Management Research News

Project management tools and techniques in high-technology SMEs

Alan Murphy Ann Ledwith

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Alan Murphy and Ann Ledwith
Enterprise Research Centre, University of Limerick, Limerick, Ireland

Abstract

Purpose – This paper aims to examine the use of project management practices in small high-technology firms and to identify what contributes to project success.

Design/methodology/approach – The results presented in this paper are based on a survey of Irish high-technology small-to medium-sized enterprises (SMEs). A questionnaire was distributed to over 200 organisations via e-mail and a response rate of 20 per cent was achieved.

Findings – Results suggest that the existence of a project manager and the use of project planning significantly contribute to project success. Control for projects resides primarily with owner-managers and achieving quality standards is a significant success criterion. Additionally, having clear goals/objectives and top management support are identified as the most important success factors in the firms surveyed.

Research limitations/implications – This paper presents the findings of an initial investigation into the management of projects within SMEs. The study has been limited by the number of respondents and also by the use of a survey as a research instrument. Further research to develop a deeper understanding of how projects are managed in SMEs and how project success can be improved would require a more varied research methodology.

Practical implications – Findings suggest that project management tools and techniques are being used to a limited extent by high-technology SMEs. Analysis suggests that the employment of a project manager and the implementation of project planning techniques are likely to contribute to the overall success of projects. SMEs also strongly believe that past experiences are a vital factor in implementing effective management procedures and determining future success.

Originality/value – While most research into the use of project management has concentrated on practices within large firms, there has been a lack of investigation into project management in small firms as addressed by this paper.

Keywords Project management, Technology led strategy, Small to medium-sized enterprises

Paper type Research paper

Introduction

Project management is a well-established discipline that defines in detail the tools and techniques that are required to define, plan, and implement any project. However, while many researchers have addressed the issues surrounding the management of projects within large firms (White and Fortune, 2002; Bryde, 2003), there has not been much published to date about the management of projects in small-to medium-sized enterprises (SMEs).

This paper examines previous empirical studies on project management implementation in various industry sectors and the success criteria and factors most frequently adopted. The paper also examines the results of a survey distributed to 200 owner/managers of high-technology SMEs in Ireland that attempts to recognise the general characteristics of projects undertaken by SMEs, the issues they encounter and their opinions on how SMEs can use project management to achieve greater efficiency and competitiveness.

SMEs, ranging from the dynamic, innovative and growth-oriented to the traditional enterprises satisfied to remain static, are critical to the economy as an engine of

Management Research News
Vol. 30 No. 2, 2007
pp. 153-166

0140-9174
DOI 10.1108/01409170710722973

economic and social development (Hallberg, 1999). Increased importance has been given to SMEs within European Union (EU) industrial policy (Floyd and McManus, 2005). According to the European Competitiveness Report of 2003, SMEs account for 99 per cent of activity in the EU. The focus on high-technology SMEs derives from their importance to the Irish economy with their capacity for generating employment and promoting innovation (Warren and Hutchinson, 2000).

Project management is a well-established well area of professional expertise and academic research aimed at encouraging improvement in a system (White and Fortune, 2002). Project management offers a systematic approach to all stages of a project by ensuring that every step is carefully planned, monitored, and measured. Although initially intended for application in large organisations with complex systems that require such a process (Baccarini, 1999), modern methods of project management can be adapted and altered to suit the needs of the smaller organisations.

This paper aims to develop an understanding of project characteristics and how they are managed within SMEs, what factors enhance project success and the perception of the potential of project management as a process. These findings will contribute to the development of a simplified approach to managing projects in SMEs.

Characteristics of SMEs

The definition of an SME has varied over time and there has been a lack of consensus about what constitutes a small or medium sized firm (McAdam *et al.*, 2005). For the purpose of this research, using the European Commission's definition, SMEs have fewer than 250 employees, a turnover of less than €250 million and/or an annual balance sheet less than €43 million. The above definition also considers the potential relationships that exist between SMEs and other enterprises defining three categories of SMEs – autonomous, partner, and linked. Most SMEs are autonomous meaning that they are completely independent or have only minority partnerships (less than 25 per cent). For practical reasons within this study SMEs were defined by their staff count and annual turnover. This approach has been adopted in many previous empirical studies (Johnson and Turner, 2000; Hudson *et al.*, 2001; Gray and Mabey, 2005; McAdam *et al.*, 2005).

SMEs exhibit both advantages and disadvantages when compared to larger organisations. Many SMEs have a greater potential flexibility and closeness to the customer and an edge towards customisation and innovation (Audretsch *et al.*, 1998). They seek out markets where their advantages count and they are not in direct competition with their larger counterparts. However, despite these key advantages, SMEs lack economies of scale, scope, and learning.

SMEs also exhibit behavioural features that give them an innovative advantage over large firms these include the ability to respond rapidly to external threats or opportunities, more efficient internal communications and interactive management cycles (Edwards *et al.*, 2001). However, Rothwell (1992) found that SMEs were limited in their ability to innovate as they, "lack the material and technological resources that enable large firms to 'spread risk over a portfolio of new products' and 'fund longer-term R&D'".

Yet is has been shown that project managers in small firms were weak in the areas of motivation, marketing, and management (Ledwith, 2004). Small firms demonstrated limited use of project management techniques and were not benefiting from project management in terms of increased new product success. Despite this result it was observed that by improving project planning, establishing clear priorities and setting clear objectives, small electronics firms could improve new product development performance by reducing project delivery times.

High-technology firms are predominantly founded by technical entrepreneurs who form a business based on the discovery and belief in a new product (Oakey and Mukhtar, 1999). High-technology SMEs are characterised by long lead times from basic research to industrial application and short lead times in commercialisation. They suffer accelerated obsolescence under global competitive pressures from new product and process innovations (Litvak, 1992). High-technology SMEs tend to have entrepreneurial management styles with organic structures and their success is often based upon sound knowledge of the business, highly skilled employees and the ability to spot a gap in the marketplace (Warren and Hutchinson, 2000).

Projects

The Project Management Institute (2000), define a project as a temporary, definitive beginning and definitive end, endeavour undertaken to create a unique product or service. Projects can be considered as the achievement of a specific objective and involve the utilisation of resources on a series of activities or tasks. Munns and Bjeirmi (1996), in their study on project success, differentiate between project success and project management success. Their definition of a project suggests an orientation towards longer-term goals such as return on investment, profitability and competition, while project management focuses on short-term goals and a more specific context for success. The following distinction between project success and project management success (Cooke-Davies, 2002):

- Project success is measured against the overall objectives of the project.
- Project management success is measured against the widespread and traditional measures of time, cost and quality.

Munns and Bjeirmi (1996) conclude that despite the differences between project success and project management success they complement each other. A project can succeed despite the failure of project management but successful project management implementation can increase the potential for success on an overall project scale.

Project management

Project management has existed, in theory, for centuries with its informal application by the Chinese and Egyptians in such feats as the Great Wall of China and the Pyramids. However, modern project management is a recent phenomenon gaining initial acceptance in the rapid development of the information technology industry (Fox, 2004).

The Project Management Institute (2000) provides a simplified definition of project management as "the application of knowledge, skills, tools, and techniques to project requirements".

The emergence of modern project management owes to three core stimuli (Baccarini, 1999):

(1) Complexity – Growing complexity of tasks and a need for a greater degree of specialisation.

(2) Change – Increasingly dynamic environments with constant pressure within organisations to implement change due to global competition.

(3) Time – Demand for tasks to be completed as quickly as possible.

Over time modern project management has emerged as a discipline that has constantly remoulded itself to allow for expansion in its practice. Crawford *et al.* (2005) suggest that as a discipline, project management is "dynamic facing new challenges, as tools, methods and approaches to management that comprise the discipline are applied to different areas, for different ends, and in different cultures".

Success criteria and success factors

When studying projects and their management a clear distinction should be made between critical success criteria and critical success factors, for example:

Success criteria are the measures by which success or failure of a project will be judged.

Success factors are the inputs to the management system that lead directly or indirectly to the success of the project (Cooke-Davies, 2002).

This distinction is supported by Belassi and Tukel (1996) who recommend that sound research on critical success factors has to:

- Distinguish between success factors and success criteria.
- Distinguish success factors within the control of the project manager and factors outside his/her control.

Determination of a project's success criteria has recently become more complex (Belassi and Tukel, 1996) with the traditional criteria of time, cost and performance no longer sufficient. On any project, there can be numerous parties each with their own perception of success. Pinto and Slevin (1989) recognised this ambiguity in determining project success by concluding that it is still not clear how to measure success because the parties who are involved in projects perceive project success or failure differently. For the purpose of this study, senior management's perception of success was considered based on their overwhelming influence in SME procedures.

Research has contributed to a significant quantity of factors that could be described as critical to a project's outcome. But projects are individual and unique and each project can have a different set of success factors. Belassi and Tukel (1996) stated that a combination of many factors, at different stages of the project life cycle, result in project success or failure. Table I outlines the key success criteria and success factors seen to be most significant from previous empirical studies.

The three basic criteria of time, cost, and quality appear regularly in Table I. Additionally, client satisfaction is seen as a significant factor in achieving overall project success. Westerveld (2003) also considered the appreciation of the various parties involved both directly and indirectly in the project.

The success factors listed in Table I include many items that could be implemented within SMEs. But in considering the application of different success factors in SMEs it is important to remember that SMEs are generally characterised as having basic organisational structures with simple planning and control systems. This would suggest that SMEs should adopt a simplified approach to managing projects. Having reviewed the success factors in Table I, six were considered to have the greatest potential benefit to SMEs:

(1) Clear goals/objectives

(2) Senior management support

(3) Resource allocation

Author	Success criteria	Success factors
Fortune and White (2006)	Not addressed	Top management support Clear and realistic objectives Efficient plan Performance monitoring Communications Resources
Crawford *et al.* (2005)	Not addressed	Relationship management Resource management Time management Cost management Risk management
Westerveld (2003)	Budget, schedule, quality appreciation by; client, project personnel, users, contracting partners and stakeholders	Leadership and team Policy and strategy Resources Stakeholder management Schedule Risks
White and Fortune (2002)	Complete within schedule Complete within budget Meet Client requirements	Clear goals/objectives Realistic schedule Top management support Adequate resources Effective risk management Clear communication channels
Cooke-Davies (2002)	Not addressed	Risk management Responsibilities plan Scope change control process Line of sight feedback Learning from experience
Belassi and Tukel (1996)	Cost Time Quality Client satisfaction	Clear goals/objectives Top management support Scheduling Sufficient resources Planning and control Monitoring and feedback Client consultaation

Table I.
Literature review of success criteria and success factors

(4) Planning, monitoring and control

(5) Client consultation

(6) Risk management.

These six factors are investigated through a survey that measures the opinions of SME owner/managers about the use project management within their organisations.

Methodology

A questionnaire was developed and distributed via e-mail to the owner-managers of over 200 firms operating across many sectors that included medical devices, telecommunications, electronics, and general engineering. A commercial business

directory, Kompass, provides general information on organisations across Ireland and was used as the source for the collection of organisations for the distribution list. Selection of SMEs from the database was dependent on two factors; number of employees and industry sector. In line with the SME definition provided earlier, employment levels had to be less than 250 people. The study concentrated on high-technology SMEs because of their importance to the Irish economy in terms of employment and wealth creation. Additionally, Oakey and Mukhtar (1999) highlight that poor business skills among technical entrepreneurs often cause their firms to be badly managed, both during formation and through expansion.

The questionnaire was piloted in three SMEs, with two academic personnel working in related disciplines, and two project management professionals with extensive SME experience. These pilot studies led to the addition and removal of questions and general improvements in wording. The questionnaire was designed using the Survey Monkey survey tool and data were analysed using SPSS.

The main objectives in developing the questionnaire were to explore the following:

(1) The basic characteristics of projects and perceived success of projects to date.

(2) The level of recognition of project management as a process within SMEs.

(3) Success criteria and success factors for projects.

(4) Project management tools and/or techniques in use and their contribution to project success.

Forty responses, yielding a response rate of 20 per cent were returned. The data collected is presented and analysed below.

Results and discussion

Descriptive analysis

Responses to the questionnaire came from the following sectors: Medical devices (25 per cent), electronics (22.5 per cent), manufacturing (32.5 per cent), telecommunications (5 per cent), Engineering and Construction (15 per cent).

On average the firms employed 65 staff, the largest firm employing 210 and the smallest having 22 employees. Questions were asked about current organisational structures and general project characteristics. Table II reports the percentage responses from these questions. Most firms described themselves as having either a traditional functional structure or a matrix structure (i.e. a mix of functional and pure project structures). Only two firms were described as being organised around projects. Most of the projects undertaken by SMEs who responded to this survey were small; 63 per cent of the firms reported that project expenditure was between 0-20 per cent of turnover, and 85 per cent had only 1-10 staff working on projects. Project durations varied considerably from under 3 months to over 12 months. However, there was agreement that projects undertaken were complex in nature.

Over half the respondents, 60 per cent, reported that project management was an identifiable process within their firms with 88 per cent of them (or 53 per cent of the complete sample) employing full-time project managers. The remaining sixteen firms (40 per cent) were not using project management.

Respondents were asked to rate success criteria and success factors on a scale of 1 to 5 in terms of their importance to the firm (where 1 = not important and 5 = very important). Table III shows the average values reported for each success criteria and success factor.

Characteristic	% of sample ($n = 40$)	Characteristic	% of sample ($n = 40$)
Organisational structure		*Project duration*	
Projectized	5	Under 3 months	25
Project-matrix	2	3-6 months	33
Matrix	38	6-12 months	27
Matrix-functional	22	Over 12 months	15
Functional	33	*Project staffing*	
Project expenditure (% turnover)		1-10 people	85
0-20	63	10-30 people	13
20-40	20	>30 people	2
40-60	10	*Firm size*	
60-80	2	1-50	50
80-100	5	51-100	25
		101-250	25

Table II. Organisational and project characteristics

Quality is rated as the most important success criterion; the literature would suggest that this is not the case in larger firms with more mature quality management systems in place. The results also suggest that project success is based more on internal than external factors. This result is supported by the level of agreement with the statement "Success of projects within my organisation is mainly determined by internal factors" in Table III. "Clear goals/objectives" and "Senior management support" were both considered the most important success factors, this supports existing literature. "Resource allocation" was also identified as an important success factor. This is not surprising as resources are frequently an issue for SMEs.

Respondents were also asked to identify the most influential decision makers within projects in their firms, average results are shown in Table IV. Not surprisingly, owner-managers were found to have the most influence in decisions relating to projects, followed by project and functional managers. This supports the belief that owner-managers are closely involved in all aspects of operations with few layers of management in most SMEs (Ghobadian and Gallear, 1997).

Most important success criteria	
Meets required quality standard	4.80
Meets specification	4.70
Appreciation by users	4.30
Completed within budget	4.30
Completed within schedule	4.20
Appreciation by stakeholders	3.78
Appreciation by project personnel	3.44
Most important success factors	
Clear goals/objectives	4.56
Senior management support	4.56
Resource allocation	4.22
Planning, monitoring and control	4.00
Client consultation	3.63
Risk management	3.22

Table III. Success criteria and success factors (mean scores)

Respondents indicated their support for a range of statements, presented in Table V. These results suggest that SME owner-managers understand the importance of a well-defined project management process and also feel that there is a difference between how large and small firms approach projects. This supports the findings of Ghobadian and Gallear (1997) who found that in managing projects large organisations possess greater capital and resources and a greater degree of specialisation than their small counterparts. The firms surveyed also appear to work closely with customers and suppliers.

Respondents were asked how they could improve project performance; some of their comments are listed below:

> Prioritisation of project tasks over other work
>
> Reviewing EVMS (Earned Value Management System) methods and honing CPI (Cost Performance Index) and SPI (Schedule Performance Index) introduction of a strong matrix management structure

Most influential decision-makers	
Owner/managing director	4.67
Project manager	4.03
Functional managers	3.92
Project steering group	3.63
Board of directors	3.00

Table IV.
Influential decision makers (mean scores)

Statements	Mean score
Previous experience is a key factor to implementing an effective system of project management	4.18
A well defined project management process is a necessity for successful implementation of projects	4.06
Organisational structure affects the management of projects	4.06
Large organisations approach projects in a different manner to SMEs	4.00
Projects undertaken by my organisation involve close collaboration with the suppliers	3.82
Success of projects within my organisation is mainly determined by internal factors (e.g. project management, proficiency)	3.79
Projects undertaken by my organisation involve close collaboration with client organisations	3.67
Project management can be applied in similar fashion in SMEs as in large organisations	3.52
Success criteria measures used by my organisation are sufficient to determine project success	3.48
Sufficient research and analysis is carried out before undertaking a new project within my organisation	3.39
Projects undertaken by my organisation are generally complex in nature	3.30
Large organisations possess advantages over SMEs in project implementation	3.23
A change of organisational structure would have a positive impact on project execution in my organisation	3.22
Adequate research and facilities on best practice in the field of project management are available to SMEs	2.90
Success of projects within my organisation is mainly dependant on external factors (e.g. market demand, government regulations)	2.61
A project can be successful despite the failure of project management	2.52

Table V.
Levels of agreement to statements (five-point Likert scales, mean scores)

By people being trained to understand the principles and benefits of same

Training of Project Managers. Clearer Goals being set and communicated to all staff involved. Better client or fact finding on site at conception stage

More control of project team

When asked if they thought that project management was too complex a process to implement in SMEs the responses were as follows:

No, it can actually be easier to implement in a smaller organisation.

No. I have worked in industries of various sizes – the approach is different but the tools are the same

You would want to be clearly identifying the benefits of it and then it may not be that complex to achieving the implementation of same

No, I do not agree, it is as easy to implement. It is just that in SMEs it is very difficult to afford the time and the resources . . . it is a growing issue for a company and a mindset

No, if adequate time and resources are given then there should not be any problems

Finally, the level of usage of a variety of project management tools and techniques was measured. These results are shown in Figure 1. They show that while many of the firms use project teams and actually plan projects few SMEs are using the more complex project management tools such as Earned Value or Critical Path Method. The data also raises a question about how SMEs use Microsoft project if they are not using it to implement the various project management techniques listed in Figure 1.

Statistical analysis

Statistical analyses in the form of independent sample *t*-tests and Pearson correlations were performed to further explore the responses and the potential relationships between them. One of the aims of the survey was to try to understand how

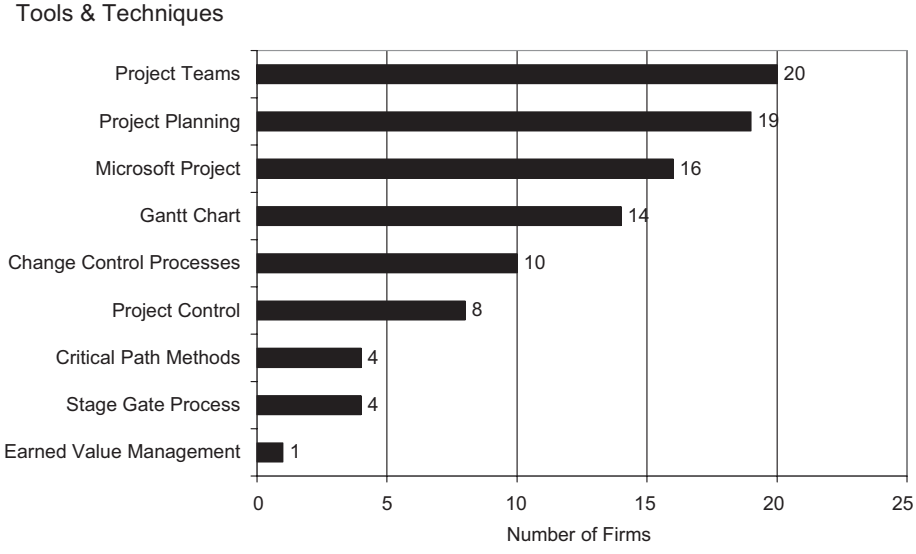

Figure 1.
Project management tools and techniques in use

high-technology SMEs manage projects and to identify management practices that may be linked with success.

In order to determine if there was a relationship between a firm's organisational structure, size and project expenditure, and the decision to employ a full-time project manager a series of *t*-tests was performed, see Table VI. The results show that there is a relationship between the organisational structure in place and the existence of a project manager. Firms that employ a project manager were more likely to have a matrix-like structure. Firms without a project manager were more likely to have a more functional structure. The results also show that there is no relationship between the number of employees and the employment of a project manager. In other words the very small firms in the sample are as likely to have full-time project managers as the larger firms surveyed. However, it was found that the firms with a project manager employed were more likely to spend a greater percentage of turnover on projects.

Table VII examines the relationships between the existence of an identifiable project management process and the same factors examined in Table VI above. Again a relationship between organisation structure and the presence of an identifiable project management process was identified. This suggests that firms who employ full-time project managers or have project management as an identifiable process are more likely to be organised as "project organisations" where the work undertaken by the organisation is in the form of projects.

For the purpose of this research three components of project success were measured:

(1) Budget – completion within the proposed or allocated budget.

(2) Schedule – completion within the estimated duration.

(3) Performance – completion to specification and meeting client's requirements.

Table VI.
Impact of full-time identifiable project manager

Factor	Firms with full-time identifiable project manager	Firms without full-time identifiable project manager	Comparison of means, sig (2-tailed)
Organisation structure	3.42	4.36	0.009*
Number of employees	1.88	1.64	0.516
% turnover spent on projects	2.00	1.14	0.020**

Note: *t*-test significance: *$p < 0.01$; **$p < 0.05$

Table VII.
Impact of identifiable project management process

Factor	Firms with identifiable project management process	Firms without identifiable project management process	Comparison of means, sig (2-tailed)
Organisation structure	3.42	4.25	0.017*
Number of employees	1.77	1.80	0.910
% turnover spent on projects	1.95	1.31	0.080

Note: *t*-test significance: *$p < 0.05$

Overall project success was calculated as the average of these three components. The data were tested for any significant relationships between key project management variables and project success; results are presented in Table VIII. Success was considered both in terms of the three components described above, budget, schedule and performance, and in terms of overall success. One of the most interesting findings from the analysis was that there was a significant positive relationship between the employment of a project manager and overall and performance success. While neither the application of project management nor the use of Microsoft project were found to significantly enhance project success organisations that use project planning techniques were more likely to achieve success in project budget and schedule. This result is supported by the level of agreement to the statement – "A well defined project management process is a necessity for successful implementation of projects" as was seen in Table V.

The data were analysed to identify any relationships between the rating by firms of difference success criteria and project success, see Table IX. The only success criterion that was linked with overall project success was "completion within schedule". In other words, firms who consider completing a project within schedule as an important success criterion are more likely to achieve project success. This result is interesting in the light of the results reported in Table III where "completion within schedule" was not reported as one of the most significant success criteria. However, previous research (White and Fortune, 2002) has identified "completion within schedule" as an important success criterion. It is also worth noting that the relationship between two success

Question	Overall	Budget	Schedule	Performance
Does your organisation have one or more full-time identifiable "project managers"?	0.018*	0.077	0.216	0.002**
Is project management an identifiable process in your organisation?	0.500	0.673	0.869	0.117
Does your organisation apply Microsoft Project as a tool?	0.663	0.831	0.845	0.232
Does your organisation apply project planning techniques?	0.016*	0.017*	0.037*	0.114

Notes: Responses to the questions above were based on a bi-polar scale. *t*-test significance (2-tailed): $*p < 0.05$; $**p < 0.01$

Table VIII.
Project management and project success

Success criteria	Pearson correlation	Sig. (2-tailed)
Completed within budget	0.253	0.136
Completed within schedule	0.448	0.006*
Meets required quality standard	0.072	0.675
Meets specification	0.064	0.712
Appreciation by user	−0.257	0.131
Appreciation by stakeholder	0.072	0.675
Appreciation by project personnel	−0.139	0.419

Note: *Correlation is significant at the 0.01 level

Table IX.
Relationship between success criteria and overall project success

criteria, "appreciation by user", and "appreciation by project personnel", and project success is negative. This implies that firms who are concerned about the extent to which users and project personnel approve of (or appreciate) a project's progress are less likely to achieve project success.

Finally, the data were tested to identify any significant relationships between the success factors that firms considered important and project success, no significant relationships were identified.

Conclusion

The findings presented in this paper are an attempt to understand the current project management practices in high-technology SMEs. The paper also reviews the major contributors to project success in SMEs. Results suggest that a majority of SMEs have identifiable project management processes and also full-time project managers, but that owner/managers are still the most influential when it comes to making decisions about projects. Also, these SMEs are more likely to be organised along projects rather than functional lines.

Meeting quality standards and specification are considered to be the most important success criteria by the SMEs surveyed while clear goals/objectives and senior management support were judged to be the most important success factors. Additionally, the results show that having a full-time project manager and applying project planning techniques are most likely to increase the chances of success. Despite the presence of a project management process being considered by the respondents as a necessity to success it is not found to contribute to project success. Finally, SMEs that consider meeting completion schedules to be a success criterion are more likely to have successful projects than those who do not.

These findings can be summarised in terms of implications for projects management within SMEs as follows:

- Project success is more likely in firms that have full-time identifiable project managers and that apply project planning techniques.
- Project success is more likely in firms that consider completion schedules to be important.

This study begins to identify the manner in which SMEs manage projects and also some project management practices that are linked with success. However it also raises several questions about the use of project management tools and techniques within SMEs and how these tools and techniques can be used to increase project success.

Further investigation is required to answer these questions, to deepen the understanding of project management in SMEs and to develop an approach to project management that can increase the likelihood of project success within SMEs.

References

Audretsch, D.B., Prince, Y.M. *et al.* (1998), "Do small firms compete with large firms?", Tinbergen Institute of Rotterdam, Centre for Economic Policy Research (CEPR) and Georgia State University.

Baccarini, D. (1999), "History of project management", School of Architecture Construction and Planning, Curtin University of Technology.

Belassi, W. and Tukel, O.I. (1996), "A new framework for determining critical success/failure factors in projects", *International Journal of Project Management*, Vol. 14, pp. 141-51.

Bryde, J.D. (2003), "Project management concepts, methods and application", *International Journal of Operations & Production Management*, Vol. 23 No. 7, pp. 775-93.

Cooke-Davies, T. (2002). "The 'real' success factors on projects", *International Journal of Project Management*, Vol. 20, pp. 185-90.

Crawford, L., Pollack, J. *et al.* (2005), "Uncovering the trends in project management: journal emphases over the last 10 years", *International Journal of Project Management*, Vol. 24 No. 2, pp. 175-84.

Edwards, T., Delbridge, R. *et al.* (2001), "Linking innovative potential to SME performance: an assessment of enterprises in industrial South Wales", *41st European Regional Science Association Meeting,* Zagreb, Croatia.

Floyd, D. and McManus, J. (2005), "The role of SMEs in improving the competitive position of the European Union", *European Business Review*, Vol. 17 No. 2, pp. 144-50.

Fortune, J. and White, D. (2006), "Framing of project critical success factors by a systems model", *International Journal of Project Management*, Vol. 24, pp. 53-65.

Fox, G.M. (2004), "Is there a role for project management in achieving improved success rates for start-up business?", University of Limerick, Limerick.

Ghobadian, A. and Gallear, D. (1997), "TQM and organisation size", *International Journal of Operations & Production Management*, Vol. 17 No. 2, pp. 121-63.

Gray, C. and Mabey, C. (2005), "Management development: key differences between small and large businesses in Europe", *International Small Business Journal*, Vol. 23 No. 5, pp. 467-85.

Hallberg, K. (1999), "Small and medium scale enterprises: a framework for intervention, small enterprise unit", Private Sector Development Department, The World Bank.

Hudson, M., Smart, A. *et al.* (2001), "Theory and practice in SME performance measurement systems", *International Journal of Operations & Production Management*, Vol. 21 No. 8, pp. 1096-115.

Johnson, D. and Turner, C. (2000), *European Business: Policy Challenges for the New Commercial Environment*, Routledge, London.

Ledwith, A. (2004), "Management of new product development in small Irish electronics firms", University of Brighton.

Litvak, I.A. (1992), "Winning strategies for small technology-based companies", *Business Quarterly*, Vol. 57 No. 3, pp. 47-51.

McAdam, R., Reid, R.S. *et al.* (2005), Innovation and organisational size in Irish SMEs: an empirical study", Department of Economics and Enterprise, Glasgow Caledonian University.

Munns, A.K. and Bjeirmi, B.F. (1996), "The role of project management in achieving project success", *International Journal of Project Management*, Vol. 14 No. 2, pp. 81-7.

Oakey, R.P. and Mukhtar, S.M. (1999), "United Kingdom high-technology small firms in theory and practice: a review of recent trends", *International Small Business Journal*, Vol. 17 No. 2, pp. 48-64.

Pinto, J.K. and Slevin, D.P. (1989), "Critical success factors in R&D projects", *Research Technology Management*, Vol. 32 No. 1, pp. 31-5.

Project Management Institute. (2000), *A Guide to the Project Management Body of Knowledge*, PMBOK Guide 2000 edition, Project Management Institute, Pennsylvania.

Rothwell, R. (1992), "Successful innovation: critical factors for the 1990s", *R&D Management*, Vol. 22 No. 3, pp. 221-40.

Warren, L. and Hutchinson, W.E. (2000), "Success factors for high-technology SMEs: a case study from Australia", *Journal of Small Business Management*, Vol. 38 No. 3, pp. 88-91.

Westerveld, E. (2003), "The project excellence model: linking success criteria and critical success factors", *International Journal of Project Management*, Vol. 21, pp. 411-8.

White, D. and Fortune, J. (2002), "Current practice in project management – an empirical study", *International Journal of Project Management*, Vol. 20, pp. 1-11.

About the authors

Alan Murphy is a research student with the Enterprise Research Centre at the University of Limerick. He is investigating the use of project management tools and techniques in small high-technology firms. E-mail: alan.murphy@ul.ie

Ann Ledwith is a lecturer in the Department of Manufacturing and Operations Engineering and a member of the Enterprise Research Centre at the University of Limerick. Her research interests include project management, the management of innovation and new product development in small firms. She is a member of the PDMA UK & Ireland Steering Group. Ann Ledwith is the corresponding author and can be contacted at: ann.ledwith@ul.ie

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2. Maricela I. Montes-Guerra, Aida R. De-Miguel, M. Amaya Pérez-Ezcurdia, Faustino N. Gimena, H. Mauricio Díez-Silva. 2015. Project Management in Development Cooperation. Non-Governmental Organizations. *Innovar* **25**, 53. [CrossRef]
3. Amin Akhavan Tabassi, Mahyuddin Ramli, Abu Hassan Abu Bakar, Abd. Hamid Kadir Pakir. 2014. Transformational leadership and teamwork improvement: the case of construction firms. *Journal of Management Development* **33**:10, 1019-1034. [Abstract] [Full Text] [PDF]
4. Sandra Miranda Neves, Carlos Eduardo Sanches da Silva, Valério Antonio Pamplona Salomon, Aneirson Francisco da Silva, Bárbara Elizabeth Pereira Sotomonte. 2014. Risk management in software projects through Knowledge Management techniques: Cases in Brazilian Incubated Technology-Based Firms. *International Journal of Project Management* **32**, 125-138. [CrossRef]
5. I E Tsolas. 2013. Construction project monitoring by means of RAM-based composite indicators. *Journal of the Operational Research Society* **64**, 1291-1297. [CrossRef]
6. Rodney Turner, Ann Ledwith, John Kelly. 2012. Project management in small to medium-sized enterprises. *Management Decision* **50**:5, 942-957. [Abstract] [Full Text] [PDF]
7. David Pollard, Iveta ŠimberováMarketing in High-Technology Firms 465-471. [CrossRef]
8. Sara Parry, Beata Kupiec-Teahan, Jennifer Rowley. 2011. Exploring marketing and relationships in software SMEs. *Management Research Review* **35**:1, 52-68. [Abstract] [Full Text] [PDF]
9. Joyce Fortune, Diana White, Kam Jugdev, Derek Walker. 2011. Looking again at current practice in project management. *International Journal of Managing Projects in Business* **4**:4, 553-572. [Abstract] [Full Text] [PDF]
10. Julie Bérubé, Martin X. Noël. 2011. Petites entreprises de services et gestion de projet : à quoitient le succès?. *Journal of Small Business & Entrepreneurship* **24**, 531-549. [CrossRef]
11. Rodney Turner, Ann Ledwith, John Kelly. 2010. Project management in small to medium-sized enterprises: Matching processes to the nature of the firm. *International Journal of Project Management* **28**, 744-755. [CrossRef]
12. Lornel Rivas, Maria Perez, Luis E. Mendoza, Anna GrimanSelection model for Software Project Management tools in SMEs . [CrossRef]
13. Amin Akhavan Tabassi, Abu Hassan Abu Bakar. 2010. Towards assessing the leadership style and quality of transformational leadership. *Journal of Technology Management in China* **5**:3, 245-258. [Abstract] [Full Text] [PDF]
14. J. Rodney Turner, Ann Ledwith, John Kelly. 2009. Project management in small to medium-sized enterprises. *International Journal of Managing Projects in Business* **2**:2, 282-296. [Abstract] [Full Text] [PDF]
15. Kolsoom Abbasi Shahkooh, Mehdi Fasanghari, Ali SharifiPrioritization of SMEs Strategies in IT Fields of Developing Countries Using Entropy Shannon 261-266. [CrossRef]
16. Lornel Rivas, María Pérez, Luis E. Mendoza, Anna GrimánTowards a Selection Model for Software Engineering Tools in Small and Medium Enterprises (SMEs) 264-269. [CrossRef]

17. S. Vinodh, G. Sundararaj, S.R. Devadasan, S. Rajanayagam, Immanuel Edinbarough. 2008. Agile ITQFD and its financial viability: a pilot project approach. *The TQM Journal* **20**:5, 520-534. [Abstract] [Full Text] [PDF]
18. Paul Lewis Reynolds, Geoff Lancaster. 2007. Predictive strategic marketing management decisions in small firms. *Management Decision* **45**:6, 1038-1057. [Abstract] [Full Text] [PDF]