Managing Projects for Innovation: A competency perspective

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Abstract

This paper uses military technological innovation to illustrate how a competence perspective can inform efforts to improve the capacity of project oriented organisations to handle the uncertainty that characterises the innovation process. Military technological innovation is about people using institutionally conditioned networks to assemble the knowledge required to foster ideas for meeting demand for novel solutions to requirements for military capability. The more innovative these ideas the less predictable the outcome of this knowledge assembly process. Organisations on both the customer and the supplier sides of military technological innovation typically use project management concepts and arrangements to organise the people involved and to deploy their specialist knowledge. However the conventional project focus on delivering a defined output to an agreed schedule, within a defined budget and to a specified standard is ill-suited to managing the uncertainty that characterises both path-dependent and disruptive military technological innovation. In order to make best use of project-oriented management arrangements while addressing the uncertainty that characterising innovation projects, project-oriented organisations need to develop particular competencies in managing knowledge, stakeholders and governance. Incorporating innovation-related competencies in project management practice has significant implications for the project management body of knowledge.

Introduction

In this paper a project is a temporary endeavour undertaken to create a unique product, service or result.[1] Projects have become an increasingly popular management device for assembling and deploying diverse and specialised intellectual resources and expertise to solve a problem or meet a need. This paper focuses on a sub-set of projects that managers establish with the express intention of devising innovative solutions to human needs – so-called *innovation projects*. Such projects entail "the development and implementation of new ideas by people who over time engage in transactions with others within an institutional context."[2]

Managers responsible for innovation are attracted to project-oriented organisational arrangements because they can be used to organise knowledge quickly and flexibly. Managers seeking to gain the knowledge required for innovation are also attracted to project arrangements because their limited life obviates the need to make irreversible resource commitments with fixed costs.[3] The paper

[1] Project Management Institute (2013): *A Guide to The Project Management Book of Knowledge (Fifth Edition)*
[2] Van de Ven Andrew 1986: *Central Problems in the Management of Innovation* in Management Science 32 (5) page 591.
[3] Sydow, Jorg, L. Lindkvist, R. De Fillipi 2004: *Project-Based Organisations, Embeddedness and Repositories of Knowledge*, in *Organisation Studies* Vol 29, No 9 p1475.

argues that, however, for managers confronting the uncertainty and ambiguity that characterises the process of innovation the advantages of conventional project-oriented organisational arrangements are offset by some compelling disadvantages. The paper uses military technological (MILTEC) innovation to illustrate, firstly, the sources of uncertainty and ambiguity in innovation more generally and to demonstrate, secondly, the gap between conventional project management procedures and those required to bring innovation projects to successful conclusion. For the purposes of this paper, *MILTEC innovation* is about people connecting through institutionally conditioned networks to assemble the knowledge required to foster ideas for meeting demand for novel solutions to requirements for military capability.

There are several reasons for using MILTEC innovation to illustrate, firstly, the deficiencies of conventional project management procedures and arrangements in the innovation context and to suggest, secondly, how those procedures and arrangements might be adapted to meet the needs of the innovation process generally. At least in Western democracies MILTEC innovation is sponsored by public sector entities responsible for providing national defence as a public good but delivered by commercial entities seeking to make a profit. This public/private interface creates sharply defined principal/agent issues that tend to be less salient and/or less complex in project-oriented transactions between commercial entities.

Secondly, nations engaged in strategic competition have a compelling incentive to exploit advances in military technology so as to achieve a military effect more economically, more efficiently and/or more effectively. Particularly in Western democracies, this incentive fosters demand for *technologically advanced* solutions to requirements for military capability. Meeting such demand encourages MILTEC innovation, subject to the prevailing appetite for the cost, schedule and technical risk involved. Managing the trade-offs involved constitutes a test of project-oriented management arrangements.

Thirdly public sector agencies engaged in the search for, selection of, procurement of and acceptance of innovative solutions to requirements for military capability have devised a rich variety of project oriented arrangements. Both public sector agencies and commercial entities engaged in the design, development and production of innovative solutions to such requirements will adopt broadly symmetrical project management arrangements. This paper relies on analysis of project-oriented organisational arrangements made by the public sector customer for MILTEC innovation to demonstrate the deficiencies of conventional project management arrangements within acceptable word limits. In order to keep the paper to an acceptable length it stops short of analysing the broadly symmetrical project management arrangements made by commercial entities involved in MILTEC innovation.

The Organisation of the Paper

The next section of the paper summarises the essential characteristics of conventional project management arrangements, viewed from an innovation perspective. In a subsequent section the sources of the complexity and ambiguity that characterise the innovation process are analysed. This leads into a description of the competencies required of actors performing the various functions involved in innovation generally and in MILTEC innovation specifically. This is followed by a comparison of the competencies required for conventional project management and those required to manage the complexity and uncertainty inherent in MILTEC innovation. The paper concludes

with a discussion of the implications of MILTEC innovation competencies for management of non-defence innovation projects.

Conventional Project Management Logic

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet project requirements. It is conventionally depicted as a linear process, starting with project initiation and then proceeding through a sequence of planning, executing, monitoring and controlling and, finally, project closure.[4] Managing projects on this basis entails ten core knowledge areas:

- initiation (including preparing a business case and developing a project management plan);
- scoping (including identifying requirements, defining the scope of work and creating a work breakdown structure)
- scheduling (including defining and sequencing activities, estimating activity resources and time);
- budgeting (including estimating costs);
- quality management (including identifying quality requirements and planning quality assurance and control);
- human resource management (including assembling, developing and managing the project team);
- communications management (including planning the dissemination to stakeholders of information about the performance of project work);
- risk management (including the identification and analysis of risk);
- stakeholder management (including identification of stakeholders and managing engagement with stakeholders).[5]

Conventional project management prescribes a detailed governance framework - comprehending roles, responsibilities and accountabilities - for managing project work and making project decisions.[6] The success of a project is conventionally measured in terms its completion within the constraints of scope, time, cost, quality, resources and risk. These parameters are approved ex ante by senior manages of the organisation(s) sponsoring the project and are agreed ex ante with the project manager in the course of project initiation.[7] The governance of projects is critical to success in these terms.

Zwikael and Smyrk, among others, have criticised this depiction of project success for its focus on project outputs (artefacts) at the expense of project outcomes expressed in terms of the value accruing to the organisation(s) that commissioned the project in the first place.[8] To rectify this deficiency they advocate extending the conventional sequence (comprising planning, executing, monitoring and controlling and termination with the production of outputs) to include, initially,

[4] PMBOK op cit 5.
[5] Ibid, p61.
[6] Ibid, p34.
[7] Ibid, p35.
[8] Zwikael , Ofer and J. Smyrk 2011: *Project Management for the Creation of Organisational Value*, Springer, page 22.

utilisation of those outputs and, subsequently, the outcomes achieved as a result of such utilisation.[9] To this end they advocate broadening the statement of project scope to include consideration of the project objective that warranted investment in the project to begin with, a list of defined target outcomes envisaged by the sponsoring organisation and a list of committed outputs to be produced by the project manager together with a statement of the criteria by which they will be judged fit for the purpose of generating the target outcomes.

Zwikael and Smyrk have also modified the conventional depiction of project governance arrangements and identified the following key players:

- The project champion who is responsible for preparing and tabling the business case for the project and who, accordingly drives and guides the process of initiation
- The project funder who approves the commitment of resources to the project (and of whom there may be more than one);
- The project owner who acts as the project funder's agent during execution and, to this end, identifies critical outputs for close attention in the project planning phase and who manages scope and schedule change during project execution;;
- The project manager who leads the planning phase (in close consultation with the project owner) and who manages project execution with particular regard to dealing with changes in the project environment, controlling deviations from the plan and revising baseline documents.[10]

Zwikael and Smyrk refinements of conventional project logic do not, however, change the underlying presumption that a project is essentially " an island with closed boundaries that relies on prescribed formulae to manage boundary relations and change through formalised communication procedures". [11]Such communication focuses on cost, schedule and quality parameters set ex ante in the project plan and treats departures from those parameters as aberrations to be corrected. Nor do such refinements change the fundamental linearity that underpins application of such tools as GANTT charts and critical path analysis. Finally, such refinements do not question the segmentalist logic underpinning such devices as the Work Breakdown Structure.

As Keegan and Turner state: "Locked within a paradigm that emphasises efficiency over effectiveness, traditional project management needs to evolve in order to embrace the different requirements for informal, organic management of innovation projects"[12]. The next section of the paper explains why these deficiencies matter in the context of managing projects for innovation.

The complexity and uncertainty of MILTEC innovation

The root cause of the complexity and uncertainty that characterises innovation projects is *project innovativeness* - the level of novelty and originality that characterises a project and that derives from the introduction of new ideas. [13] Originality – the ability to think and act independently in

[9] Ibid, page 15
[10] Ibid, page 28.
[11] Kapsall , Maria (2011): *Systems thinking in innovation project management: A match that works* in International Journal of Project Management, Vol 29 Issue 4 page 398.
[12] Anne Keegan and J. R. Turner (2002): *The Management of Innovation in Project-Based Firms* in Long Range Planning, No 35 page 378.
[13] Kapsall, op cit page 398

order to create something new or different through a process of idea generation and communication - fosters unpredictability and self emergence. To this extent it leads to uncertainty in innovation projects. Complexity and uncertainty can also flow from the impact of project innovativeness on:

- The market (an innovation is radical for the market if it satisfies for the first time hitherto unsatisfied needs, creating major customer benefits but possibly at the price of commensurate changes in customer behaviour);
- Technology stocks and flows (an innovation is technologically radical if the knowledge embedded in its architecture, components or materials is substantially different to existing knowledge which may be rendered obsolescent);
- Organisational arrangements (an innovation is organisationally innovative if it causes changes in, for example, strategy, structure, processes, competencies, incentive syst4emsd or culture);
- The environment (an innovation is environmentally radical if it leads to, for example, the establishment of new infrastructure, regulatory changes or changes in value systems). [14]

Innovativeness, then, can be gauged in terms of the levels and types of change that can be attributed to the innovation when it is implemented. The higher the level of innovativeness that characterises a project, the greater the degree of ambiguity and the higher the uncertainty about know who, know what and know how. New knowledge is required to navigate this ambiguity and to push back this uncertainty. Generating this new knowledge requires teams both inside and outside the organisation with more diverse skills than would otherwise be the case. Those more diverse teams need to cooperate more intensively and to do so for longer periods of time. Achieving the requisite levels of cooperation requires the exploitation of social, intellectual and financial capital in flexible ways.

Such cooperation must be enabled and supported. It cannot be imposed. Gemunden at al have suggested that, in these circumstances, the project organisation will require:

- A measure of autonomy in determining how it will achieve its goals (recognising that the ultimate purpose of will be determined by those commissioning the project – see below);
- Structural and locational autonomy (enabling the project organisation to determine its own composition and operating processes, to manage its interaction with other organisations and to facilitate knowledge exchange by enabling innovators to work together in small groups so as to construct a common problem space, foster mutual trust and identify common goals;
- Resource independence (that is the project organisation has sufficient resources to complete its tasks including, for example, undertake feasibility studies, build prototypes, and experiment with alternative designs and to sustain its operations until those tasks are completed);
- Sufficient managerial autonomy to enable members of the project organisation to self organise having regard to the tasks to be undertaken and the resources available. [15]

[14] Gemunden, Hans, S. Salomo, K. Holzle (2007): *Role Models for Radical Innovations in Times of Open Innovation* in Creativity and Innovation Management Vol 16 No 4 page 410. .

Overall, devising novel solutions to human needs demands a degree of originality. But the associated unpredictability is inimical to the planning and control that characterise conventional project management and that are intended to render project processes sufficiently predicable to be managed. The next section of the paper discusses the competencies required to devise novel solutions to requirements for military capability under these conditions .

The competencies required for MILTECH innovation

In this paper *competence* is a typically idiosyncratic knowledge capital that allows its holders to perform activities – in particular solve problems – in certain ways and typically to do this more efficiently than others. Because of its skill-like character, competence has a large tacit component, and is asymmetrically distributed.[16] In order to facilitate discussion of competence in the innovation context, the paper draws on Eliasson's notion of a *competence bloc.*[17] This comprises actors with the various competencies needed to generate, identify, select, develop and exploit new business ideas successfully. Such actors comprise individuals and – more commonly – groups and teams of people who perform the roles of customer, innovator, entrepreneur, venture capitalist and industrialist.

Such a bloc works through the dynamic interaction of people or groups of people embodying the tacit competencies required to perform these functions – what Eliasson called 'dynamic functionality'.[18] Eliasson's *competence bloc* explicitly takes into account the costs inherent in generating and communicating knowledge and recognises that converting tacit knowledge into communicable knowledge is expensive and may entail prohibitive loss of content. Hence business mistakes and the failure of experiments are the practical consequence of bounded rationality and a normal cost of innovative development.[19] Finally the bloc's dynamic functionality depends on mutually supportive links among its constituent customer, innovator, entrepreneur, venture capitalist and industrialist elements.

The customer element of the competence bloc

The *informed customer* values an innovation and plays a pivotal role in the innovation process. The customer's willingness and ability to pay for that value sustains the innovation process. In effect, the more advanced and radically new the product and technologies involved, the more important the customer becomes to the innovation process:

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[15] Gemunden, Hans, S. Salomo and A. Krieger (2005): *The Influence of Project Autonomy on project success* in International Journal of Project Management Vol 23 pp 366-368.
[16] N. Foss, The emerging competence perspective in N. Foss and C. Knudsen (eds): *Towards a Competence Theory of the Firm*, London, Routledge, 1996, p. 1.
[17] Gunnar Eliasson, Competence blocs in the experimentally organized economy in Gunnar Eliasson (ed.), *The Birth, the Life and the Death of Firms: The Role of Entrepreneurship, Creative Destruction and Conservative Institutions in a Growing and Experimentally Organized Economy*, The Ratio Institute, Stockholm, 2005.
[18] Ibid., p. 56.
[19] Ibid., pp. 27-28.

> In the long term … the quality of the products will be limited from above by the quality of customers' understanding of the usefulness of the product, their willingness to pay and their contribution of user knowledge to the development of the new product/technology.[20]

In the MILTEC innovation context the customer comprises several actors with varying interests in a given innovation. In democracies those actors will include elected representatives of the nation's taxpayers who are accountable to those taxpayers for the proper use of funds appropriated for national defence (including the procurement of innovative solutions to requirements for military capability). The MILTEC innovation process is shaped by the competence with which elected representatives interpret the advice they receive from capability planners and adjudicate pressure from other interests with a stake in the outcome of the innovation process

The customer bloc will also include the capability planners who formulate requirements for military capability, who identify the need for novel solutions to those requirements and who secure political approval to act on that need. By acting on a legitimate need for a military capability the planners initiate the MILTEC innovation process. The competence with which they articulate that need shapes subsequent choices by procurers, suppliers and users. For example, MILTEC innovation will be stifled if planners frame requirements in terms of capabilities demonstrated by other militaries in other circumstances, leading to Military-off-the-shelf (MOTS) and Commercial-Off-the-Shelf (COTS) solutions. Conversely, MILTEC innovation will be stillborn if planners frame requirements beyond the capacity of innovators to solve within an acceptable time frame and at acceptable cost.

A third group of actors populating the customer element of the competence bloc are those who specialise in the search for, selection of and procurement of solutions to an endorsed requirement for military capability. The procurers influence the MILTEC innovation process decisively: the competence with which they set the parameters within which they search for a solution determines which innovators participate in the process. The competence with which procurers judge the relative economy, efficiency and effectiveness of candidate solutions influences the choice of lower risk, path dependent innovations or higher risk more disruptive but more strategically advantageous innovations. Finally, the competence with which the procurers manage the procurement process (including, for example, the sharing of cost, schedule and technical risk with suppliers, the specification of solutions and the ownership of intellectual property) determine the incentive for suppliers to move an innovation from prototype to production.

The military users of the artefacts so procured constitute a fourth group of actors in the customer element of the competence bloc. In the MILTEC innovation context, military users

[20] Gunnar Eliasson, *Advanced Public Procurement as Industrial Policy: The Aircraft Industry as Technical University*, Springer, New York, 2010, p. 43.

complete the innovation process by deciding whether or not a novel artefact is fit for purpose and by then embedding that artefact in a socio-economic system and finally by learning how to use it so as to gain military advantage. The competence with which users evaluate an artefact to establish its fitness for purpose sets the parameters for the final stage of the innovation process. The competence with which users develop a doctrine to enable them to make effective use of an artefact is a key determinant of the effectiveness with which that artefact is embedded in the military socio-economic system. Finally, the effectiveness with which the military user masters the strengths and weaknesses of the artefact in operations and the efficiency with which such learning by using is transmitted back to the supplier determines the extent to which the artefact is refined and diffused in a further iteration of the innovation process.

The innovator element of the competence bloc

In Eliasson's model*, innovators* combine old and new technologies into new, composite technologies. Innovation outcomes are driven by the way innovators combine technologies (both old and new) in novel ways or apply them to solve new problems. But the supply of novel technological combinations is a necessary but not a sufficient condition for innovation:

> Technologies have to be identified and commercialised to result in economically and socially valuable output ... and this is the phase when critical project selection by economic criteria occurs, large resources have to be mobilised and business mistakes are committed.[21]

In the MILTEC innovation context it is the innovators who identify a technological opportunity in the requirements discourse and who generate ideas for meeting a requirement for military capability. In MILTEC innovation technological opportunities are often generated by the interaction of artefact users and artefact producers and the germination of an idea to meet a capability requirement may well precede formal articulation of that requirement by capability planners.

In order to develop new technologies MILTEC innovators may need to be competent in the basic research required to identify the basic principles underpinning the idea and in the applied research required to formulate the technology concept and to undertake the analysis and conduct the experiments required to prove the concept.[22] In order to identify existing technologies that may be adapted to meet the perceived capability requirement the MILTEC innovator will need to be a competent and assiduous technology scout with a network of connections that enable him/her to identify relevant technological developments and to understand their relevance to the nascent requirement.

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[21] ibid., p. 44.

[22] US Department of Defense (2011): Technology Readiness Assessment (TRA) Guidance available at http://www.acq.osd.mil/chieftechnologist/publications/docs/TRA2011.pdf accessed 3 August 2018.

The entrepreneur element of the competence bloc

In Eliasson's model it is *entrepreneurs* who have the skill required to pick, ex ante, what innovative combination of technologies will be profitable. According to Eliasson:

> The task of the entrepreneur is to identify commercial winners among the suppliers of innovations and to get his/her technology choice onto a commercial footing. The understanding of the entrepreneur may be of a long run nature, or more temporary in the sense that they may have to reconsider their decision or make a business mistake. The main thing is that the entrepreneur acts on the perceived opportunity ...[23]

In the MILTEC innovation context both the public sector customer and the commercial industrialist elements of the competence bloc host actors performing the entrepreneurial function. In the case of the public sector customer, the capability entrepreneur will typically occupy a position (for example, in the capability planning organisation) at a node in the connections among users, innovators and planners. In the case of the commercial supplier, the entrepreneur will typically occupy a position in the marketing division of a company and be responsible for scanning the environment for opportunities relevant to that company's capabilities. The commercial entrepreneur will also know who has the complementary knowledge required to supplement the company's organic capacity to develop and produce a solution to the required capability. A key competence of both the public and commercial MILTEC entrepreneurs is the combination of knowledge of the institutional arrangements by which a requirement is formalised and the legitimacy to act through those arrangements to engineer a search for a solution to that requirement that takes into account relevant technological opportunities identified by the innovators.

The venture capitalist element of the competence bloc

Eliasson's competence bloc makes explicit provision for *venture capitalists* who not only provide early finance for start-ups but who are also industrially competent selectors of entrepreneurs. In Eliasson's usage it is the venture capitalists that understand the entrepreneurial choice and, on that basis, provide the risk capital that entrepreneurs require to commercialise the innovation they select. Subject to the quality of assessment and judgement involved, venture capitalists reduce the incidence of business mistakes. Venture capitalists are rewarded for the quality of their judgement in the form of capital gains on their equity in the entrepreneur's venture.

In the MILTEC innovation context, the venture capitalist function is often performed by capability planners with the authority to commit the public funds required to pay companies to design, develop and test early prototypes developed by the innovators. The objective is to generate the knowledge both customer and supplier need in making an informed judgement as to whether or not the prototype can be developed to meet performance targets at acceptable cost and within an acceptable time frame. While much depends on the

[23] Eliasson, Competence blocs, in Eliasson (ed) p. 60.

institutional context, the commercial suppliers may share the cost of venture capital required to develop prototypes in return for the right to use the intellectual property so generated for other commercial purposes.

The industrialist element of the competence bloc

Industrialists [R1]constitute the final element of Eliasson's competence bloc. It is *industrialists* who have the functional competence required to carry the selected design/prototype on to industrial scale production, marketing and distribution. According to Eliasson it is the existence of an industrialist willing and able to take the entrepreneur's artefact to the market that is the keystone of the structure of incentives required for the functioning of the competence bloc as a whole.

In the MILTEC innovation context it is the industrialist who often begins to work with a user to verify the prototype system's performance in an operational environment. This may be a staged process in which a prototype system or component is integrated into higher level systems and tested as part of a pilot program. The intent is to generate the knowledge required to enable both customer and supplier to commit to production at a known cost within a designated timeframe and at an agreed quality. The process of demonstrating pilot systems, incorporating those systems into commercial designs and demonstrating their readiness for full commercial deployment is characterised by asymmetric distribution of knowledge about the artefact's performance between customer (the transaction principal) and supplier (the principal's agent in that transaction).[24] Devising commercial arrangements that align the supplier's interests with those of the MILTEC customer demands particular competencies.

The next section of the paper maps these MILTEC related competencies onto the modified arrangements for project governance proposed by Zwikael and Smyrk and outlined earlier in the paper.

Reconciling MILTEC innovation competence and the governance of innovation projects

The MILTEC *project funder* is the person with the authority to commit resources to a project established to develop novel solutions to requirements for military capability. Depending on nation-specific governance arrangements, the project funder may be an elected representative with executive authority or, more commonly, an official exercising delegated funding authority on behalf of that representative. In democracies the project funder is accountable, either directly or indirectly, to the citizens' representatives for the proper use of public funds appropriated for national defence. In order to ensure that elected decision makers behave in accordance with citizens' expectations, their power is constrained to specific responsibilities by the nation's constitution, laws and conventions. Decision making

[24] See, for example, Ceric, Anita 2012: *Communication Risk in construction projects: Application of principal-agent theor*y in the International Journal of Organisation, Technology and Management in Construction, Vol 4 no 2 page 524.

by MILTECH project funders and their delegates must be demonstrably consistent with due processes that have been agreed over time and that are generally understood and widely accepted by the citizens.

Such transparency "provides citizens with the means to check and validate the actions of decision makers and their supporting public sector administrators. It also provides the legal and political means to hold public officials accountable for breaches of responsibility or of process…It is the level of transparency and accountability that is provided by a democratic state's system of governance that allows its citizens to presume that the state works in their collective interest and that, should some failure of government occur, the mechanisms for public scrutiny are capable of review and redress in the public interest. It is this assurance, tested by defaults over time, that creates trust in the system and the confidence of the state's citizens to function within it." [25]

Democratic governance arrangements , then, have profound implications for the competencies expected of project funders. These competencies include an ability to articulate a convincing public rationale for spending taxpayers' dollars on novel solutions to requirements for military capability. They also include an ability to demonstrate that such expenditures comply with established institutional arrangements. For present purposes the essential point is that project funders accountable for MILTEC innovation in democracies require institutional competencies that are not recognised in conventional project management arrangements. Failure to adapt MILTEC project governance to accommodate democratic institutions will render the project funder and his/her advisers vulnerable to criticism, encourage risk averse behaviour and thereby undermine the functional dynamics of the competence bloc.

The *project champion* initiates MILTEC innovation projects by sponsoring the requisite business case. In gaining support for the business case, however, the MILTEC innovation project champion needs more than the standard attributes of enthusiasm and confidence, persistence, and the capacity to bring the right people together. Gemunden et al have analysed the barriers project champions help overcome, the type of power underpinning their influence and the nature of the value creating functions they perform. This analysis highlights the need for MILTEC project champions to have the following competencies:

- the specific technical knowledge required to understand the innovation process, to articulate the issues in accordance with the dominant professional paradigm and to address barriers based on technical ignorance;
- the hierarchical power and legitimacy required to drive the project in the face of resistance by vested interests and to secure the necessary resources in the face of competition from other priorities;

[25] Michael, Ewen J, 2006: *Public Policy: The Competitive Framework*, Oxford University Press, page 223.

- the organisational know how and intra-organisational networks required to connect supporters with power to supporters with expertise in order to overcome internal bureaucratic and internal administrative barriers;
- strong personal ties not only inside but especially outside the organisation (to customers, suppliers and research partners) and the ability to leverage this external, inter-organisational network to gain the support of external actors.[26]

The MILTEC innovation *project owner* is likely to be placed in a permanent organisation (and will often be a former project champion). In the early stages of MILTEC innovation (up to, say, the development of prototypes), the project owner may be located in the capability planning element of the customer group. From this location the project owner is well placed to represent the project funder's interests in judging the merits of the fledgling innovation as it progresses through the various levels of technological maturity up to prototype stage. The competencies required of the project owner for effective representation of the project funder's interest will hinge on his/her ability to judge the likelihood that the nascent innovation will satisfy the project funder's intent in an acceptable time frame and at an acceptable cost.

Once a MILTEC prototype has been verified in an operational environment, however, the competencies required of the project owner are likely to change. For example, the project owner may be expected to secure the risk capital required to produce the innovation, to engage with potential users and to manage the principal agent issues inherent in pilot production and in pre-commercial demonstration. Effective representation of the project funder's interests in this changed environment may warrant transferring responsibility for project ownership to the capability procurers. In these circumstances the project owner's competencies will hinge on his/her ability to manage the project's external environment including engaging the future user and demonstrating to citizens and their representatives that emergent innovation represents acceptable value for money.

By contrast, the *project manager* is likely to be much more focussed on managing the intra-project environment in the MILTEC innovation context. During the early stages of the MILTEC innovation process, the project manager and his/her project team is likely to be heavily preoccupied with the design and development activities that characterise the innovator function. As the technology matures, the project manager's role is likely to place greater emphasis on entrepreneurial activity (including recognising the need for and making the case for funds and other resources required to progress the project. As the project moves into the post-prototype stages the project manager and his/her project team is likely to be the prime point of contact with the industrialist responsible for bringing the innovation into full commercial production.

[26] Gemunden, Hans Georg, S. Salomo and K. Holzle (2007*): Role Models for Radical Innovations in Times of Open Innovation* in Creativity and Innovation Management Vol 16 no 4 page…

Performance of the innovator and entrepreneur functions in the MILTEC innovation context places particular demands on the competencies of the project team and the skills of the project manager. In essence, the MILTEC innovation project team is generating the technological and other knowledge that the project owner needs to ensure that development by the project team of a novel solution to a capability requirement is proceeding in accordance with the project funder's intent. The project manager and his/her team obviously need to convince the project owner that public monies for which the funder is accountable are being expended in a proper manner. The uncertainties inherent in the innovation process will often create a more demanding challenge for the project manager and his/her team to demonstrate that technological and other uncertainties are being progressively reduced over time[27], that artefact development is proceeding at acceptable cost and within an acceptable time frame and that performance targets are reasonably likely to be attainable.

Gauging the appropriate balance of economy. efficiency and effectiveness in investing in the early developmental stages of MILTEC innovation poses special challenges for the project team/project manager. The uncertainties that characterise the innovation process are inimical to the traditional evaluation of investment flows based on forecasting cash flows, calculating the net present value (NPV) of those flows and making an irrevocable commitment to proceed (or otherwise) with the investment on the basis of those ex ante calculations. In the MILTEC innovation context, the project owner and the project manager may be able to limit the downside risk of loss of investing in R&D and to enhance the prospect of securing upside benefit of such investments by proactively choosing to defer, expand, contract or abandon a developmental project. This so called real options approach to investment is gaining acceptance in industries characterised by high volatility and uncertainty and in which flexible decision making is highly valued.[28] For present purposes the essential point is that in the MILTEC innovation context, where project owners and project managers face high uncertainty and large costs if they get irreversible investments wrong, their ability to formulate, administer and retain project funder support for flexible, extensive and scalable investments in research and development is a core competency.

Conclusion

This paper discusses the competencies required for efficient and effective management of MILTEC innovation projects from a knowledge management perspective. The paper demonstrates, however, that knowledge management for innovation requires skills, procedures and aptitudes s that diverge markedly from those required to manage the ten core knowledge areas that underpin the conventional approach to planning, executing, monitoring and controlling and finishing of projects. The paper demonstrates that, if managers of innovation are to gain the potential benefits

[27] Winch, Graham D. 2004: *Rethinking project management – project organisations as information processing systems?* Paper presented at PMI Research Conference,11-14 July 2004, London, UK

[28] Yeo K.Y. and F, Qiu 2002: *The value of management flexibility—a real option approach to investment evaluation* in International Journal of Project Management (21) pp246-248.

of project oriented management arrangements, they will need more than exhortations to be mindful of personal attributes of project managers such as, for example,' be results oriented', 'have a head for details', 'be politically savvy', 'be capable of dealing with ambiguity, set-backs and disappointments'.[29] That said, the paper shows how the competencies required for managing innovation projects complement and extend the generic skills that Kerzner has identified as required of conventional project managers - for example, team building, leadership, conflict resolution, technical expertise , planning and so on.[30]

In sum, a focus on competence in knowledge management for innovation projects highlights the need for more nuanced treatment of, for example, stakeholder management and project governance in the conventional project management literature. In this context the paper also corroborates the shift in emphasis in more recent scholarship away from the quantitative aspects of planning and towards recognition of the importance of qualitative behaviours and skills in project management success.[31] Finally, use of a rich domain of innovation project practice (in the current instance military technological innovation) to test generic project management precepts suggests that efforts to develop a single all-encompassing body of project management knowledge may be reaching the point of diminishing marginal returns.

29 Frame, J. D. (1999): *Building Project Management Competence*, cited by Springer, Mitchell L (2013) in *Project and Program Management – A Competency-based Approach* (second edition), page 5. .

30 Kerzner, H. (2009): *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (Tenth Edition), page 148.

31 Springer, Mitchell L. (2013): *Project and Program Management – A Competency-based Approach* (Second Edition), pp7-10.

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