**INVESTIGATING THE APPLICATION OF PROJECT MANAGEMENT PRINCIPLES TO RESEARCH PROJECTS – AN EXPLORATORY STUDY**

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**Abstract**

The management of research projects can be subject to significant uncertainty due to the knowledge creation process that is undertaken. The systematic investigation of a research area requires adoption of a scientific approach along with an appropriate level of creativity and this can present certain challenges in regard to managing research projects. Project management has developed to support industrial projects in areas such as construction, manufacturing and information technology. Therefore, the question arises: Are the standardized techniques of project management adequate to support effective delivery of research projects that involve a high level of knowledge based activities? This paper will report on the results of an exploratory study based on a systematic literature review, which has been carried out in order to improve our understanding of the key features and issues arising from the application of project management principles to research projects. The literature has been considered in regard to the process, structure, people and technology dimensions. The paper includes synthesis of a proposed research agenda in order to advance the knowledge base on the management of research projects.

**Keywords**

Research projects, project management, systematic literature review.

# Introduction

Research projects are an essential part of knowledge production in contemporary society and this extends to the social sciences as well as science and technology applications (Gibbons et al., 1994). Indeed research projects are undertaken by different types of organizations, including industrial companies, governmental agencies, independent research institutes and academic institutions. Although there is much literature on the subject of conducting scientific research, for example, on the need to ensure adequate design principles (Bordens and Abbott, 2002) and robust research methodologies are employed (Teddlie and Tashakkori, 2009), there is much less material on the actual management of research projects. The importance of conducting the scientific research itself should of course not be underestimated (Bush, 1945); the specific approaches and features of the research will be associated with the knowledge base of the corresponding subject area, e.g. physics, biology, or chemical engineering. But in order to conduct scientific research there is a need to have the necessary resources (such as the researchers or graduate students) and associated funding as well as the required equipment, supporting infrastructure and any consumables and other materials. There is also a need for a research plan that describes how the research work will be undertaken and specifies the goals and objectives of the project; such a plan will likely articulate the deliverables that are to be produced as well as important milestones for the project. Research is therefore implicitly delivered through projects that have a schedule and a budget as well as a research specification that needs to be achieved according to a pre-defined set of quality criteria. Indeed the selection and prioritization of research projects can be an important consideration for technology-driven industrial companies (Mottley and Newton, 1959), which need to ensure that the project outputs contribute to the company’s competitive advantage.

Although research projects have structural, process and people dimensions just like other projects, there is additionally the need for creativity in regard to the knowledge discovery process (Bush and Hattery, 1956). Adoption of management systems for research projects should support such creativity and knowledge-based activities, and consequently a fine balance is needed between implementing management approaches to support the efficient and effective delivery of projects while not stifling creative activities and innovation. If we consider the case of higher education institutions, there are academic freedoms in regard to research directions along with a culture of not implementing overly commercial or rigid management approaches while still ensuring that the strategic plans of the university are delivered (Nickson, 2014). Universities are also increasingly engaged in research and technical work that results in knowledge exchange with third-parties, such as through technology transfer involving the commercialization of intellectual property (Matkin, 1990) and university-industry research collaboration (Philbin, 2008). In the latter case, these collaborations are delivered through research projects, where again there is a need to deliver the projects – on schedule, within budget and according to the research objectives or project specification. Consequently, there would appear to be much scope for the adoption of project management techniques at higher education institutions (Austin, 2013), for instance to support both the development and delivery of research projects. However, in regard to the project management profession (Kerzner, 2013), the discipline has developed to serve industries such as construction, manufacturing and IS/IT (information systems/information technology). These applications do not necessarily have the same degree of need for knowledge generation and creativity when compared to research projects.

Project management as discipline is a structured approach that is process driven. Although more recently there has been the increasing prevalence of agile project management techniques (Highsmith, 2009) and also a recognition that a ‘one size fits all’ approach to managing projects is not universally successful (Shenhar and Dvir, 2007). Consequently, it is useful to investigate whether the standardized approaches of project management can support the effective delivery of research projects, which are subject to uncertainty and exhibit signs of complexity. In order to achieve this goal, this paper includes details of a preliminary investigation based on a systematic literature review of the project management of research projects. A systematic literature review approach was chosen as the mode of enquiry since it allows all the current issues and features associated with managing research projects to be identified and recorded. For further background on this research approach, see for example the work of Brereton et al. (2007) for a detailed description of the systematic literature review process. This method also serves as the basis to frame the research agenda for the management of research projects and inform future studies in the area.

**Literature Review**

The section on the systematic literature review includes a description of the methodology that was implemented as well as the results and initial data analysis.

**Methodology**

Exhibit 1 provides an overview of the methodology that was pursued in this research study. The methodology is composed of eight stages. Stages 1 and 2 of the process involved definition of the objectives of the research as well as development of the research protocol. This was followed by stages 3, 4 and 5, which involved the database search, application of the exclusion criteria to the search results followed by the data analysis of the publications. Stages 6, 7 and 8 of the process involved identification of the systematic literature review findings, synthesis of the research agenda and finally the conclusions of the research study.

**Exhibit 1.** Main stages of the research methodology.



**Results**

The systematic literature review was undertaken using the Google Scholar academic search engine. This database was selected because it contains a broad range of literature sources that span management, technology, engineering and other related academic areas. The search was carried out on the 18th January 2017. The search was for publications that contained the following terms “Research Projects” AND “Project Management”, and resulted in 36 publications. The following exclusion criteria were applied:

* Working papers (non-published) were excluded as the level of peer review employed could not be confirmed.
* Publications that did not employ any form of recognized research methodology were excluded.
* Publications that did not include sufficient coverage of research projects were excluded.
* Any repeated publication items were excluded.

Once the criteria had been applied, this reduced the number of publications to 21. These publications all covered in an appropriate level of detail the project management aspects associated with research projects.

**Analysis**

Exhibit 2 provides a graphical view of the publications per year. Apart from the single publication in 1986, all the others are from 2005 onwards. It can be seen that the number of publications has been steadily increasing from 2005 to 2016. The peak number of publications of 4 occurred in the year 2016 (i.e. the most recent full year), with 3 publications in each of 2013 and 2015. This analysis highlights that there appears to be a trend of an increasing number of publications in the area of project management and research projects, although this finding is tentative due to the limited sample size. Nevertheless we can view the subject area as an emerging field of investigation within the research community.

**Exhibit 2.** Publications from the systematic literature review per year.



In regard to the type of publications, the set includes journal articles, conference proceeding papers and a book chapter as highlighted in Exhibit 3. This shows that apart from the single book chapter, the remaining publications are journal articles and conference papers, which represent roughly half of the publication set each. The publication sources include a diverse set of titles, ranging from publications in project management, technology and innovation management through to healthcare management and information systems related journals and conferences. This indicates that the subject matter is being approached from different perspectives and is therefore inherently multidisciplinary.

Exhibit 4 provides details of the research methodologies employed in the publications. There appear to be a particularly broad range of methodologies used. This includes conceptual studies, systematic literature reviews, quantitative surveys and interviews, mixed methods, case studies as well as various qualitative techniques that were employed. This analysis indicates that the literature does not favor a particular methodology when researchers are investigating the project management aspects of research projects.

**Exhibit 3.** Breakdown of publication type.



**Exhibit 4.** Research methodology of the publications.

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| **Research methodology** | **Publication references** | **No.** |
| Conceptual studies involving example applications | Mustaro and Rossi, 2013; Huljenić et al., 2005; Aghayan et al., 2014 | 3 |
| Systematic literature review | vom Brocke and Lippe, 2015; Visser et al., 2016 | 2 |
| Case study investigation involving document analysis and semi-structured interviews | vom Brocke and Lippe, 2010a; Hald et al., 2012 | 2 |
| Hypothesis and semi-structured interviews | Beukers, 2011 | 1 |
| Mixed method (surveys and structured interviews) | Chin and Spowage, 2008 | 1 |
| Development of guidelines based on literature and practical experience | vom Brocke and Lippe, 2010b | 1 |
| Stakeholder engagement and multi-organizational pilot study | Peykari et al., 2013 | 1 |
| Multi-organizational research study | Balaguru and Rajagopalan, 1986 | 1 |
| Interviews (unstructured and semi-structured) and qualitative content analysis | Riol and Thuillier, 2015 | 1 |
| Investigation of a collaborative development project with feedback and lessons learnt | Van der Merwe et al., 2015 | 1 |
| Large-scale qualitative study, including interviewer-administered surveys and semi-structured, ethnographic-style interviews | Sha and Childs, 2014 | 1 |
| Interviews with project participants | Ibrahim et al., 2013 | 1 |
| Application of project management principles to a research project | Vachan, 2012 | 1 |
| Thematic analysis, including open-ended interviews and structured interviews | Lippe and vom Brocke, 2016 | 1 |
| Case study involving reflective observation | Sargent et al., 2007 | 1 |
| Case study with qualitative research methods applied | Löhr et al., 2016 | 1 |
| Project description and discussion of proposed future work | Rauser and Vamborg, 2016 | 1 |

**Findings from the Systematic Literature Review**

In order to structure the findings from the systematic literature review, it is useful to consider the key organizational attributes associated with managing research projects and a useful framework to apply is the organizational design paradigm (see for instance the work of Miles et al., 1978). Consequently, we can consider the systematic literature review findings according to four main groups of features, which are as follows:

* *Process*: This relates to the systematic series of actions that are carried out during research projects and includes project management processes.
* *Structure*: This relates to the underlying characteristics or components of research projects and includes project management related structures.
* *People*: This relates to the human and social dimensions of research projects and includes project management resources.
* *Technology*: This relates to the IS/IT (information systems/information technology) dimensions of research projects and includes project management technology infrastructure.

Exhibit 5 provides a summary of the systematic literature review findings in terms of the research areas addressed and main insights, which are categorized according to these four groups of features.

**Exhibit 5.** Systematic literature review findings.

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| **Feature** | **Research areas addressed and main insights** |
| Process | * Collaborative research projects involving the work of consortium partners are distinct from other types of projects and the development of supporting guidelines has been undertaken (vom Brocke and Lippe, 2010b).
* The importance of project management processes, such as needs assessment for health research project, evidence based resource allocation and structured engagement of project stakeholders (Peykari et al., 2013).
* Application of project management principles and processes to academic research projects (Mustaro and Rossi, 2013).
* Although the processes and principles for system development projects and research projects compare well, these two different types of projects have been found to have significantly different success factors (Visser et al., 2016).
* Large-scale qualitative research projects have been found to benefit from adoption of project management approaches to help ensure corrective and preventive actions are implemented in a timely and systematic fashion, thereby minimizing risks and ensuring quality standards are achieved (Sha and Childs, 2014).
* Investigation of project management methodology requirements to support the management of undergraduate engineering research projects (Chin and Spowage, 2008).
* The importance of effective risk management in parallel with the project operation environment and the implications for research projects (Ibrahim et al., 2013).
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| Structure | * Collaborative research projects can be subject to much uncertainty, where freedom and flexibility is needed to generate innovative outputs. But in order to mitigate such uncertainty, there is a requirement for tight management. Therefore, there is a need to balance management control with flexibility to ensure creative research approaches may flourish in projects (vom Brocke and Lippe, 2015).
* Creativity is important in project management. Additionally, project management includes administrative project management and technical project management, which involves managing the technical scope, creative thinking and sense-making (vom Brocke and Lippe, 2010a).
* Research projects have certain “particularities”, e.g. proving that something cannot be done may still represent a positive outcome for a research project and hence research project management practices need to be adjusted accordingly (Huljenić et al., 2005).
* Research projects include formal and informal activities and processes. Additionally there are the internal and external dimensions that need to be managed carefully (Hald et al., 2012).
* Implementing a project management office (PMO) structure for medical and health research systems can support both researchers and research managers to improve the efficiency of clinical studies (Aghayan et al., 2014).
* The management of research projects can be compatible with classical project management where there is an organizational acceptance and supporting culture for the adoption of management approaches. Although, classical project management may not fully support human factors and the uncertainties present in research projects and so a contingent project management approach is proposed (Riol and Thuillier, 2015).
* Demonstration of the application of project management principles (such as initiation, planning, monitoring, control and implementation) to the design and completion of research projects in a health setting (Vachan, 2012).
* Collaborative research projects can be challenged due to ambiguously defined goals as well as the heterogeneous interests of different partners. Consequently, adopting situation or context specific approaches is encouraged in this context (Lippe and vom Brocke, 2016).
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| People | * The importance of people oriented soft-skills on research projects. Challenges for research projects have been found to involve managing project members, leadership without authority as well as a lack of commitment from the respective organization (Beukers, 2011).
* Project challenges for agricultural research projects can include a lack of human resources and material as well as poor relations with senior management. Also, insufficient project deadlines as well as a lack of inter-disciplinary co-operation within the projects (Balaguru and Rajagopalan, 1986).
* The allocation of adequate time and resources that support improved communication between project team members is proposed in order to minimize conflicts that may arise across research projects (Löhr et al., 2016).
* Academic project coordinators often do not work in a professional project office context, where activities are distributed across projects and standardized tools and methods are available to support efficient project management activities (Rauser and Vamborg, 2016).
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| Technology | * The project management community has adopted internet-based technology to become more efficient in controlling and managing the stages of a project. Connectivity across projects as well as collaborative research projects over different countries can introduce new challenges for the management of such projects (Van der Merwe et al., 2015).
* Dynamic systems project management can help mitigate risks arising from technology implementation in health systems projects (Sargent et al., 2007).
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**Research Agenda**

It is possible through considering the findings from the systematic literature review to synthesize the following areas that require further development and hence Exhibit 6 provides a summary of the proposed research agenda for the project management of research projects.

**Exhibit 6.** Proposed research agenda.

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| **Feature** | **Research areas** |
| Process | * Exploring flexibility in project management processes to improve contingency and the ability to support uncertainty in research projects.
* Management processes that support international collaborative research projects, including large-scale consortium based projects.
* Project management and technology management processes to be deployed in industry – Supporting integration of research outputs into new product development related activities.
* Economic assessment of research outcomes in regard to the commercial application of intellectual property (IP) and contribution to industrial competitiveness.
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| Structure | * Designing research governance structures to be aligned with portfolio, program and project level management perspectives.
* Adapting project management structures (such as the project management office) to support knowledge based and creative research practices.
* Role of culture, perspectives and willingness to accommodate changes in an academic environment in regard to adopting new project management practices.
* Assessing the level of project management maturity in research and technology driven organizations.
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| People | * The complementary and supportive roles of project management and principal investigators on research projects.
* Design of project management training programs tailored to support skills development of participants in research projects.
* Role of senior management in promoting project management adoption in research organizations.
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| Technology | * Project management systems that support collaborative research projects involving multiple organizations.
* Role of cloud based systems in supporting research projects and knowledge-based activities.
* Communications technologies that enable agile project management practices in a research environment, e.g. application of Kanban workflow software.
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**Discussion and Conclusions**

Research is implicitly conducted through projects and hence the ability to manage such projects is likely to have a significant impact on the performance of the research activities. Project management has developed to support various industries, such as construction and IT, and so the question arises: Can project management principles be applied to the management of scientific research projects? This paper has sought to address this question through undertaking a systematic literature review, which identified 21 publications that include detailed coverage of both project management and research projects. These publications employed a broad range of research methodologies from various conceptual, quantitative and qualitative methods through to other mixed method and hybrid research approaches. The publications also occurred in a diverse range of titles and international conferences, indicating that the subject matter is inherently multidisciplinary.

A number of the publications highlighted the benefits of adopting process methodologies to support project management, such as schedule management and risk management. Indeed the ability to undertake planning, scheduling, monitoring and control activities to ensure projects are designed and delivered successfully would appear to be a universal feature of project management that extends not just to research projects but to all types of projects. Research projects do have many of the same challenges as other types of projects, in regard to deploying resources, maintaining on-time delivery and the need to ensure expenditure is kept within budget. But many publications identified in the systematic literature review also highlighted the importance of the creative side of research projects. This is further underscored in the case of collaborative research projects, where more than one party is working jointly on the delivery of a research initiative. The ability to manage uncertainty associated with generating new knowledge as well as the ability to maintain effective communications across such projects would appear to be important for managing these collaborations. ICT (information and communications technology) systems including cloud-based project management can have an important role in enabling remote and virtual working as well as facilitating document storage and effective communications for such collaborative projects. Adoption of such systems is encouraged to help facilitate knowledge sharing and communication across research projects and especially projects involving remote working or virtual teams.

Different types of organizations are engaged in the delivery of research projects and this includes industrial companies as well as academic institutions and independent research institutes. In regard to companies, there is a need to select and prioritize projects. Additionally and in regard to the industrial landscape, there is a need to ensure research projects are able to generate the required knowledge outputs that contribute to enhancing the company’s competitiveness and this can be through contributing to NPD (new product development), new service delivery or improved manufacturing processes. In such cases, project management will help to ensure research projects are managed efficiently and effectively but related technology management techniques such as technology roadmaps (Kostoff and Schaller, 2001), technology forecasting (Philbin, 2013) and TRL (technology readiness levels) frameworks (Mankins, 2009) can also be utilized in order to ensure projects are aligned with industrial requirements.

Research projects can be structured so that research objectives are managed according to a planned approach and just like other types of projects, project management resources (including the project manager, administration and other support teams) are deployed to support the researchers to meet the milestones specified in the research plan. Large-scale research programs and projects may benefit from having access to a dedicated research program manager or project manager; conversely a project manager may be providing support to several smaller projects. In this context, there is scope for the project management office (PMO) approach to be adopted, through standardizing the project support mechanisms available, providing project management tools and templates as well as ensuring a consistent approach to projects is adopted across a wider portfolio. For background material and a treatise on the role and functioning of the project management office, see the work of Philbin (2016). Other studies have explored how different types of project management can be adopted in higher education institutions, including managing education, research and knowledge exchange projects through using agile methodologies (Philbin, 2015 and 2017).

Adoption of ICT to support the project management process offers scope to improve project communications as well as tracking project information and internet enabled project management tools are being increasingly adopted by many different types of organizations concerned with project management. Implementing project management approaches in universities needs to be supported by appropriate training and education initiatives aimed at improving project management skills (Ramazani and Jergeas, 2015). At research intensive universities, faculty members are often under pressure to publish their research studies in reputable journals (especially in the case of working towards tenure) and consequently there is a direct incentive for research projects to be completed in a timely fashion so that such knowledge dissemination can take place. There would appear to be much scope for project management to help expedite such activities. However, a supporting culture will need to be in place to ensure there is awareness and acceptance of the benefits of utilizing management approaches in an organizational environment hitherto where management, commercial business practices and systems are not always readily adopted. Key to this challenge is the ability to ensure academic freedom in research projects is not compromised.

As discussed, there would appear to be merit in adopting structured and process-driven approaches for the management of administrative work in academia. It is less clear, however, on the scope for project management to play in the management of the actual knowledge generating activities associated with research work, including the crucial need for creative and academic freedom. It is postulated that project management can have a role to play in supporting this knowledge dimension of research projects. But the structures and processes of project management will need to be tailored to the specific needs of the research project. The project management function should support the knowledge discovery process, e.g. through facilitating improved communication of research results, enabling storage of research data and information in a suitable project database, tracking research outcomes against the research plan, or maintaining a research issue log. Consequently, there are many instances where project management techniques and the underlying principles can be applied to the management of research projects. This application should be contingent on the actual needs of the project. Indeed authors have proposed how project management as a discipline needs to further accommodate contingency (Cicmil et al., 2016), i.e. the project management approach to be deployed should be contingent (or dependent) on the circumstances of the project. The creative or innovative dimension is therefore of paramount importance to research projects if the scientific developments are to yield the required knowledge outputs and ultimately project management needs to be focused on supporting this process.

Future work is suggested across the areas identified in the aforementioned research agenda for project management and research projects. Additionally, multi-organization research studies are proposed in order to understand in more detail the critical success factors for the management of research projects and this can be undertaken for example through a mixed method approach involving the use of a survey instrument along with semi-structured interviews of the participants.

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