1-1-2014

# Building workforce competencies through complex projects

Andrew Sense
*University of Wollongong*, asense@uow.edu.au

Senevi Kiridena
*University of Wollongong*, skiriden@uow.edu.au

# Building workforce competencies through complex projects


## Abstract

This chapter illuminates the current theories and concepts concerning complexity and the project management workforce competencies necessary to deal with it in projects. It exposes the valuable, yet underutilised, opportunities complex projects may present to develop the knowledge and competencies of a workforce to successfully manage complexity within a project space and across an organisation more generally. The theoretical implications of this analysis imply that more research is necessary to establish a framework of competencies that relate appropriately to the levels of complexity within a project. The practice implications are profound since managing complexity in projects requires a more expansive and divergent set of practitioner skills that move well beyond the baseline 'technically oriented' project management skills set. In sum, this chapter highlights the current strengths and weaknesses of extant research and standards concerning complexity in projects and provokes discussion on developing a workforce that is more 'complexity' capable.



## Keywords

competencies, complex, workforce, building, projects


## Disciplines

Engineering | Science and Technology Studies


## Publication Details

Sense, A. & Kiridena, S. (2014). Building workforce competencies through complex projects. In R. Harris & T. Short (Eds.), Workforce Development: Perspectives and Issues (pp. 153-171). Singapore: Springer Science+Business Media.

# Chapter 9
# Building Workforce Competencies through Complex Projects

**Andrew Sense and Senevi Kiridena**

## Abstract

This chapter illuminates the current theories and concepts concerning complexity and the project management workforce competencies necessary to deal with it in projects. It exposes the valuable, yet underutilised, opportunities complex projects may present to develop the knowledge and competencies of a workforce to successfully manage complexity within a project space and across an organisation more generally. The theoretical implications of this analysis imply that more research is necessary to establish a framework of competencies that relate appropriately to the levels of complexity within a project. The practice implications are profound since managing complexity in projects requires a more expansive and divergent set of practitioner skills that move well beyond the baseline 'technically oriented' project management skills set. In sum, this chapter highlights the current strengths and weaknesses of extant research and standards concerning complexity in projects and provokes discussion on developing a workforce that is more 'complexity' capable.

## Introduction

Projects are embedded in most organisations as a means to 'get things done' effectively and to meet an array of corporate objectives. As such, the project management (PM) competencies of staff members to undertake projects are core to realising such goals. In the past in many organisations, project management has generally been viewed as linear and process-focused, requiring relatively short-term resource allocations and primarily concerned with meeting explicit and well-defined cost, specification and time deliverables. The skills required in that more simplistic frame of reference have necessarily been aligned to technique-driven matters. However, the effectiveness of the traditional positivist technique-based approaches to managing projects has increasingly been challenged in the light of greater recognition of the significance of human, behavioural and social dimensions in contemporary project-based undertakings. This is clearly demonstrated in major journals in the PM field, wherein the vast majority of research and publications are concerned with those attributes. In addition, given the now much wider range of significant and complex projects being undertaken across multiple fields of endeavour in organisations (e.g. organisational change and new product development projects), possessing or accessing appropriate PM competencies is increasingly a key strategic concern for organisations.

Until now practitioners have generally attained explicit PM competencies through participation in vocational and tertiary education programs, as well as through experience-based professional accreditation (in addition to practice experience). The bodies of PM knowledge produced by various professional bodies in the field of PM are mostly considered 'standards' or 'guidelines' to refer to, but importantly they also inform these education and accreditation programs. In more recent times, in response to the diverse range of projects now pursued and the high rate of project failures, or projects not meeting desired outcomes, the phenomenon of 'complexity' in projects has gained greater researcher attention. This research has generally attempted to explain what complexity is and how it manifests in projects and, indeed, what might be the requisite competencies needed to manage it. At this time, however, the various bodies of PM knowledge do not seem to be guiding or informing a sufficient response to this issue.

Moreover, as PM researchers such as Sense (2011) have posited, the skills and knowledge gained in singular projects is not only valuable within that space but also spans other organisational boundaries as the PM practitioner moves around and engages across an organisation and beyond it. In that way, the PM space becomes the generator of skills and new knowledge that may help transform the broader organisation – provided the project space is properly nurtured to achieve that. One of the initial difficulties is for an organisation to appreciate and embrace the notion that projects and project

teams can be major sites and catalysts for workforce development. Secondly, it might also be difficult to observe that, within each project, there may be different layers of competencies necessary to effectively manage the levels of complexity involved. In any case, a 'complex project', so considered, presents multiple opportunities to develop staff through exposure and actions in engaging with it during the project lifespan. Concomitant to that, training and education programs could provide conceptual insights and degrees of guidance to practitioners seeking to develop their skills and knowledge on this topic. Therein lays a challenge for research to deliver sufficient insights on this topic to better inform educational programs and for industry to recognise and encourage the development of staff on managing complexity in projects.

As one step towards informing the development of a workforce capable of leading complex projects and dealing with business complexity more competently, in this chapter we offer a discussion of the concepts and theories about project complexity and the competencies necessary to engage with it in projects. We first outline the concept of complexity and then discuss how complexity has been embraced by the PM community. At this point we provide a tiered framework of project complexity based on alternative perspectives. We then proceed to examine the PM bodies of knowledge (BOKs) with a particular emphasis on identifying the competencies required and the deficiencies within the current BOKs for dealing with the effects of project complexity. We then provide a chapter summary and concluding comments.

## The Concept of Complexity

The term 'complexity' or the state of 'being complex' generally connotes the difficulty in understanding and describing something, whether it is an artefact, organism or a phenomenon. Within the realm of complex systems science, the concept of complexity refers to the behaviour of systems that cannot be represented by elegant mathematical equations, and the degree of complexity is often expressed in terms of the amount of information necessary to describe the behaviour of a system (Bar-Yam 2002; Mitchell 2009). These systems can be physical systems such as infrastructure networks, biological systems such as the human brain, ecological systems such as a rainforest or social systems in societies. Weaver (1987), in his classic article 'Science and complexity', referred to three types of problems: few-variable problems of simplicity that can be represented by mathematical equations; many-variable problems of disorganised complexity that are subject to the laws of statistical mechanics; and several-variable problems of organised complexity that cannot be solved using either of the two approaches above. The main focus of Weaver's explanations, however, was on the problems of 'organised complexity', on which he claimed science has not yet concurred due to the number of variables involved and the nature of the interactions between those variables. The interpretations of the term 'complexity' found in other literature revolve around this third type of problem. Notwithstanding the many variations in the way the concept of complexity has been interpreted in different fields, there is some convergence on the point that complexity arises out of the emergent behaviour of a system that consists of components that interact in non-linear ways without being controlled by a central authority. This emergent behaviour is a result of those system components extracting information from their environment and using it continually to adapt and respond appropriately within their environment. This means that the behaviour of complex systems as a whole might not be directly inferred by the behaviour of their components. Another widely cited property underlying the emergent behaviour of complex systems is their dependence on initial conditions, or what is commonly known as the 'butterfly effect'. In the following section we will consider how the concept of complexity relates to projects and PM practice.

## Project Complexity

Many authors have argued that the PM competencies underpinned by the existing BOKs are inadequate to manage contemporary projects (Jaafari 2003; Pollack 2007; Saynisch 2010; Thomas and Mengel 2008; Winter et al. 2006). The scale and number of projects managed by an organisation at a given time, the alternative investment arrangements and the array of stakeholders involved, as well as the level of accountability and scrutiny on major projects, present new challenges and

requirements for senior PM practitioners (Edum-Fotwe and McCaffer 2000; Ingason and Jónasson 2009; Williams 1999). Thus, in the PM literature there are frequent calls to review the existing BOKs for their relevance or utility to be able to meet the PM competency demands expected in these uncertain and dynamic project environments. Such a call primarily rests on the following premises:

- Projects are becoming increasingly complex.
- There is increasing influence from a wide range of stakeholders.
- A significant proportion of projects have failed to meet stakeholder expectations (Baccarini 1996; Thomas and Mengel 2008; Vidal et al. 2011; Williams 1999; Winter et al. 2006).

Although there has been no conclusive evidence to support a causal relationship between the 'PM competencies' underpinned by the current codified BOKs and 'project performance' (Crawford 2005; Thomas and Mengel 2008), the PM competence of project managers is perceived to have a major impact on project performance (Crawford 2005; Morris et al. 2006a). In many contemporary projects, then, the necessity for practitioners to have more advanced competencies to be able to deal with and positively influence a range of complex and diverse issues within a project may clearly be more profound. Much of the recent discussion and debate on what constitutes such advanced PM, however, has revolved around the notion of 'project complexity'. Despite this perceived significance of the impact of complexity on project performance and the substantial research efforts directed towards studying project complexity, there appears to be no consensus on precisely how complexity relates to PM practice (Baccarini 1996; Geraldi 2009; Vidal and Marle 2008; Vidal et al. 2011; Williams 1999).

## *Project Complexity: Alternative Perspectives*

Projects, by definition, are unique, one-time endeavours consisting of a large number of varied and interdependent activities (Gido and Clements 2009; Larson and Gray 2011). This basic definition itself implies the intrinsic 'complexity' (as per the dictionary meaning of the term: consisting of many different and interconnected parts) of project-based undertakings. Project complexity is often interpreted relative to human cognition and capacity to understand, explicate and manage a project. For example, Vidal and colleagues defined project complexity as 'the property of a project which makes it difficult to understand, foresee and keep under control its overall behaviour, even when given reasonably complete information about the project system' (2011: 719). Project complexity has been researched substantially in recent times, particularly in terms of conceptualisation, operationalisation and dealing with its effects on PM practice (Baccarini 1996; Remington et al. 2009; Vidal and Marle 2008; Williams 1999). The range of views expressed by authors includes such assertions as 'the ideas [of complexity] apply equally to small in-house projects as to large complicated programs' (Weaver 2007: 2) and 'they [projects] are truly complex [if] they have multiple structural elements interacting and changing as they progress' (Whitty and Maylor 2009: 305).

A summary of the most commonly cited dimensions of project complexity and the aspects of each dimension that induce managerial complexity is provided in the following table. Additionally, in italicised text under the aspects of each dimension, we provide a descriptor of how each dimension impacts on PM practice.

**Table 9.1** Dimensions of Project Complexity and Related Aspects

| **Dimensions of project complexity** | **Selected aspects of each dimension that induce managerial complexity** ***and a descriptor of how it impacts PM practice*** | **Authors** |
|---|---|---|
| Structural | Project size; differentiation (variety) and interdependency between project elements<br>*Dealing with the intricacy and messiness of the large number of different and interdependent elements* | Baccarini (1996); Maylor et al. (2008); Vidal and Marle (2008); Williams (1999); Whitty and Maylor (2009) |

| | | |
|---|---|---|
| Technical | Technologies involved; methods adopted; scope and goals of the project<br>*Lack of knowhow and clarity due to the novelty in methods and technologies, and the ambiguity in goals and scope* | Bosch-Rekveldt et al. (2010); Remington and Pollack (2007); Turner and Cochrane (1993); Williams (1999) |
| Environmental | Location; market conditions; legal, political and industry landscape – which are beyond the control of the project team<br>*Lack of capacity to predict and control the impact of external influences; non-linear progression of the project* | Antoniadis et al. (2011); Bosch-Rekveldt et al. (2010); Remington and Pollack (2007); Vidal and Marle (2008); Weaver (2007) |
| Organisational | The composition and experience of the project team; the status/profile and expectations of stakeholders; strategic directions; project structure and management style; culture<br>*Dealing with the turbulence caused by self-organisation and emergence of the project system due to internal forces* | Antoniadis et al. (2011); Bosch-Rekveldt et al. (2010); Remington and Pollack (2007); Weaver (2007) |
| Change | The shifting dynamics within and between project elements<br>*Managing the continued adaptation and evolution of the project system in response to internal and external forces* | Cooke-Davies et al. (2007); Maylor et al. (2008); Remington and Pollack (2007); Saynisch (2010); Whitty and Maylor (2009) |

The more recent published work on project complexity generally reflects a view that a highly complex project consists of a large number of diverse elements interacting spontaneously in a dynamic operating environment where uncertainty impacts on project goals and methods. This interpretation is largely consistent with the properties and behaviour of complex systems introduced in the previous section. Linked intimately to that general perspective, then, more advanced PM may be considered as the art and science of adaptively engaging with a project's various interacting elements, including relevant actors in its environment, in uncertain or dynamic conditions to deliver on project outcomes, as expected by stakeholders.

However, we consider such broad generalised statements about project complexity and associated PM definitions to be somewhat inadequate to inform PM practice. Instead, and drawing on the dimensions of project complexity identified in the table above, we suggest that three levels of project complexity can be articulated, as briefly discussed below – these three levels are a useful way to appreciate or interpret 'how' a project is complex rather than simply whether a project is complex or not.

## *Projects as Complicated Systems*

The literature often distinguishes 'complex' projects from 'complicated' or 'large' projects, the distinction between the two being the 'nature of the relationships' between the elements of the project (Maylor et al. 2008; Thomas and Mengel 2008; Weaver 2007; Whitty and Maylor 2009). For instance, large-scale engineering and construction projects are considered to be complicated projects, but they may not necessarily be complex projects. If the nature of relationships between various elements of a project is such that the interactions between elements are non-linear and this results in emergent behaviour of the whole system, then it is considered a 'truly' (or highly) complex project (Maylor et al. 2008; Whitty and Maylor 2009). Again, these are some of the properties of complex systems identified in the previous section. However, a complicated project can also induce managerial challenges depending on the nature of its structure and the interdependencies between its elements. 'Structural complexity' is the most widely acknowledged dimension of project complexity. It essentially relates to the physical composition and configuration of a project – namely, task variety or the degree of differentiation and the interconnectedness or the interdependencies between various

subsystems or elements of the project – that can induce managerial challenges relating to dealing with intricacy and messiness (Baccarini 1996; Williams 1999). However, this is not considered a property of a truly complex system.

### *Projects as Complicated Systems in Dynamic Environments*

Although structural complexity has been widely cited as a key dimension of project complexity, a number of authors have argued that structural complexity alone would not induce managerial complexity. Projects are viewed as 'socio-technical systems' (Taylor and Felton 1993) consisting of people, processes, structures and technology, which interact with other systems and actors in their environment. Therefore, in addition to the structural complexity of projects, the tightening life cycles of contemporary projects, dynamic project environments and the elusive stakeholder expectations may mean that:

- Project goals may not always be clear or set firmly at the conceptual development phase.
- Changes in client requirements may lead to changes in project scope and schedule.
- When technical methods of developing products are not known at the outset, the fundamental building blocks such as work breakdown structures may be less applicable.

A number of authors have explained these aspects in terms of the impact of 'technical complexity' and 'environmental complexity' on managerial decision making and goal attainment, as caused by various characteristics of projects, referred to earlier, as well as the influence of a range of internal and external environmental factors (Bosch-Rekveldt et al. 2010; Vidal and Marle 2008). Technological complexity relates to the knowhow embedded in project tasks, methods or outcomes; and the environmental complexity relates to the factors that induce uncertainty or impact on the stability of the project. However, the extant literature does not discern whether or not the interactions between project elements and its environment are non-linear and result in emergence behaviour of the project as a whole, in the same sense as has been established in complex systems science.

### *Projects as Complex Adaptive Systems*

Another emerging and, arguably, more radical perspective on project complexity emphasises that projects do display such properties as social interaction, emergence, self-organisation and evolution and, therefore, they should be treated as complex adaptive systems (similar to biological systems or ecosystems). For example, Remington and Pollack claimed that 'most large and many small projects exhibit characteristics such as phase transition, adaptiveness and sensitivity to initial conditions' (2007: 3). Whitty and Maylor asserted that truly complex projects 'have multiple structural elements interacting and changing as they progress' and that 'they are socially constructed entities' (2009: 305). The significance of these properties is particularly discussed in relation to managerial complexity within the non-traditional domains of PM (i.e. outside the traditional areas of engineering and construction) such as organisational change and research and development projects. Moreover, a growing number of authors have claimed that conceptualising projects from the above perspective represents a fundamental shift away from the traditional school of PM thought towards a new paradigm of PM (Cooke-Davies et al. 2007; Remington and Pollack 2007; Saynisch 2010). Again, even within this stream of literature, the properties of projects that lend them to be classified as complex systems have not been well-articulated in theoretical terms (compared to what has been espoused in complexity science literature); neither have they been empirically validated.

The three levels of project complexity outlined above can be mapped on to the hierarchy shown in Figure 9.1 below. This figure pictorially summarises how the various dimensions of complexity relate to our three derived levels of project complexity and also indicates their incremental impacts on PM practice as project systems become more complex. We note that what is most important and relevant to this discussion, however, is the managerial complexity induced by certain properties or characteristics of project systems and the way a project system interacts with its surroundings rather

than the complexity of the project per se, or whether the project qualifies to be complex in an academic sense.

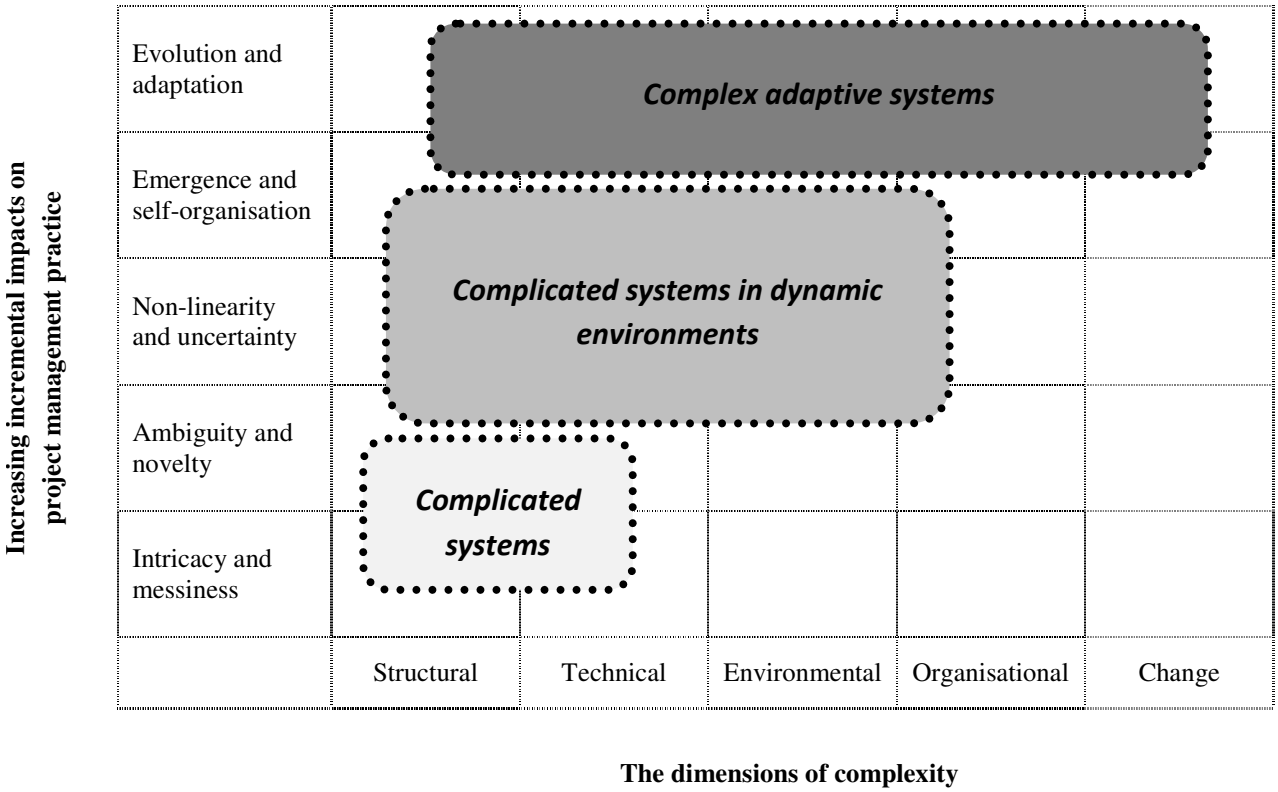


**Fig. 9.1** A hierarchy of project complexity

Having developed this conceptualisation of project complexity, in the following section we now move to reviewing the major PM BOKs with a view to evaluating their relevance to PM practice, particularly in terms of dealing with project complexity.

## Project Management (PM) Bodies of Knowledge (BOKs)

Codified BOKs introduced by PM professional associations reflect the frameworks of knowledge or competency standards expected of PM practitioners to perform effectively in a professional capacity (Morris 2001; Stretton 2006). As such, the competency standards built into these BOKs form the basis for certification of professionals and the accreditation of education and training programs in the area of PM. They are also used as frameworks for guiding continuing professional development, as well as in the development of internal organisational PM methodologies. In this section, we present a summary of our review of the major PM bodies of knowledge. Although a broader perspective on bodies of knowledge or 'stock of knowledge' may infer the sum total of knowledge embodied in a variety of codified forms, our review was limited to the BOKs adopted by major PM professional bodies. We first summarise the structure and content of the selected BOKs and then provide a review of their relative strengths and limitations. This is followed by an account of the coverage of advanced PM competencies in these BOKs.

### *The Structure and Content of the Major PM BOKs*

Since the publication of *A guide to the PM body of knowledge* (PMBOK® Guide) by the US-based Project Management Institute (PMI) in the mid-1980s, there have been a number of similar BOKs introduced by other PM professional associations around the world. The three prominent BOKs that are considered to be rather exclusive are: the PMBOK® Guide; the UK-based Association of Project Management (APA)'s BOK; and the Project and Program Management for Enterprise Innovation

(P2M) standards promoted by the Project Management Association of Japan. While the PMBOK® Guide or its adapted versions are prevalent in many countries across the world, including in Australia, the APA's BOK and its adapted versions are claimed to be widely applied in European countries (Morris et al. 2000, 2006b; Stretton 2006). In addition to the above three BOKs, the UK Office of Government Commerce has introduced a process-based PM methodology called 'PRoject IN Controlled Environments' (PRINCE2), which is claimed to be a non-proprietary best practice guidance widely used by UK government agencies (http://www.prince2.com/what-is-prince2.asp).

The PMBOK® Guide contains 37 competency elements covering nine core areas of PM knowledge: integration, scope, time, cost, quality, human resource, communication, risk and procurement. PMI has more recently introduced two other standards for program management and portfolio management, as well as an organisational project management (capability) maturity model (OPM3). Additionally, the PMI has published construction and government extensions to the PMBOK® Guide, as well as a suite of practice standards and frameworks. The APA's BOK contains 52 competency elements organised under seven broad areas: context, planning, execution, techniques, business and commercial, organisation and governance, and people and the profession. The P2M standards includes competency elements organised under 11 knowledge areas: strategy, finance, systems, organisation, target, resources, risk, information, relationship, value and communication.

The EU-based International Project Management Association (IPMA)'s IPMA Competence Baseline (ICB) and the complex project manager (CPM) competency standards published by the Australia-based International Centre for Complex Project Management (ICCPM) – previously known as the College of Complex Project Managers – are the other two main BOKs cited in PM literature. ICB is a framework of reference comprising: 11 elements of technical competences for project management; 15 elements of behavioural competences expected of project personnel; and 11 elements of contextual competences applicable to projects, programs and portfolios – the framework is claimed to have been adopted by over 50 member associations of the IPMA. ICCPM's CPM competency standards are guided by 'nine views which define behaviours of complex project managers in the workplace, each of which operates as a continuum with a TPM/GM node and a CPM node' (ICCPM 2008: 8). The ICCPM claims that its CPM competency standards are 'based upon a complexity/uncertainty and emergence-based paradigm; use multiple views and dialectics to define behaviours that together provide insight and understanding; require a substantial level of underpinning knowledge; and define required special attributes' (ICCPM 2008: 12).

Morris and colleagues have noted that, although there are no major disparities between the three major BOKs referred to above, 'the APM BOK and P2M are much broader in conceptual breadth and scope than the PMBOK® Guide' (2006a: 713). Additionally, the professional competency standards adopted by the IPMA, ICCPM and the Australian Institute of Project Management (AIPM) are assessed with emphasis on demonstrable performance, whereas the competency standards of the other BOKs referred to earlier are assessed against the underpinning knowledge and skills. This distinction has been discussed in the literature in terms of attribute-based versus performance-based approaches to competency standards (Crawford 2005; Delo and Hepworth 2010). Attribute-based standards rely on knowledge, skills, experience and personality traits or behaviours that result in effective or superior performance of a person in the job, whereas performance-based standards emphasise performance demonstrable through workplace practices relevant to a particular professional or occupational area. The choice between the two may depend on the purpose and context of their application: for example, if the focus is on accreditation or selection of entry-level PM practitioners then an attribute-based approach would be applied with a view to identifying those with the highest potential, whereas if the focus is on accreditation at senior levels or performance evaluation, then a performance-based approach would be preferable (Delo and Hepworth 2010). However, in recent times it appears that most professional associations have been moving towards using combined attribute-based and performance-based assessment regimes.

### *Relative Strengths and Limitations of the Major PM BOKs*

Ongoing reviews of the status and progress of PM as a profession in general, and the relevance and credibility of the various PM BOKs in particular, point to a number of issues associated with the

existing PM BOKs on multiple fronts. For instance, citing the work of Crawford (2005), Thomas and Mengel have noted that

> professional associations the world over are introducing ever more project management standards and certification processes ... yet the trend towards professionalism and the focus on standardisation come into question as the behavioural and personal competencies of project managers outside of PM standards appear to be more relevant for their workplace performance than the tools and techniques emphasised in the standards. (2008: 304)

The other major issues relating to the current PM BOKs cited in the literature include the lack of a sound empirical basis for supporting the BOKs; lack of a globally recognised framework of PM competency standards; lack of a considered approach to developing PM competency standards; and the influence of vested interests in maintaining existing standards (Crawford 2005; Morris et al. 2006b; Pollack 2007; Saynisch 2010).

In the recent past there have been numerous calls to extend the existing PM knowledge base to incorporate the human and behavioural aspects (interpersonal, motivational, communication, negotiation, conflict resolution and the like) of PM competence. The PMI's PMBOK® Guide, the most widely adopted standard, has been particularly criticised for continuing to focus on project execution at the expense of the human and behavioural aspects of PM (Pant and Baroudi 2008; Pollack 2007). For example, in critiquing the so called 'hard paradigm' of PM, Pollack (2007) noted the PMBOK® Guide's strong links to positivist philosophies that promote reductionist approaches and control with low emphasis on interpersonal matters and participation. He further questioned the Fsefficacy of the PM tools and techniques embodied in the traditional BOKs in that they are based on basic assumptions of predetermined, clear and certain project goals that do not hold in projects with inherent uncertainty. Although the PMBOK® Guide has undergone several revisions or updates, since its introduction, critics have claimed that there have been no significant changes made to its structure and, arguably, much of its content (Crawford 2005; Morris et al. 2006b; Stretton 2006). However, a cursory review of the latest editions of the major BOKs referred to above indicated that the relevant professional bodies have been responding to these criticisms in recent times, and the current versions of most BOKs contain competency elements reflecting the human and behavioural aspects of PM. Additionally, a number of publications have also reported on work carried out to extend or examine the existing BOKs to address the domain-specific issues – such as in the construction, defence and public sector fields (Ayer and Bahnmaier 1995).

Irrespective of these recent amendments, Crawford has claimed that 'there is no statistically significant relationship between performance against the widely used [PM competency] standards in their entirety, and senior management perceptions of the effectiveness of workplace performance' (2005: 15) – thus suggesting a difference between the knowledge and practices valued by PM practitioners and those valued by senior managers. Perhaps reflecting that disconnect, a growing body of literature has also criticised the traditional reductionist approaches to managing projects for their limitations in dealing with the managerial challenges brought about by the emergent and dynamic nature of contemporary projects (Morris et al. 2006a; Pollack 2007; Thomas and Mengel 2008).

### *The Coverage of Complex PM Competencies in the Major PM BOKs*

Although the major PM professional bodies appear to be responding to most of the criticisms referred to earlier, through the ongoing revisions of their BOKs, there is no evidence to suggest that the competencies advocated in the literature to manage complex projects are being incorporated into existing BOKs. Most professional bodies assess competencies of PM practitioners at different levels for certification. The BOKs invariably refer to project complexity, non-complex projects, complex projects, programs and portfolios. For instance, IPMA's competency standards for Level A certification (http://www.ipma.ch) specify the criteria for determining the complexity of a portfolio or program as follows:

- the number, importance, variety and complexity of active projects in the program or portfolio and number of project managers directed;
- proposals to the overseeing body for decision and own decisions;
- the selection and development of project management requirements, processes, methods, techniques, tool, regulations and guidelines in the organisation;
- influence on the selection, training and employment of project managers; and
- coordination of all projects of the portfolio or program and ensuring compliance to strategy.

These attributes, at best, reflect the structural, technical and environmental dimensions of project complexity, but fall well short of the characteristics or properties of the 'complex adaptive systems' described earlier in this chapter. A complexity index and project complexity are also widely referred to in the AIPM's competency standards, but the term 'complexity' appears not to have been enumerated as such.

By comparison, the CPM competency standards developed by the ICCPM have included an interpretation of complex projects as 'open, emergent and adaptive systems that are characterised by recursiveness and non-linear feedback loops' and a further description that 'complex projects:

- are usually adaptive system of systems;
- have high uncertainty in scope definition;
- are distributed;
- have ongoing environmental and internal turbulence;
- are implemented through wave planning; and
- are unable to be decomposed to elements with clearly defined boundaries' (ICCPM 2008: 4).

Although these characteristics reflect the properties of complex adaptive systems referred to earlier, Whitty and Maylor have severely criticised the CPM competency standards for not satisfactorily establishing 'any measures or threshold of complexity' (2009: 307); 'the definition [of complex projects] and the process [of developing the standards] was flawed' (p. 308); and 'the standards are not established on evidence-based practices' (p. 309).

All in all, the articulation of project complexity and the level of representation of competencies required to manage complex projects in the current BOKs are currently, at best, underdeveloped.

## Project Management Competencies for Complex Projects

The literature suggests that professional bodies, government agencies, educational institutions, the corporate sector and the research community are all showing increasing interest in PM competence. This is evident from the heightened efforts to develop competency standards, qualification frameworks, educational programs and internal organisational frameworks, as well as scholarly contributions (Chen et al. 2008; Crawford and Cabanis-Brewin 2006; Delo and Hepworth 2010; Edum-Fotwe and McCaffer 2000; Rose et al. 2007; Suikki et al. 2006).

### *Major Categories of PM Competence*

The extant literature on PM competence reflects five major areas of project manager competence.

1. technical expertise applicable to particular domains of professional practice such as engineering, construction, defence, information systems, information technology, organisational change, research and development and new product development;
2. managerial competencies of planning, organising, leading and control – across the key areas identified in the traditional PM BOKs and the knowledge of PM methods and tools;
3. human and behavioural skills as opposed to the knowledge of PM methods and tools;
4. advanced competencies to deal with the challenges in managing large projects, programs and portfolios, including strategic, political and legal issues; and

5. higher order conceptual skills, knowledge and competencies to deal with the challenges brought about by the complexity of projects and dynamic project environments.

Technical knowledge pertaining to specific areas of professional practice is generally considered to be a basic requirement for junior PM roles and, in most cases, entry-level project managers are technically qualified practitioners. However, it is widely agreed that, as a project manager progresses to senior ranks, what is really necessary is an appreciation of the managerial challenges brought about by the technical sophistication of a project rather than an in-depth understanding of the technical aspects per se. This notion is further supported by the fact that most contemporary projects are multidisciplinary in nature and, therefore, it is unlikely that a single project manager will possess the breadth and depth of technical expertise to cover multiple discipline areas – besides, it is customary that project managers seek input from technical experts or consultants, as needed.

Managerial competencies outlined in the second category above are comprehensively covered in the traditional PM BOKs. The traditional approaches to managing projects are largely informed by the doctrines of 'systems engineering' and 'control theory'. For example, the magnitude of a large project can be effectively dealt with by breaking it down into smaller more manageable work items using such techniques as work breakdown structures and responsibility matrices. Similarly, the interrelations and interdependencies between work items can be dealt with using the critical path method or program evaluation and review technique. Software tools also play a key role in the effective and efficient management of project information, particularly for coordination and control purposes. There is strong consensus that these perspectives, as well as a wide range of PM methods and tools, are adequately covered in the standard PM curricula offered by educational institutions, and that the vast majority of PM practitioners demonstrate these competencies well.

The third category of PM competency above emphasises the significance of a range of human and behavioural skills – for example, interpersonal, communication and motivation – commonly referred to as 'soft' skills. Many authors have argued that, while the competencies underpinned by the current PM BOKs are essential for PM success, it is these soft skills that differentiate high performing project managers from the rest (Alam et al. 2010; Edum-Fotwe and McCaffer 2000; Gillard 2009; Henderson 2004; Pant and Baroudi 2008; Rose et al. 2007). For instance, based on a review of the content of text books, journal articles and PM education programs in the US, Australia and Europe, Ingason and Jónasson noted the discipline's increasing focus on 'interpersonal competences, relationship management, resource management, and strategic alignment' (2009: 59). Through a survey of PM personnel in south-east Queensland, Lei and Skitmore (2004) identified a wide range of soft skills, including communication, networking and stakeholder management. The effectiveness of alternative forms of leadership has also been the subject of interest in a number of empirical studies (Lei and Skitmore 2004; Loo 2002; Prabhakar 2005; Suikki et al. 2006). As such, there is a strong consensus that competencies relating to the application of PM methods and tools must be supplemented by a range of soft skills that are vital for PM success.

In addition to the competencies referred to above, senior practitioners who manage large projects, programs or portfolios are expected to possess advanced competencies demanded by a range of contextual circumstances comprising strategic, political and legal dimensions (Bourne and Walker 2004; Edum-Fotwe and McCaffer 2000; Hyväri 2006; Ives 2005; Patanakul and Milosevic 2008; Suikki et al. 2006). Remington and Pollack noted that 'project managers are expected to deliver outcomes in increasingly ambiguous and politically charged environments' (2007: 1). Based on data gathered from three case studies, Bourne and Walker hypothesised that 'there is a need for project managers to be skilled in managing at the third dimension ... [that is] to understand the need for, have the ability, and be willing, to "tap into the power grid" of influence that surrounds all projects' (2004: 226). While recognising the need to develop new PM competencies to deal with the challenges brought about by turbulent business environments, Suikki and colleagues (2006) emphasised the significance of skills such as leadership, self-management and organisational learning. Based on a survey of project managers in the construction industry, Edum-Fotwe and McCaffer (2000) identified a number of skills, including managerial, legal and communication, that are perceived to be essential for developing PM competency in a changing industry environment. As such, apart from the conceptual skills and more advanced competencies required in such areas as negotiation, conflict

resolution and change management, senior project managers may also need to demonstrate such broad-based competencies as strategic insight, political acumen and legal acuity.

It is widely recognised that competencies underpinned by the existing PM BOKs which emphasise planning and control are inadequate to manage complex projects. Koppenjan and colleagues claimed that 'the management of large engineering projects is often a combination of the focus on planning and control, and the ambition to be flexible given the complexity and uncertainties that characterises these kinds of projects' (2011: 740). Some authors have even claimed that managing complex projects requires new or radically different ways of thinking and conceptualising, as well as competencies in new areas of practice. For instance, Remington and Pollack (2007: 2) advocated 'systemic pluralism' as a novel approach to managing projects in complex contexts, which they claimed falls under the school of 'critical systems thinking' that emphasises 'theoretical and methodological pluralism', while recognising the systemic nature of projects. The gaps between those competencies represented by the current BOKs and what is required to manage complex projects have often been expressed in such polarised terms as 'the ability to predict and control' versus 'understand and facilitate', and developing 'trained technicians' versus 'reflective practitioners' (Bosch-Rekveldt et al. 2010; Crawford et al. 2006; ICCPM 2008; Jaafari 2003). The CPM competency standards developed by the ICCPM, for example, have highlighted higher-order conceptual skills such as the ability to identify the underlying patterns in rather random paths followed by the behaviour of complex systems and the importance of viewing problems using multiple metaphors and dialectics (ICCPM 2008). Thomas and Mengel (2008) have emphasised the importance of a wide range of competencies, including shared leadership, social competence, emotional intelligence, skills in organisational politics and the importance of visions, values and beliefs. While acknowledging the value of traditional PM tools in situations where project goals are clear and remain relatively stable over time, Remington and Pollack (2007) have proposed a suite of tools for complex PM – such as causal maps, target outrun cost and temporal cost–time comparison – from which managers can choose, depending on the source of project complexity. Taxen and Lillieskold (2008) have also explored the role of alternative PM tools in managing integration and critical dependencies in projects under what they called 'turbulent and complex circumstances'.

## Summary and Conclusions

Based on our transverse of the extant literature on project complexity, we have presented and described three levels of project complexity – complicated systems, complicated systems in dynamic environments, and complex adaptive systems – in opposition to any singular universal definition. An evaluation of the current PM BOKs against extant literature on complex PM found that a range of complex PM competencies discussed in the literature are not represented in the widely adopted PM BOKs. The most prominent complex PM competencies discussed in the literature reflect the knowledge and understanding of advanced concepts relating to systems thinking and complexity theory and higher-order cognitive skills required to deal with the managerial challenges brought about by the 'emergent', 'adaptive' and 'dynamic' behaviour of complex projects. We also noted that, in recent times, most PM professional associations have been responding to long-running criticisms of their previously limited focus on traditional approaches to PM by incorporating competency elements representing human and behavioural aspects into their standards. The conception and issues about PM complexity outlined in this chapter may help practitioners, and project management–based organisations in particular, to reassess and interpret their complexity training and development needs – ultimately leading to the deployment of targeted and customised education and training options on this topic.

In effect, the current coverage to this point within the well utilised BOKs (and other sources) on the issue of project complexity is more centred on exhortations about the need to recognise complexity and to do something about it, rather than to explicate a set of empirically derived competencies that may better guide the understanding and actions of PM practitioners. What is most pertinent for practice development then is that these guides and literature are currently insufficient for this educational task. This indeed may be a timing issue where research will ultimately catch up with the world of practice. Secondly, developing a PM workforce that is capable of planning for, recognising and executing for complexity that is appropriate in their circumstances is a worthwhile

goal that fuels project success, but as yet there is no clarity around the set of competencies and processes actually required to achieve such outcomes. Thirdly, if one views the project workplace as serving as an epicentre for staff development, projects and their complexity issues represent a significant learning and growth opportunity for individuals. Therein, higher-order competencies development (involving knowledge, skills and personal attributes: Crawford 2005) not only serves the immediate demonstrable needs of the projects at hand, but translate across the organisation as those persons move around and integrate their activities within the organisation. Thus the project workplace may also serve as a significant learning and development entity (Sense 2009) that helps transform the individuals involved and the practices of an organisation over time.

## References


Alam, M., Gale, A. et al. (2010). The importance of human skills in project management professional development. International Journal of Managing Projects in Business, 3(3), 495–516.

Antoniadiis, D.N., Edum-Fotwe, F.T., & Thorpe, A. (2011). Socio-organo complexity and project performance. International Journal of Project Management, 29(7), 808–816.

Ayer, F.L., & Bahnmaier, W. (1995). Toward a defence extension to the project management body of knowledge. International Journal of Project Management, 13(2), 125–128.

Baccarini, D. (1996). The concept of project complexity – a review. International Journal of Project Management, 14(4), 201–204.

Bar-Yam, Y. (2002). Dynamics of complex systems. Boulder, CO: Perseus Books.

Bosch-Rekveldt, M., Jongkind, Y. et al. (2010). Grasping project complexity in large engineering projects: the TOE (Technical, Organizational and Environmental) framework. International Journal of Project Management, 29(6), 728–739.

Bourne, L., & Walker, D.H.T. (2004). Advancing project management in learning organizations. Learning Organization, 11(3), 226–243.

Chen, P., Partington, D., & Wang, J.N. (2008). Conceptual determinants of construction project management competence: a Chinese perspective. International Journal of Project Management, 26(6), 655–664.

Cooke-Davies, T., Cicmil, S. et al. (2007). We're not in Kansas anymore, Toto: mapping the strange landscape of complexity theory, and its relationship to project management. Project Management Journal, 38(2), 50–61.

Crawford, L. (2005). Senior management perceptions of project management competence. International Journal of Project Management, 23(1), 7–16.

Crawford, J.K., & Cabanis-Brewin, J. (2006). Competency and careers in project management. In P.C. Dinsmore (Ed.), AMA handbook of project management (pp. 248–264). New York: Amacom.

Crawford, L., Morris, P. et al. (2006). Practitioner development: from trained technicians to reflective practitioners. International Journal of Project Management, 24(8), 722–733.

Delo, A., & Hepworth, A. (2010). Assessing the competent project manager. Provek. http://www.hcsprovek.co.uk/Documents/Assessing%20the%20competent%20project%20manager%20v1-0-1.pdf. Accessed 7 June 2011.

Edum-Fotwe, F.T., & McCaffer, R. (2000). Developing project management competency: perspectives from the construction industry. International Journal of Project Management, 18(2), 111–124.

Geraldi, J.G. (2009). What complexity assessments can tell us about projects: dialogue between conception and perception. Technology Analysis & Strategic Management, 21(5), 665–678.

Gido, J., & Clements, J.P. (2009). Successful project management. Mason, OH: South-Western Cengage Learning.

Gillard, S. (2009). Soft skills and technical expertise of effective project managers. Issues in Informing Science & Information Technology, 6, 723–729. http://iisit.org/Vol6/IISITv6p723-729Gillard599.pdf. Accessed 9 September 2011.

Henderson, L.S. (2004). Encoding and decoding communication competencies in project management – an exploratory study. International Journal of Project Management, 22(6), 469–476.

Hyväri, I. (2006). Success of projects in different organizational conditions. Project Management Journal, 37(4), 31–41.

ICCPM (2008). Complex project management competency standards: version 3.3. Canberra: International Centre for Complex Project Management. http://www.iccpm.com/index.php?option=com_k2&view=itemlist&layout=category&task=category&id=2&Itemid=253. Accessed 9 September 2011.

Ingason, H.T., & Jónasson, H.I. (2009) Contemporary knowledge and skill requirements in project management. Project Management Journal, 40(2), 59–69.

Ives, M. (2005). Identifying the contextual elements of project management within organizations and their impact on project success. Project Management Journal, 36(1), 37–50.

Jaafari, A. (2003). Project management in the age of complexity and change. Project Management Journal, 34(4), 47–57.

Koppenjan, J., Veeneman, W. et al. (2011). Competing management approaches in large engineering projects: the Dutch Randstad rail project. International Journal of Project Management, 29(6), 740–750.

Larson, E.W., & Gray, C.F. (2011). Project management: the managerial process. New York: McGraw-Hill Irwin.

Lei, W.W.S., & Skitmore, M. (2004). Project management competencies: a survey of perspectives from project managers in south-east Queensland. Journal of Building and Construction Management, 9(1), 1–12.

Loo, R. (2002). Working towards best practices in project management: a Canadian study. International Journal of Project Management, 20(2), 93–98.

Maylor, H., Vidgen, R., & Carver, S. (2008). Managerial complexity in project-based operation: a grounded model and its implications for practice. Project Management Journal, 39(S1), S15–S26.

Mitchell, M. (2009). Complexity: a guided tour. New York: Oxford University Press.

Morris, P.W.G. (2001). Updating the project management bodies of knowledge. Project Management Journal, 32(3), 21–30.

Morris, P.W.G., Patel, M.B., & Wearne, S.H. (2000). Research into revising the APM project management body of knowledge. International Journal of Project Management, 18(3), 155–164.

Morris, P.W.G., Crawford, L. et al. (2006a). Exploring the role of formal bodies of knowledge in defining a profession. International Journal of Project Management, 24(8), 710–721.

Morris, P.W.G., Jamieson, A., & Shepherd, M.M. (2006b). Research updating the APM body of knowledge 4th edition. International Journal of Project Management, 24(6), 461–473.

Pant, I., & Baroudi, B. (2008). Project management education: the human skills imperative. International Journal of Project Management, 26(2), 124–128.

Patanakul, P., & Milosevic, D. (2008). A competency model for effectiveness in managing multiple projects. Journal of High Technology Management Research, 18(2), 118–131.

Pollack, J. (2007). The changing paradigms of project management. International Journal of Project Management, 25(3), 266–274.

Prabhakar, G.P. (2005). Switch leadership in projects: an empirical study reflecting the importance of transformational leadership of project success across twenty-eight nations. Project Management Journal, 36(4), 53–60.

Remington, K., & Pollack, J. (2007). Tools for complex projects. Cornwall, UK: MPG Books.

Remington, K., Zolin, R., & Turner, R. (2009). A model of project complexity: distinguishing dimensions of complexity from severity. In: Proceedings of the 9th International Research Network of Project Management Conference, Berlin, 11–13 October 2009.

Rose, J., Pedersen, K. et al. (2007). Management competence, not tools and techniques: a grounded examination of software project management at WM-Data. Information and Software Technology, 49(6), 605–624.

Saynisch, M. (2010). Beyond frontiers of traditional project management: an approach to evolutionary, self-organisational principles and the complexity theory – results of the research program. Project Management Journal, 41(2), 21–37.

Sense, A.J. (2009). The social learning character of projects and project teams. International Journal of Knowledge Management Studies, 3(3/4), 195–208.

Sense, A.J. (2011). The project workplace for organizational learning development. International Journal of Project Management, 29(8), 986–993

Stretton, A.M. (2006). Bodies of knowledge and competency standards in project management. In P.C. Dinsmore (Ed.), AMA handbook of project management (pp. 15–24). New York: Amacom.

Suikki, R., Tromstedt, R., & Haapasalo, H. (2006). Project management competence framework in a turbulent business environment. Technovation, 26(5–6), 723–738.

Taxen, L., & Lillieskold, J. (2008). Images as action instruments in complex projects. International Journal of Project Management, 26(5), 527–536.

Taylor, J., & Felton, D. (1993). Performance by design: sociotechnical systems in North America. Upper Saddle River, NJ: Prentice Hall.

Thomas, J., & Mengel, T. (2008). Preparing project managers to deal with complexity – advanced project management education. International Journal of Project Management, 26(3), 304–315.

Turner, J.R., & Cochrane, R.A. (1993). Goals-and-methods matrix: coping with projects with ill defined goals and/or methods of achieving them. International Journal of Project Management, 11(2), 93–102.

Vidal, L., & Marle, F. (2008). Understanding project complexity: implications on project management. Kybernetes, 37(8), 1094–1110.

Vidal, L., Marle, F., & Bocquet, J. (2011). Measuring project complexity using the analytic hierarchy process. International Journal of Project Management, 29(6), 718–727.

Weaver, W. (1987). Science and complexity. American Scientist, 36(4), 536–544.

Weaver, P. (2007). A simple view of complexity in project management. Mosaic Project Services. http://www.mosaicprojects.com.au/PDF_Papers/P070_A_Simple_View_of_Complexity.pdf. Accessed 14 June 2011.

Whitty, S.J., & Maylor, H. (2009). And then came complex project management (revised). International Journal of Project Management, 27(3), 304–310.

Williams, T.M. (1999). The need for new paradigms for complex projects. International Journal of Project Management, 17(5), 269–273.

Winter, M., Smith, C. et al. (2006). Directions for future research in project management: the main findings of a UK government-funded research network. International Journal of Project Management, 24(8), 638–649.