Conference paper

Smith, N.J., Bower, D.A. and Aritua, B. (2008) *A Complexity Science Based Approach to Programme Risk Management.* In: 22nd IPMA World Congress, 9-11 November 2008, Rome.

A Complexity Science Based Approach to Programme Risk Management

Nigel J. Smith, *BSc, MSc, PhD, CEng, FICE, MAPM*
Professor of Project & Transport Infrastructure Management, School of Civil Engineering, University of Leeds UK
Denise Bower, *BEng, PhD, MASCE*
Professor of Engineering Project Management, School of Civil Engineering, University of Leeds UK
Bernard Aritua[1], *Bsc, MSc, GMICE, MAPM*
Research Associate and Doctoral Research Scholar, School of Civil Engineering, University of Leeds UK

Abstract

Programme management has rapidly gained acceptance as a vehicle for achieving organisational strategic objectives and as a means of aligning projects with the overall strategy of the organisation. Managing programme risk poses challenges which are different from those in project management. Attempts to modify and apply project risk management techniques to programme risk management have experienced difficulties. The implications of the challenges of programme risk management extend beyond the tools and techniques. Recent research shows that that programme management is neither an extension, nor a scaled up version of project management. Philosophically, a paradigm shift from the predominantly mechanistic and reductionist mindset to a more appropriate paradigm based on complexity science and the theory of complex adaptive systems is required. This leads to the conclusion that the classic event based view of risk is inappropriate in modelling and analysing programme risk which need to be treated as holistic and dynamic.

Keywords

Complexity, Projects, Programmes, Risk

1. Introduction

The management of risk is one of the main issues facing organisations today. As a result, the last two decades have witnessed advances in the body of knowledge and best practice recommendations from researchers, Governments, professional institutions and industry leaders. Initially the predominant focus was on project risk management. However, recent reports have emphasised the need to manage risk at the strategic level. Since programme management is increasingly viewed as the link between projects and organisational strategies, programme risk management has also come under increasing scrutiny. After the initial generic guidance on programme management, risk management at the programme level was identified as critical for programme success (CCTA, 1995). The *Managing Successful Programmes (MSP)* Guide (OGC, 2007) and the *OGC Gateway Review Process* have played a significant role in this drive to focus on programme risk management; especially in UK public sector. Despite these efforts the Engineering and Physical Sciences Research Council (EPSRC) sponsored network *Rethinking Project Management* concluded that there is a fundamental need to rethink the concepts upon which multiple management of projects are based (EPSRC, 2006, Winter et al., 2006).

The aim of this paper is to set out an alternative approach to programme risk management. The central argument for the proposed approach is that complexity science and the theory of complex adaptive systems provide a theoretical basis to enable a better understanding of programme management.

2. The Research

The findings in this paper are based on mixed methods multiple case study research on the experience of the pilot schemes and first waves of Building Schools for the Future, BSF. BSF is an immensely ambitious scheme designed

[1] Corresponding Author:
B. Aritua
Tel +44 (0)113 343 2241,
email: cenbar@leeds.ac.uk
University of Leeds, Leeds, LS2 9JT.

to rebuild or refurbish nearly all secondary schools in England over 15 years at an estimated cost of £45 billion, with local authorities participating in a series of 15 investment 'waves' (DfES, 2004). A study of reports and documents on the BSF schemes in the public domain was undertaken. This was then supplemented by semi-structured interviews with key participants and study of business cases. The interviews were digitally recorded were permissible and then transcribed and analysed using NVivo software.

3. Programme Management- A Conceptual Model

The term programme/programme management is used by authors in different contexts and even to mean different things. However the review of literature showed that a common theme was the coordination of multiple projects to gain benefits that would not be possible to obtain if the projects were managed independently. In practice, however, the manner in which multiple projects are implemented, and the resulting benefits, are extremely variable. Furthermore programmes are also closely linked to business and corporate strategies and are seen to provide the link between individual projects and overall strategies. The OGC 2007 Best Practice Guide on *Managing Successful Programmes* (OGC, 2007) definition was adopted for this research :

> *'a temporary, flexible, organisation created to co-ordinate, direct and oversee the implementation of a set of related projects and activities in order to deliver outcomes and benefits related to the organisation's strategic objectives….During a programme life cycle projects are initiated, executed, and closed. The programme provides an umbrella under which these projects can be co-ordinated. The programme integrates the projects so that it can deliver an outcome greater than the sum of its parts'*

This definition is apt since it draws attention to the key role of programme management in extracting benefits that would not have been possible if the individual projects were managed independently. The definition also makes explicit the contrast between achieving *outcomes* as contrasted with o*utputs* in project management. Furthermore the function of linking projects to strategy through programmes is clear

Programme management is extensively interactive with organisational strategic management and individual projects (Reiss, 1996). It is instrumental in adding value to the organisation during strategic change initiatives. The organisation's strategic management team has the role of identifying and articulating the need for change while projects are used as the instrument of change. The need for programme management becomes apparent when the scope of change is so extensive as to require delivery through several projects over protracted periods. Programme management therefore occupies a position between strategy formulation and delivery and should be a pivotal function in any changing or developing organisation providing full circle vision across the boundaries of strategy development and project delivery. The model in Figure 1 highlights this concept of programme management. Because the research case studies are principally public sector organisations, the model reflects a public sector programme management approach.

Essentially, the main proposition in Figure 1 is that a link should exist between Government Policy and the built infrastructure asset needed to provide some kind of public service whether this refers to education transport or health care. The built infrastructure enhances the realisation of benefits so that the policy and strategies are translated into end-user services. The gray area at the centre of Figure 1 represents the multi-project environment. Ideally, risk in the multi-project environment should be managed through a holistic programme management approach. This is the focus of the research. The process of translating policy and strategies to built infrastructure assets that deliver benefits is embodied in the business case and captured in the OGC gateways review process. Since the gateways review process is driven by risk, discussion of the business case development process inevitably leads to management of risk and stakeholders. From this perspective, programme management is seen as providing a vehicle for considering both internal and external multi-project environment (Morris and Jamieson, 2006, Pellegrinelli, 2002). Thus the conceptual model in Figure 1 shows that programme management provides strategic fit between policy and organisational strategy and the built infrastructure with concomitant benefits. In this sense programme management is a vehicle for change. The following section develops this theme of programme management as a change agent from a complexity science perspective.

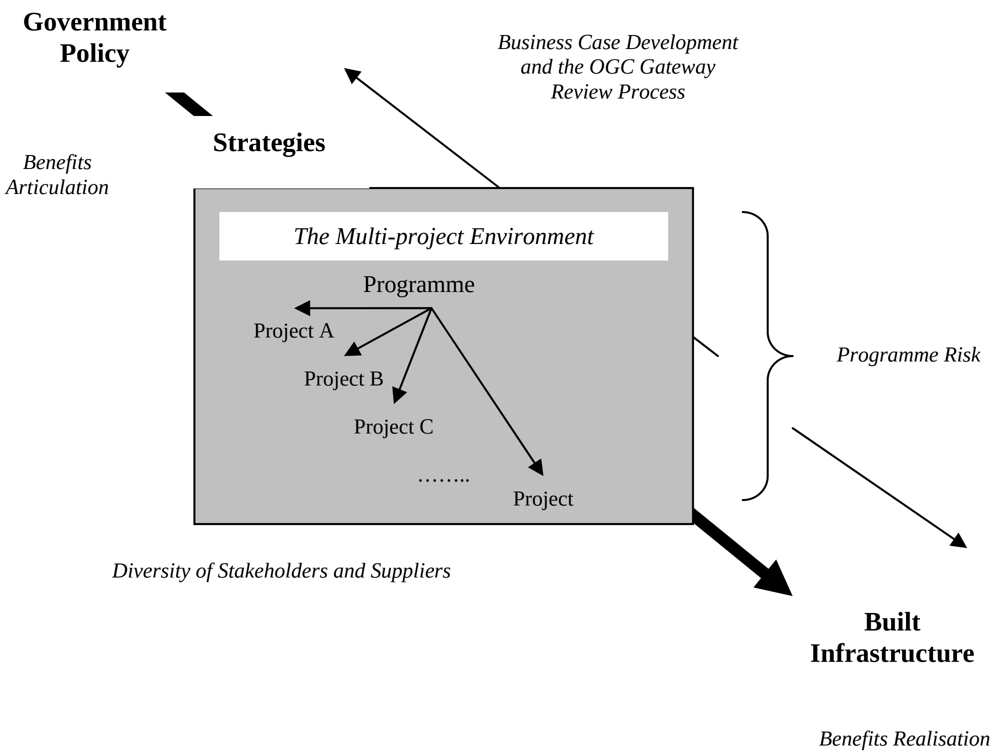

Figure 1 – A Conceptual Model of Programme Management

1. Thinking of Programmes as Complex Adaptive Environments

Chaos and Complexity theory are concerned with the behaviour of dynamic systems (systems capable of changing over time). Some systems, though they are constantly changing, do so in a completely regular manner whereas others lack stability. Unstable systems move further and further away from their starting conditions until/unless they are altered by some over-riding constraint. Stable and unstable behaviour as concepts are part of the traditional repertoire of the physical sciences. Chaotic behaviour conceptualises the behaviour in between.

As Holland explains, systems behaviour may be divided into two zones, plus the boundary between them (Holland, 1998). There is a stable zone where if it is disturbed, the system returns to its initial state; and then there is the zone of instability, where a small disturbance leads to movement away from the starting point, which in turn generates further divergence. Which type of behaviour is exhibited depends on the conditions which hold: the laws governing behaviour, the relative strengths of positive and negative feedback mechanisms. Under appropriate conditions, systems may operate at the boundary between these zones, sometimes called a *phase transition*, or the '*edge of chaos*' (Lorenz, 1993). It is here that systems in chaos exhibit bounded instability – unpredictability of specific behaviour within a predictable general structure of behaviour. Chaotic behaviour in this sense is different from its common language usage as 'a state of utter confusion and disorder'. Before the emergence of complexity theory, the unpredictability of such systems was attributed to *randomness* – a notion that bundles up all unexplained variation and treats it as best captured by probabilities. According to chaos theory apparently random results can be produced without the need for any probabilistic element at all. Gleick succinctly explains that 'chaos begins where classical science stops' (Gleick. J, 1993). Classical science suggests a mechanistic view of the world and encourages scientists to search for fixed theories using linear methods and simple 'cause and effect' approaches. In classical science non-linear systems are generally considered too unpredictable and dynamic to be effectively researched (Eve et al., 1997). Ott notes that chaos theory encourages searching for explanations and patterns that connect rather than divide, that link together and create new approaches, and encourage new ways of viewing the world (Ott, 1993). According to Waldrop chaos science is about understanding and explaining the apparent disorder that exists in non-linear dynamic systems (Waldrop, 1993). It is considered to be a subset of complexity science; for it was the discovery of chaos theory which stimulated further explorations into the behaviour of complex systems and dynamics which are the essence of complexity.

Edward Lorenz is credited with the discovery of the phenomenon of 'sensitive dependence on initial conditions' which is often termed the *butterfly effect* in which he showed that all systems are exceptionally sensitive to their initial or starting conditions and that small variations over a period of time can lead to major changes in non-linear systems (Lorenz, 1979). Lorenz also showed that complex systems as a whole may exhibit behaviour that may appear erratic and unpredictable at first glance but observation over longer periods or on a wider panorama will show patterns in an orderly whole (Lorenz, 1993). The pattern of trajectories are referred to as the *strange attractor* (also called *Lorenz or butterfly attractor* (Ruelle and Takens, 1971)). They are called '*strange*' to distinguish them from *stable attractors*; states to which the system reliably returns if disturbed. A strange attractor has the property of being *fractal* or *self-similar* – that is, its pattern repeats itself at whatever scale it is examined (Stewart, 2002).

Complexity research is new relative to classical science, wide ranging and cross disciplinary in nature (Dent, 1999, Eve et al., 1997, Lewin, 1999, Manson, 2001). As a result it is difficult to define or even to map its boundaries. Some researchers refer to the study of complex systems rather than complexity theory or science, however there is no all encompassing definition and it has been argued that by its very epistemic nature, there is no need for one (Richardson and Cilliers, 2001). McMillan explains that complexity science is concerned with the study of dynamics of complex adaptive systems which are non-linear, have self-organising attributes and emergent properties (McMillan, 2004). Johnson shows that complexity science explains a number of common phenomena. For example, complexity has improved understanding of world markets, ant colonies, traffic systems, urban planning, airline networks, seismology, and virus research; among others (Johnson, 2001). Conceiving these phenomena through a lens of complexity theory has provided a platform for new approaches, processes and techniques.

As Phelan states, whilst there are many definitions of the broad field of complexity, there are some commonalities that are core in the different concepts of complexity (Phelan, 2007). Systems that exhibit the characteristics of complexity theory are known as complex adaptive systems. In relation to this paper, the fundamental question therefore relates to whether it is reasonable to perceive programmes as complex adaptive systems. Aritua et al have shown this to be the case as programmes exhibit the characteristics of complex adaptive systems such as adaptability, self-organisation, emergent behaviour and non-linearity (Aritua et al., 2008). The implications of the above perception represent a major divergence of mindset regarding what change means. Underlying the majority of the different models of change is the basic philosophy that springs from classical Newtonian science which is mechanistic in nature. This view of change seeks to apply reductionist and linear approaches to managing change. On the other hand complexity based views treat the change process holistically and view the organisation as dynamic, self-organising and non-linear. Since self-organising systems are constantly on the edge of chaos, change is viewed as normal and is embraced. In the complexity science philosophy, complex systems are viewed as constantly changing and therefore no attempt is made to centrally control every last detail. Table 1 summarises the distinction between the mechanistic and complexity science views of change. The following section shows how the principles in this section are applied to programme risk management.

2. A Complexity Science based Framework for Modelling Programme Risks

The 2007 OGC guide *Managing Successful Programmes* makes the difference between programmes and projects clearer than other previous guides by suggesting that programmes are established to deliver change, however the mechanistic and reductionist mindset is evident from suggestions that project risks should be *escalated to programme level or higher* if the project manager can not handle them. The complexity science approach to programme management does not view programmes as advanced forms of project management. In a comparative bibliometric study of 517 program management related articles and 1164 project management articles published in the last 21 years in leading scientific business journals, Arto et al have recently provided evidence delineating the boundaries between programme and project management (Artto et al., 2008). Their work corroborates the arguments in this research and the *Rethinking Project Management* conclusions.

From Mechanistic to Dynamic: Change is……..		
Viewed through traditional classical science philosophy	⇒	Viewed through lens of complexity theory
Treated essentially as mechanistic and linear	⇒	Viewed as dynamic, self-organising and non-linear
Dealt with using reductionist methods	⇒	Treated from a holistic view point
Disruptive	⇒	Normal
Addressed by seeking uniformity	⇒	Addressed by embracing diversity
Incremental	⇒	Turbulent
An event	⇒	Continuous
Calamitous	⇒	Full of opportunities and unleashes creativity
Controllable therefore seek centralised and hierarchical strategy	⇒	Uncontrollable hence emphasis on networks and not hierarchical
Abnormal	⇒	Normal
Precise and objective	⇒	Imprecise and vague
Cause & Effect thus seek correlations	⇒	Revolutionary and incremental hence patterning

Table 1. A Different way to Perceive Change. Adapted from McMillan (McMillan, 2004)

Figure 2 outlines the key features of the proposed complexity based approach. The proposed approach begins with outlining the purpose of the programme, anticipated benefits and expected outcomes. The model in Figure 1 may be used for this purpose. The sources of programme risks can then be determined using available approaches that enable issues around context and content to be explored. The complexity approach then recommends a series of steps aimed at identifying patterns and connections between the risks (rather than dealing with 'show stoppers' only). The clustering attempts to use the concepts of the butterfly effect to deal with risks that would have wide ranging effects. Often, there is no need to go beyond the results of the qualitative analysis. And when the decision involves a choice between options, the decision tree approach may be suitable. If there is a need to undertake further modelling then consideration has to be given to the availability of information and the approach recommended here is to opt for probabilistic based modelling approaches in the first instance. If the possibility exists to obtain more detailed quantitative data to back-up the modelling then provided it adds value to the analysis, this may be warranted. Else, when past experience is available and can be expressed in subjective/linguistic terms fuzzy logic may be a better option (Ross, 2004, Ayyub and Klir, 2006). Info-gap modelling should be used as a last resort or when the decision requires a test of robustness (Ben-Haim, 2006). The aim of Risk modelling is to inform decision making. This is the argument advanced by Smith et al (Smith, 2003) and which this research concurs with. The results from the modelling should inform various facets of the decision making process. The quantification of risks should be constantly reviewed in view of available information.

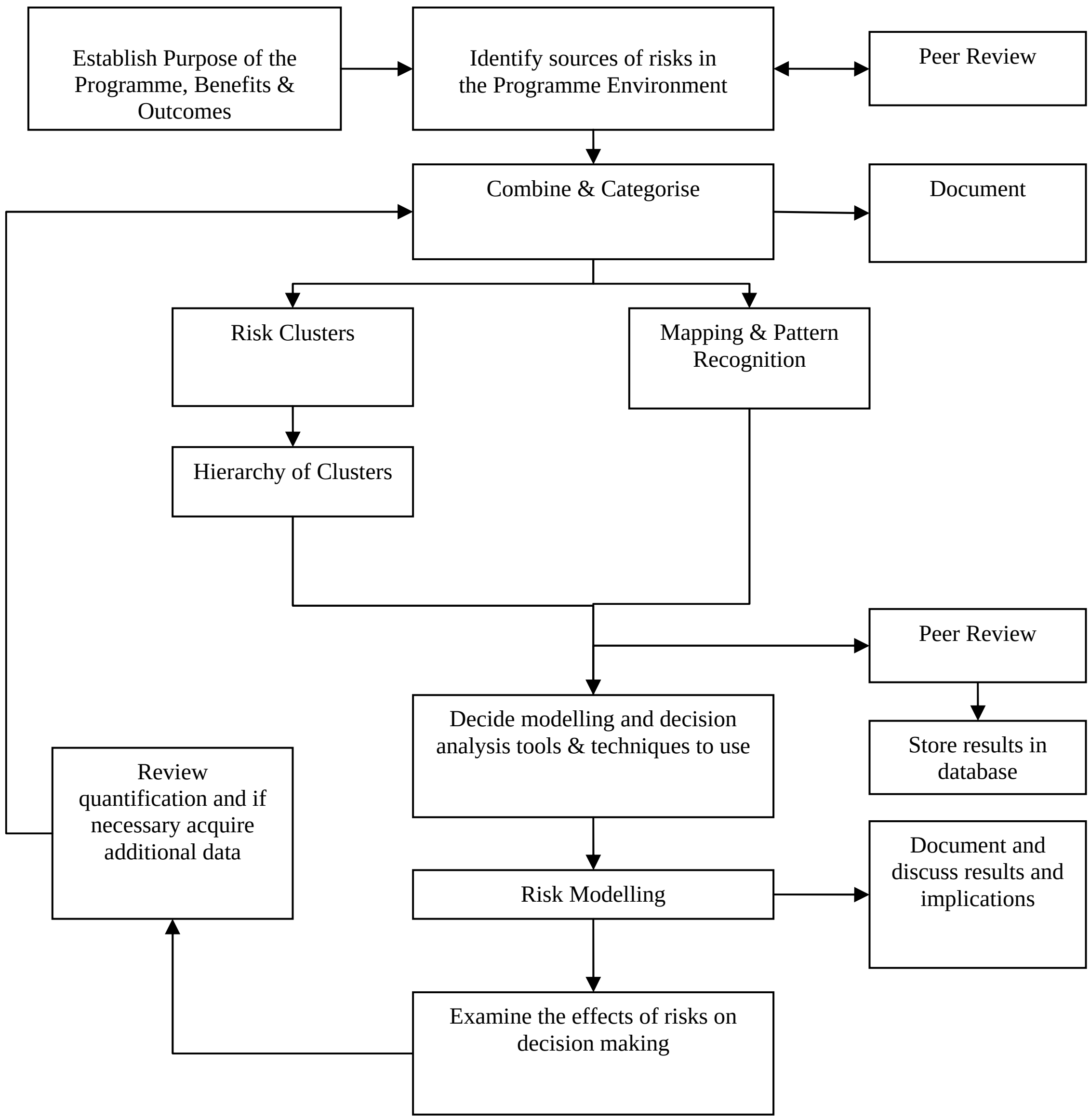

Figure 2 – A Framework for Modelling Programme Risks

Selected References:

1. Aritua, B., Smith, N. J. & Bower, D. (2008), Construction Client Multi-Projects - A Complex Adaptive Systems Perspective. *International Journal Of Project Management,* In Press, Corrected Proof.
2. Artto, K., Martinsuo, M., Gemünden, H. G. & Murtoaro, J. (2008), Foundations Of Program Management: A Bibliometric View. *International Journal Of Project Management,* In Press, Corrected Proof.
3. Ayyub, B. & Klir, G. (2006), *Uncertainty Modeling And Analysis In Engineering And The Sciences* London, Chapman & Hall/Crc Press.
4. Ben-Haim, Y. (2006) *Info-Gap Decision Theory : Decisions Under Severe Uncertainty,* Amsterdam ; London, Elsevier.
5. CCTA (1995) *Management Of Programme Risk*, HMSO.
6. Dent, E. B. (1999) Complexity Science: A Worldview Shift. *Emergence,* 1**,** 5.
7. DFES (2004) Better Buildings, Better Design, Better Education. In Department For Education And Skills (Ed.), A Report On Capital Investment In Education.
8. EPSRC (2006) Rethinking Project Management. *Epsrc Network 2004-2006.* Manchester.
9. Eve, R. A., Horsfall, S. & Lee, M. E. (1997) *Chaos, Complexity, And Sociology : Myths, Models, And Theories,* Thousand Oaks, Calif., Sage Publications.
10. Gleick. J (1993) *Chaos,* London, Abacus.
11. Holland, J. H. (1998) *Emergence : From Chaos To Order*, Oxford, Oxford University Press.
12. Johnson, S. (2001) *Emergence: The Connected Lives Of Ants, Brains, Cities And Software,* New York, Touchstone.
13. Lewin, R. (1999) *Complexity : Life At The Edge Of Chaos,* Chicago, Ill. Chichester, University Of Chicago Press ; Wiley.
14. Lorenz, E. N. (1979) Predictability: Does The Flap Of A Butterfly's Wings In Brazil Sett Off A Tornado In Texas? *Meeting Of The American Association For Advancement Of Science.* Washington.
15. Lorenz, E. N. (1993) *The Essence Of Chaos,* London, Ucl Press.
16. Manson, S. M. (2001) Simplifying Complexity: A Review Of Complexity Theory. *Geoforum,* 32**,** 405-414.
17. Mcmillan, E. M. (2004) *Complexity, Organizations And Change : An Essential Introduction,* London, Routledge.
18. Morris, P. W. G. & Jamieson, A., . (2006) Linking Corporate Strategy To Project Strategy Via Portfolio And Program Management. *International Journal Of Project Management,* 25**,** 57-65.
19. OGC (2007) *Managing Successful Programmes,* The Stationery Office.
20. Ott, E. (1993) *Chaos In Dynamical Systems,* Cambridge, Cambridge University Press.
21. Pellegrinelli, S. (2002) Shaping Context: The Role And Challenge For Programmes. *International Journal Of Project Management,* 20**,** 229-233.
22. Phelan, S. (2007) What Is Complexity Science, Really? *Forthcoming In A Special Issue Of Emergence On What Is Complexity Science?* . Dallas, University Of Texas At Dallas.
23. Reiss, G. (1996) *Programme Management Demystified : Managing Multiple Projects Successfully,* London ; New York, E & Fn Spon,.
24. Richardson, K. & Cilliers, P. (2001) What Is Complexity Science? A View From Different Directions. *Emergence,* 3**,** 5-23.
25. Ross, T. (2004) *Fuzzy Logic For Engineering Applications-2nd Edition,* London, John Wiley & Sons.
26. Ruelle, D. & Takens, F. (1971) On The Nature Of Turbulence. *Communications In Mathematical Physics,* 20**,** 167-192.
27. Smith, N. J. (2003) *Appraisal, Risk And Uncertainty,* London, Thomas Telford,.
28. Stewart, I. (2002) *Does God Play Dice? : The New Mathematics Of Chaos,* Oxford, Blackwell.
29. Waldrop, M. M. (1993) *Complexity: The Emerging Science At The Edge Of Order And Chaos,* London, Viking.
30. Winter, M., Smith, C., Morris, P. & Cicmil, S. (2006) Directions for Future Research In Project Management: The Main Findings Of A UK Government-Funded Research Network. *International Journal of Project Management,* 24**,** 638-649.