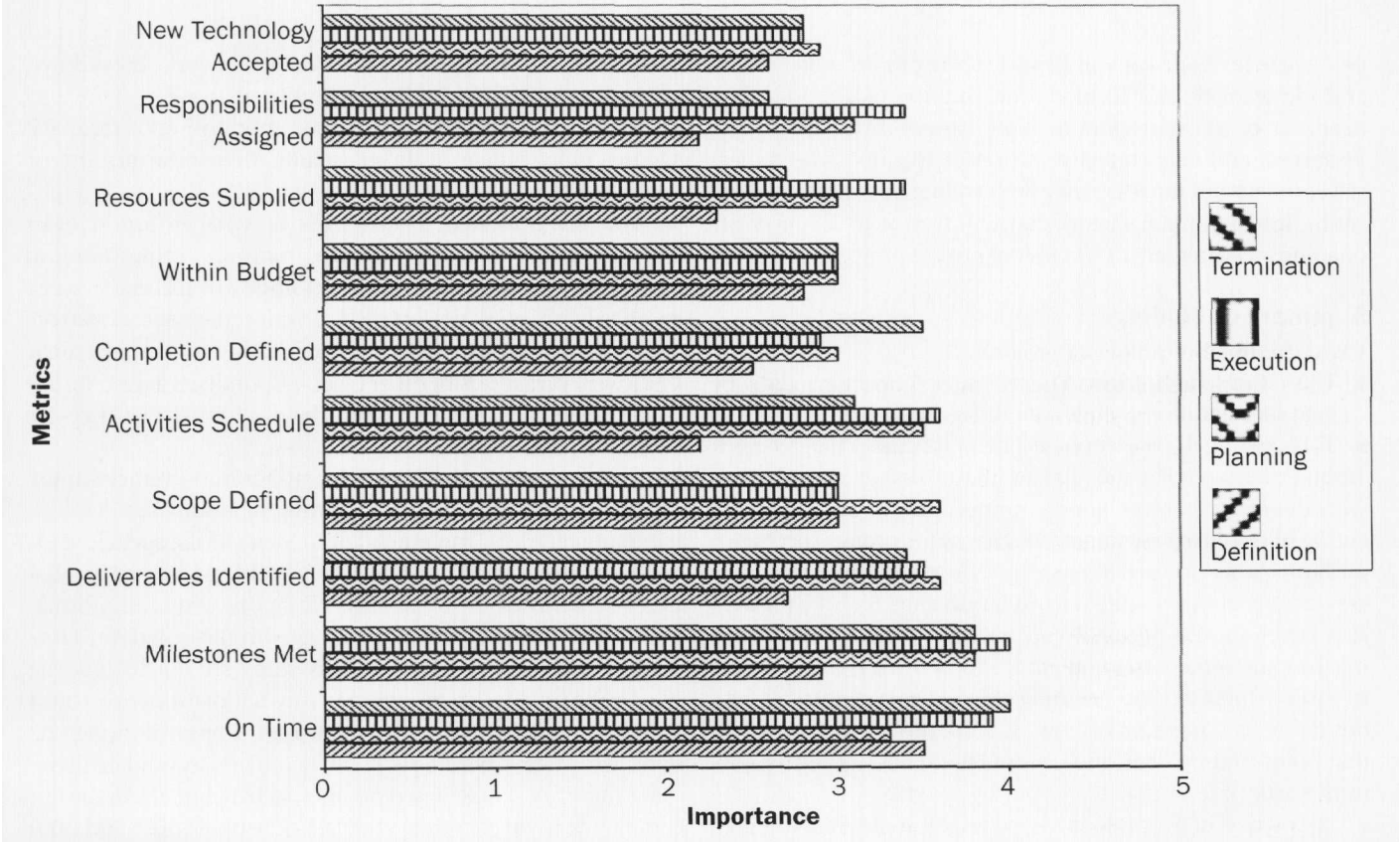

Figure 3. Project Metrics by Phases

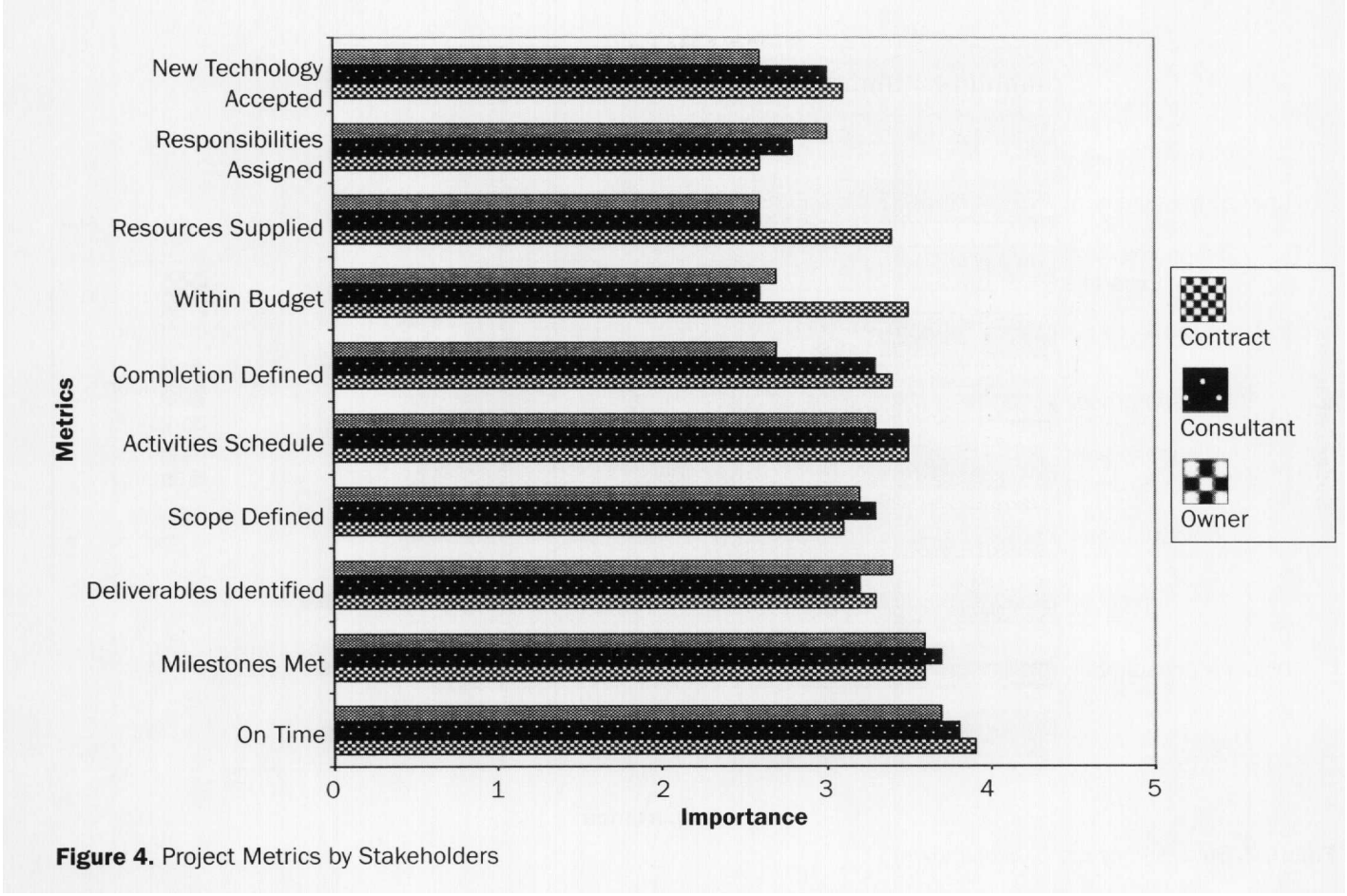

Figure 4. Project Metrics by Stakeholders

performance objectives will be met. If the project stakeholders and the team do not formally measure the factors that they deem to be most important, they cannot hope to predict its success and take corrective action as required. The project stakeholders and the team may be spending their time on measuring less important factors that will lead it to an incorrect ongoing measurement of whether or not the project is a success.

Summary of Findings

Based on the results, the authors found:

- The ratings for a particular project success factor did not change very significantly between different phases;
- Throughout all project phases, there was general agreement among survey participants that a project mission, consultation with the project owner, good communication, and the availability of resources are important factors for project success;
- Participants on each project agreed on certain project success factors, but they tended to either disagree on how the success factor should be measured, or they did not attempt to measure the success factor at all;
- Project metrics were not fully utilized as a predictive tool but rather as a measure of how well the project performed to that point in time. This often is too late to allow effective corrective action;
- The owners of the projects agreed unanimously that it is very important for the project to meet the needs of the end user;
- Responsibility breakdown structures, work breakdown structures, and CSFs were not well utilized;
- The owners did not have control, monitoring or feedback systems independent of those used by the contractors and/or consultants;
- Time taken to align stakeholders on what is important to the project probably would help improve communication, reduce rework, and enhance the possibility of success;
- The alignment of project metrics with project success factors and priorities appears to be an opportunity for improvement in the software industry.

Recommendations

It is widely accepted that there is room for improvement in the delivery of software projects including new software development, upgrades, or implementation. Many of the specific studies in this area suggest either what the problems may be or what needs to be in place for success. While this is useful information, it does not help the practitioner with the question: "How do I achieve greater success?" This study set out to link the symptoms for success or failure with what constructive action may be needed to achieve such success. These recommendations, which have been tested on live projects to validate them, make that critical link. Based on internal benchmarks in the test companies, savings in time and cost of between 10% and 30% were matched by improved quality and end-user acceptance.

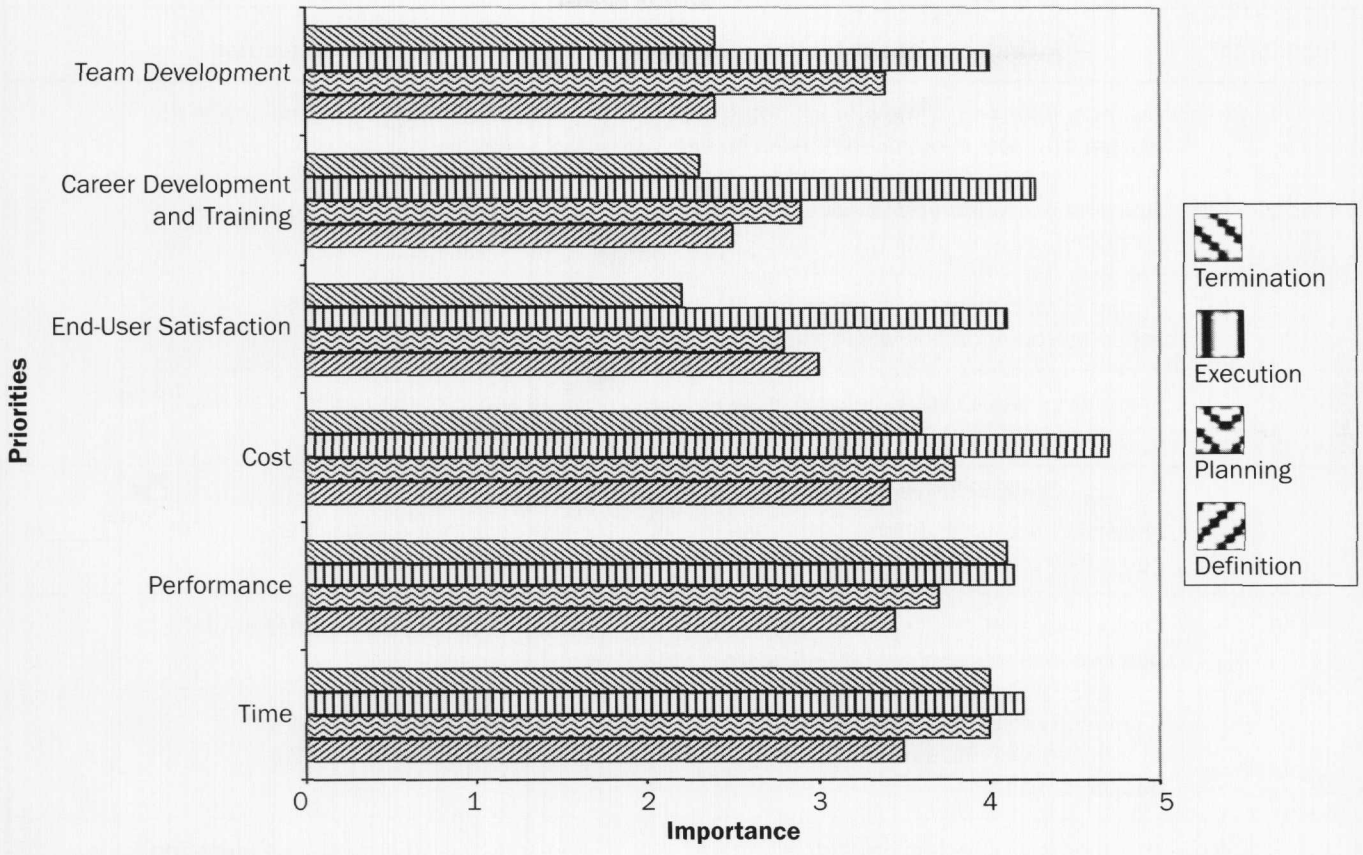

Figure 5. Project Priorities by Phase

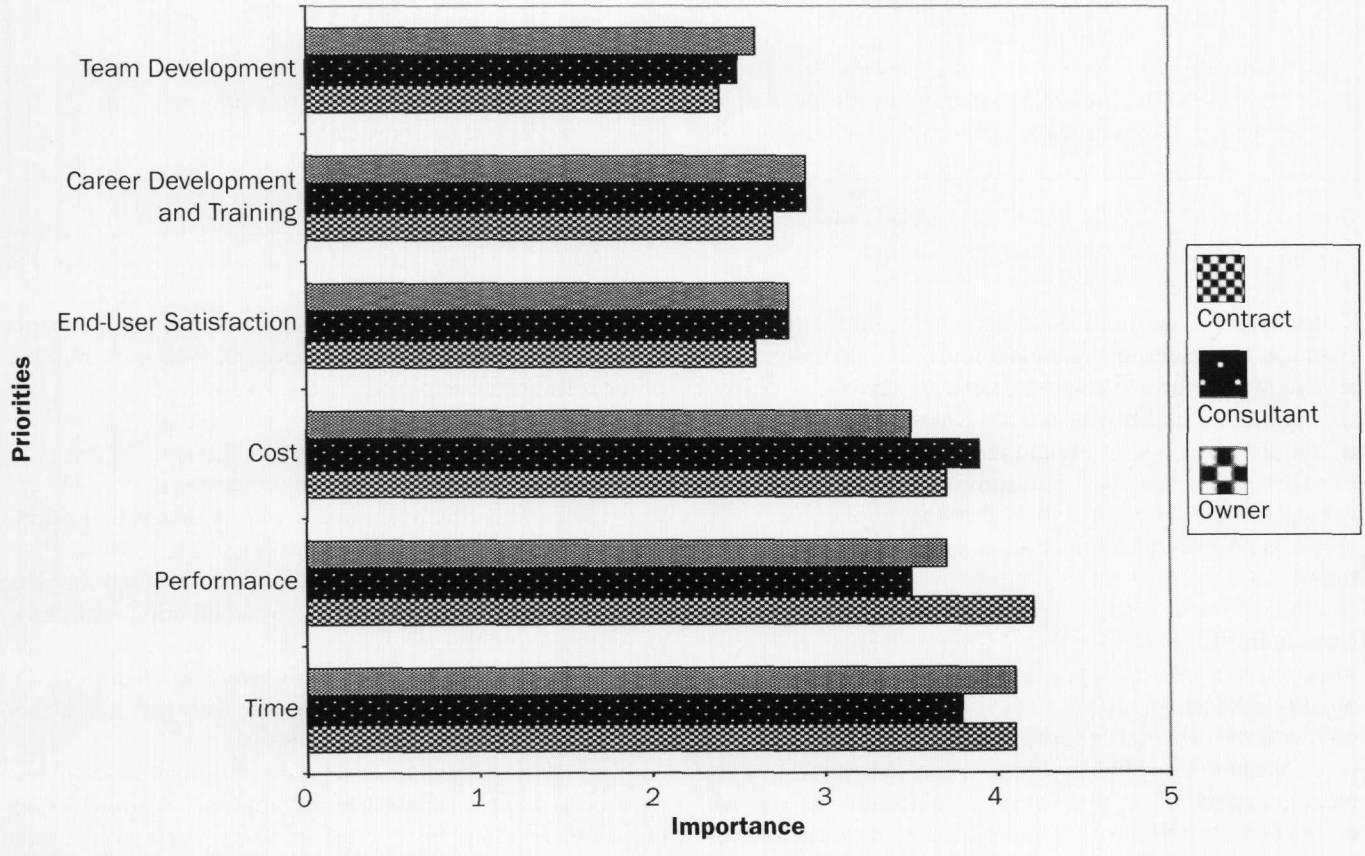

Figure 6. Project Priorities by Stakeholders

Rank order	Critical success factors	Project metrics
1	Owner is informed of the project status and his/her approval is obtained at each stage	Project completed on time or ahead of schedule
2	Owner is consulted at all stages of development and implementation	Milestones are identified and met
3	Proper communication channels are established at appropriate levels in the project team	Deliverables are identified
4	The project has a clearly defined mission	The scope of the project is clearly defined and quantified
5	Top management is willing to provide the necessary resources (money, expertise, equipment)	Activities and logical sequences are determined and scheduled (CPM)
6	The project achieves its stated business purpose	Project completion is precisely defined
7	A detailed project plan (including time schedules, and milestones) with a detailed budget in place	The project is completed within a predetermined budget
8	The appropriate technology and expertise are available	Resource requirements are identified and supplied as needed
9	Project changes are managed through a formal process	Responsibilities are assigned
10	The project is completed with minimal and mutually agreed scope changes	A specific new technology is adopted and accepted by end users

Table 1. Overall 10 Most Important Critical Success Factors and Metrics

The recommendations that follow represent the four most significant elements identified and tested in this study:

- Link your project to corporate business strategy;
- Align major stakeholders on key issues;
- Simplify project controls and metrics;
- Make sure effective communication and expectation management is maintained throughout the project life.

Greater detail on how these aspects are implemented can be found in Hartman (2000).

Conclusions

Although the projects surveyed were rated as successes, some projects lacked defined goals or defined metrics to measure this success. If the owner, contractor, and consultant on a project all have different ideas of what success is and how success will be measured, it is unlikely that everyone (or possibly anyone) will be satisfied when the project is completed. There are many tools that can be utilized to ensure a successful project. For the software industry, it may just be a matter of learning what tools are available and how to use them properly to raise the number of successful software projects to an acceptable level.

The authors hope that this study will help in:

- Considering a holistic approach for the project;
- Understanding what is important for success;
- Understanding the dynamics of project drivers and priorities and that these may shift over time;
- Getting and maintaining alignment of major stakeholders including the immediate project team on all important strategic and tactical issues;
- Realizing better planning and more effective control;
- Accomplishing a successful project with satisfied stakeholders, project teams, and customers.

Some general guidelines for how this may be achieved have been offered. The suggested approaches to achieving project success have been tested on live projects with consistently successful outcomes.

Acknowledgments

The authors would like to thank all the students of the fundamentals of project management class of the project management specialization at the University of Calgary who conducted the interviews reported in this paper. Thanks also are due to all industry personnel who gave their time and participated in the interview surveys. The authors also would like to thank the Natural Sciences and Engineering Research Council of Canada (NSERC), the Social Sciences and the Humanities Research Council of Canada (SSHRC), and industry partners who support the research program of the project management specialization at the University of Calgary. In addition, the authors thank referees of this paper for their useful comments and constructive suggestions to improve it.

References

Abdel-Hamid, T., & Madnick, S. (1990). The elusive silver lining: How we fail to learn from software development failures. *Sloan Management Review, 32* (1), 39–47.

Adams, S.M., Sarkis, J., & Liles, D. (1995). The development of strategic performance metrics. *Engineering Management Journal, 7* (1), 24–32.

Atkinson, R. (1999). Project management: Cost, time, and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management, 17* (6), 337–342.

Baccarini, D. (1999). The logical framework method for defining project success. *Project Management Journal, 30* (4), 25–32.

Bailey, R. (1996). Approving systems projects: Eight questions an executive should ask. *PM Network, 10* (5), 21–24.

Barnes, M. (1991). Innovation—Why project management is essential to successful business. *International Journal of Project Management, 4* (4), 207–209.

Belassi, W., & Tukel, O.I. (1996). A new framework for determining critical success/failure factors in projects. *International Journal of Project Management, 14* (3), 141–151.

Butterfield, L., & Edwards, R. (1994). PM software development using PM techniques. *Proceedings of the Project Management Institute's 25th Annual Symposium*, Vancouver, Canada. Upper Darby, PA: PMI, 522–526.

Byers, R., & Blume, D. (1994). Tying critical success factors to systems development. *Information and Management, 26* (1), 51–61.

Clarke, A. (1999). A practical use of key success factors to improve the effectiveness of project management. *International Journal of Project Management, 17* (3), 139–145.

Cooke-Davies, T. (2002). The 'real' success factors on projects. *International Journal of Project Management, 20* (3), 185–190.

Demery, K. (1995). Magic schedules delivering consumer software on time. *Proceedings of the Project Management Institute's 26th Annual Symposium*, New Orleans, LA. Upper Darby, PA: PMI, 662–667.

Duncan, W.R. (1991). Concern of project managers counterpoint vive la difference. *PM Network, 5* (6), 33–34.

Fisher, E., & L'Abbe, M. (1994). PM implementation through organizational change. *Proceedings of the Project Management Institute's 25th Annual Symposium*, Vancouver, Canada. Upper Darby, PA: PMI, 277–283.

Fisher, K.J. (1991). Project management will drive revenue recognition for software providers. *PM Network, 5* (6), 25–28.

Fowler, A., & Walsh, M. (1999). Conflicting perceptions of success in an information systems project. *International Journal of Project Management, 17* (1), 1–10.

Gibbs, W. (1994). Software's chronic crisis. *Scientific American, 271* (3), 86–95.

Gioia, J. (1996). Twelve reasons why programs fail. *PM Network, 10* (11), 16–19.

Hartman, F. (2000). *Don't park your brain outside: A Practical Guide to Improving Shareholder Value with SMART Management*. Newtown Square, PA: PMI.

Hartman, F., & Ashrafi, R. (1996). Failed successes and successful failures. *Proceedings of the Project Management Institute's 27th Annual Symposium*, Boston, MA. Upper Darby, PA: PMI, 907–911.

Hartman, F., & Ashrafi, R. (1998). Project management in the IT/IS industry. *Proceedings of the Project Management Institute's 29th Annual Symposium*, Long Beach, CA. Newtown Square, PA: PMI, 706–709.

Hartman, F., & Jearges, G. (1996). Simplifying project success metrics. *Proceedings of the 40th Meeting of the American Association of Cost Engineers (AACE) International*, Vancouver, B.C., Canada. Morgantown, WV: AACE International, PM.7.1–PM.7.4.

Ingram, T. (1994). Managing client/server and open system projects: A 10-year study of 62 mission-critical projects. *Project Management Journal, 25* (2), 26–36.

Jiang, J., Klein, G., & Balloun, J. (1996). Ranking of system implementation success factors. *Project Management Journal, 27* (4), 49–53.

Johnston, A.K. (1995). *A hacker's guide to project management*. Oxford, U.K.: Butterworth-Heinemann.

Jones, C. (1994). *Assessment and control of software risks*. Burlington, MA: Yourden Press.

Kiernan, M. (1995). *Get innovative or dead*. Vancouver, Canada: Dougas & Mcintyre.

King, J. (1995). 'Tough love' reins in IS projects. *Computerworld, 29* (23), 2.

Lane, P., Palko, J., & Cronan, T. (1994). Key issues in the MIS implementation process: An update using end user computing satisfaction. *Journal of the End User Computing, 6* (4), 3–13.

Lavence, D. (1996). Project management in IT/MIS: An ever increasing challenge. *Proceedings of the Project Management Institute's 27th Annual Symposium*, Boston, MA. Upper Darby, PA: PMI, 464–466.

Levene, R.J., Bentley, A.E., & Jarvis, G.S. (1995). The scale of project management. *Proceedings of the Project Management Institute's 26th Annual Symposium*, New Orleans, LA. Upper Darby, PA: PMI, 500–507.

Lim, C.S., & Mohamed, M.Z. (1999). Criteria of project success: An exploratory re-examination. *International Journal of Project Management, 17* (4), 243–248.

Lucas, J.J. (1995). Work management: Why can't information managers manage? *Proceedings of the Project Management Institute's 26th Annual Symposium,* New Orleans, LA. Upper Darby, PA: PMI, 304–310.

Martin, E.W. (1982). Critical success factors of chief MIS/DP executive. *MIS Quarterly, 6* (2), 1–9.

Martin, J.E. (1994). Revolution, risk, runaways: Three Rs of IS projects. *Proceedings of the Project Management Institute's 25th Annual Symposium,* Vancouver, Canada. Upper Darby, PA: PMI, 266–272.

Munns, A.K., & Bjeirmi, B.F. (1996). The role of project management in achieving project success. *International Journal of Project Management, 14* (2), 81–87.

O'Conner, M.M., & Reinborough, L.M. (1992). Quality projects in the 1990s: A review of past projects and future trends. *International Journal of Project Management, 10* (2), 107–114.

Otto, R.A., Dhillon, J., & Watkins, T. (1993). Implementing project management in large-scale information-technology projects. In P.C. Dinsmore (Ed.). *AMA Handbook of Project Management* (pp. 352–361). New York: Amacom.

Peters, L. (1996). The master's touch in project success-where, how, when, what, of leading projects to excellence. *Proceedings of the Project Management Institute's 27th Annual Symposium.* Boston, MA. Upper Darby, PA: PMI, 806–812.

Phan, D., Vogel, D., & Nunamaker, J.F., Jr. (1995). Empirical studies in software development projects: Field survey on OS/400 study. *Information and Management, 28* (4), 271–280.

Pinto, J., & Slevin, D. (1988). Critical success factors across the project life cycle. *Project Management Journal, 19* (3), 67–75.

Pinto, J.K., & Kharbanda, O.P. (1995). *Successful project managers: Leading your team to success.* New York: Van Nostrand Reinhold.

PMI Standards Committee. (2000). *A guide to the project management body of knowledge.* Newtown Square, PA: Project Management Institute.

Raybould, M. (1996). Is project management of software projects a special case. *Proceedings of the Project Management Institute's 27th Annual Symposium.* Boston, MA. Upper Darby, PA: PMI, 549–554.

Raz, T. (1993). Introduction of the project management discipline in a software development organization. *IBM Systems Journal, 32* (2), 265–277.

Redmond, W.F. (1991). The evolution of project management in corporate systems development projects. *Proceedings of the Project Management Institute's 22nd Annual Symposium,* Dallas, TX. Drexel, PA: PMI, 129–134.

Roetzheim, W. (1993). Managing software projects: Unique problems and requirements. In P.C. Dinsmore (Ed.). *AMA Handbook of Project Management* (pp. 347–352). New York: Amacom.

Samuels, R. (1996). Managing software programs: A different kind of animal. *Proceedings of the Project Management Institute's 27th Annual Symposium,* Boston, MA. Upper Darby, PA: PMI, 627–633.

Shank, M., Boynton, A., & Zmud, R. (1985). Critical success factor analysis as a methodology for MIS planning. *MIS Quarterly, 9* (2), 121–129.

Stevens, W.M. (1991). Concerns of project managers this & that "Yes, but ...". *PM Network, 5* (2), 14–18, 22.

Simmons, D.B. (1992). A win-win metric based software management approach. *IEEE Transactions on Engineering Management, 39* (1), 32–41.

Tan, R. (1996). Success criteria and success factors for external technology transfer projects. *Project Management Journal, 27* (2), 45–56.

Thamhain, H. (1994). Designing modern project management systems for a radically changing world. *Project Management Journal, 25* (4), 6–7.

Turner, J.R., McLaughlin, J.J., Thomas, R.D., & Hastings, C. (1994). A vision of project management in 2020: Interactive session. *Proceedings of the Project Management Institute's 25th Annual Symposium,* Vancouver, Canada. Upper Darby, PA: PMI, 634–635.

Walsh, J.J., & Kanter, J. (1988). Towards more successful project management. *Journal of Systems Management, 39* (319), 16–21.

Wateridge, J. (1995). IT projects: A basis for success. *International Journal of Project Management, 13* (3), 169–172.

Wateridge, J. (1998). How can IS/IT projects be measured for success? *International Journal of Project Management, 16* (1), 59–63.

Ward, J.A. (1994). Productivity through project management: Controlling the project variables. *Information Systems Management, 11* (1), 16–21.

Whitten, N. (1995). *Managing software development projects* (2nd ed.). New York: John Wiley & Sons.

Zahedi, F. (1987). Reliability of information systems based on the critical success factors—formulation. *MIS Quarterly, 11* (2), 187–204.

Zells, L. (1991). Balancing trade-offs in quality, cost, schedule, resources, and risk. *Proceedings of the Project Management Institute's 25th Annual Symposium,* Dallas, TX. Drexel, PA: PMI 112–118.

Zells, L. (1994). World-class software practices. *Proceedings of the Project Management Institute's 25th Annual Symposium,* Vancouver, Canada. Upper Darby, PA: PMI, 249–253.

Appendix 1. Project Details

Data on 12 software projects was collected. A brief description of the projects follows for the interest of the readers of this paper.

Project	Value	Duration
Facilities information and reporting management system	$1 million	15 months
Data transmission security system	$4 million	Two years
Network management software	$4 million	One year
Financial systems	$14 million	Two years
Software project for a major defense project	Not reported	Two years
Photo and driver's license information system	$2 million	One year
Flip-Chip implementation	Not reported	Not reported
Business process control system	Not reported	Not reported
Implementation of a new corporate reserve database	$6.5 million	One year
Development of a new version of software	$1.5 million	One year
Accounting system implementation	$0.5 million	Three months
Design and implementation of a software system to manage customer contract information	$1.2 million	Two years

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