INNOVATION AND THE DYNAMICS OF CAPABILITY ACCUMULATION IN PROJECT-BASED ORGANISATIONS

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Project-based firms face particular difficulties in managing innovation. This paper builds on the literature on concepts of project-based organisations to develop an approach to innovation management linking work acquisition, execution and learning. The conceptual framework is expressed in diagrammatic form, providing a succinct representation of the complex relationships and a starting point for analysis of the opportunities and challenges facing the management of project-based organisations, including those impeding success, in particular the role of time pressures. The analysis helps to elucidate findings from prior in-depth studies of a large number of engineering and design firms. The paper also provides pointers for future research.

Keywords: Capabilities, innovation, project-based firms, modelling, system dynamics

1. Introduction

This paper examines the relationship between project acquisition practices and innovation in project-based service organisations. Analysing project acquisition and innovation alongside project execution exposes key issues for commercial success in project-based firms. While the acquisition of work is an essential condition for survival in the short term, innovation and the development of new capabilities are preconditions for the exploitation of new markets and the adaptation to a shifting environment. Work acquisition and innovation are closely linked within project organisations. Not only does innovation enable the acquisition of new, complex and demanding work; the acquisition of work in turn, influences the potential path of learning and innovation. Learning occurs predominantly in the context of project execution. Project acquisition strategies are therefore a key lever for decision makers in project-based organisations trying to shape learning and innovation. The paper highlights the way in which current practices and strategies for acquiring work relate to the development of innovative capabilities in project-based firms. In this particular attention is paid to the influence of time availability in the execution process on capability accumulation and innovation.

The contributions of Edith Penrose (1959) and the many subsequent scholars employing related approaches have supported the central role that resources play in the performance of the firm. The resource-based approach investigates resources as the source of competitive advantage (Wernerfelt, 1984; Rumelt, 1984; Barney, 1986; Diericks and Cool, 1989; Montgomery and Wernerfelt, 1988; Peteraf, 1993; Mahoney and Pandian, 1992). The competence literature focuses on the ability to manage, maintain, renew and deploy resources (Prahalad and Hamel, 1990). The "dynamic capabilities" literature stresses the crucial importance of the high-level capability to develop resources (Teece *et al.*, 1997). Resources are not static; but change over time. The dynamic resource based view of strategy (Warren, 2002) stresses the accumulation of resources over time as well as the impact of these dynamics on performance. This paper builds on insights provided by the literature in focusing on the resources of the project-based organisation. Our analysis is based on examination of the causal links between resources, their accumulation, depletion rates, and different work acquisition and innovation strategies.

Project-based firms often innovate in collaboration with other organisations; clients, suppliers or project partners, rather than in isolation. Their activities draw on knowledge from sources such as universities which are not directly involved in the projects they carry out. A complex web of relationships underlies innovative processes, as the 5th generation of innovation models recognises (Rothwell, 1992). For the purpose of this paper we have chosen to focus on specific issues of innovation in the project-based firm itself – the resources and capabilities, work acquisition and innovation strategies of the firm. Setting the boundary of the study does not imply that relationships beyond this definition are unimportant for innovation in project enterprises. We restrict ourselves to studying the resources of the firm and factors under its control, because we contend that – at least in first approximation – the firm environment beyond the system boundary is not changed by the choices made within the firm, and its effect on the firm and subsequent performance is therefore not changed by the firm. In short, this means that, for example, the firm will through its

activities not add significantly to the stock of knowledge available from external sources. This approach allows us to identify the processes and mechanisms linking work acquisition and innovation and the management levers available to the firm. It will be amongst tasks left for future study to refine these findings by putting more emphasis on changes in the firm environment.

Project-based firms operate in many sectors of the economy: from advertising and the creative industry, to IT, engineering and construction. In all these sectors, the characteristics of project-based firms and the environment within which they operate make it difficult for decision-makers to see the consequences of their project acquisition activities in regards to their potential to build innovative capabilities. These issues are significant because of the contribution of project-based firms to the economy, and because of the desirability of improving performance of these businesses through systematic learning and innovation processes. Research into innovation in project-based firms and new insights into the levers available to managers in such organisations, have therefore the potential to help these organisations and the wider economy and society to benefit from innovations originating within project-based firms.

Since innovation in project-based firms occurs regularly in the context of project execution and more infrequently within dedicated R&D efforts, the nature of innovative activities in these organisations is episodic (Gann and Salter, 2000) and therefore more difficult to plan. Learning is crucially influenced by the learning opportunities in projects, determined both by the nature of the work, and the resources available within project execution for innovative problem solving. The organisational context of project-based organisations presents a challenge for carrying out innovation (Gann and Salter, 2000). The particular characteristics of the markets within which some project-based organisations operate, such as the construction industry, can also act as barriers to innovation (Nam and Tatum, 1997).

Capabilities are accumulated on the project level and specific efforts are required to counter their dissipation at the completion of a project to ensure the transfer of knowledge to other projects and to the organisation. A key feature (and key challenge) in these organisations is therefore to overcome the limitation of a learning process which is essentially discontinuous (Brady and Davies, 2004). Time-constraints and the lack of slack in project-based firm severely constrain the effort than can be invested in learning activities and innovation. The speed and focus of projects can; nevertheless, lead to targeted learning, although, the contribution of this accumulated knowledge at the project level to the strategic requirements of the wider organisation and its performance over time remains uncertain. Project-level knowledge must be captured and made accessible in order to be available across the organisation. The loss of valuable knowledge and obsolescence can threaten the organisational knowledge base, particularly in complex and rapidly evolving knowledge areas. The literature on knowledge management has considered some of these issues and recommended strategies and techniques for tackling them. However, time pressures as well as the relative autonomy at the project level in many organisations in project execution often act as a disincentive to the transfer of this knowledge to the organisational core. There is a challenge in linking learning within project processes to learning in core business processes in project-based firms. Nam and Tatum (1997) have identified slack as a prerequisite for innovation in construction companies. Clearly, slack can also be

costly and wasteful. Moreover, there are also concerns that excess slack might even have negative consequences for innovation itself. In manufacturing an inverse U-relationship between slack and innovation has been found which has been understood as the result of two counterbalancing effects: while lack of slack prevents experimentation, too much slack can result in unfocused and undisciplined experimentation not resulting in positive innovative outcomes. (Nohria and Gulati, 1996).

The paper builds upon results from an EPSRC research project in which a systems dynamic model was developed, and used, in a project-based firm to assist the management of bidding processes in order to improve the selection and delivery of innovative projects. Previously, one of the authors had conducted intensive research with a large number of project-based organisations in a variety of sectors (including IT, engineering, construction, architecture), focusing in particular on innovation in those organisations. Research as well as long-term consultancy relationships with companies of different sizes (from SMEs to large multinationals) allowed identifying generic challenges facing project organisations at different levels within these organisations (from project team level to board level). Through workshops, interviews and the observation of work practices this research resulted in a detailed understanding of how professionals in these organisations undertake work, how they are managed, and how learning from and across projects is possible. In this fieldwork it became clear that many different project-based organisations encounter particular difficulties in planning and sustaining systematic learning and capability development over time within the vagaries of the project environment where varying projects are the focus of learning and time constraints are often severe. The relationships and interdependencies between activities on the project and at the business level of the organisation presented particular challenges for innovation in a diverse set of project-based organisations.

This paper aims to clarify the relationships between strategies for acquiring new orders, the type of work delivered, and the capability of project-based firms to innovate by drawing together existing knowledge in a systematic fashion. The paper is divided into six sections. This introductory section is followed by section two, describing the approach taken in this work. The third section draws together lessons from previous research to systematise them in diagrammatic form. Section four presents an analysis of the factors influencing capability accumulation and the feedback loops linking different elements of the project-based organisation concentrating in particular on the role of time pressures. In section five, we discuss the findings and use the conceptual insights gained through this process to view the experience of project based-firms and their challenges in developing innovative capabilities in a new light. Section six presents our conclusions, discusses the limitations of this paper and raises new questions for research and practice.

2. Approach

In this paper we draw together a conceptual framework of the relationship between work acquisition and the development of innovative capabilities based on theories captured in the growing literature of project-based organisations. Building on the

theoretical conceptualisations on aspects of the problem found in the literature we develop a more comprehensive picture of the relationships. We synthesize the existing literature in diagrammatic form. This approach allows us to build incrementally a coherent and consistent expression of a theory. In expressing a theory in causal loop form we follow an increasing number of scholarly contributions in organisational and management studies (Hall, 1976; Sastry, 1997; Repenning, 2002). Our approach therefore develops a new conceptualisation (expressed in causal-loop form) based on a study of existing theories, in doing so, we follow the approach used by Sastry (1997) as well as Rudolph and Repenning (2002), who characterise this as a special case of grounded theory building – based not on primary empirical research, but on learning from previous theoretical conceptualisations.

The use of causal-loop diagrams and other tools from System Dynamics (Sterman, 2000) facilitates the analysis of the feedback loops in the system in which project-based firms operate. This is a powerful way for examining the resistance of the system against a desired change (e.g. the development of capabilities to move into a new market) or to understand the reasons why managerial actions do not have the desired consequences. This approach gives also the opportunity to draw on findings and methods of system dynamics work in related areas such as project management (Cooper, 1980; Lyneis, 2001), innovative organisations (Saeed, 1998), innovation and diffusion (Milling, 2002), work acquisition and workload fluctuations (Bayer *et al.*, 2005)

In the diagrams presented below variables correspond to real-world phenomena, which can be operationalised and are at least, in principle, measurable, even if this may be more difficult for those corresponding to intangible concepts (such as reputation or capabilities). We follow the standard conventions used in causal-loop diagrams and in system dynamics (Sterman, 2000) more widely and denote causal connections with arrows. The variable at the origin of the arrow influences (possible in conjunction with others) the variable at the head of the arrow, the + (or –) sign denotes that – all else remaining equal – a small increase in the value of the variable at the origin will result in an increase (or decrease) of the variable at the head compared to the value it otherwise would have. In addition to these causal links normally found in causal loop diagrams, we also distinguish state (stock, level) variables from auxiliary and flow (rate) variables. State variables are marked with a box around the variable name. This distinction is useful in the further analysis of relationships since the resources of an organisation are state variables which accumulate over time, and can therefore only indirectly be changed by changing the associated flow variables.

3. Work acquisition, work execution and innovation in project-based firms

In this section a conceptualisation of the project-based organisation is further developed. This will form the basis of our analysis of the relationship between work acquisition, work execution and innovation. We begin by identifying key resources and capabilities, and then map out the effects of these resources and the factors which influence resource accumulation. Necessarily this will require a certain degree of simplification. We look at three areas in turn: work acquisition, work execution and

finally, at innovation and capability building as the particular interest of this paper. By doing this we are able to construct a map of the key relationships influencing performance and behaviour of the project-based firm (see appendix).

3.1 Resources and capabilities

Competitive advantage derives from the capabilities of an organisation. Resources (productive assets of the firm) working together create capabilities (what a firm can do). (Grant, 2005, p.139) Following Warren (2002) we define asset stocks as including both tangible and intangible resources and capabilities. In this paper asset stocks are understood as comprising assets (both tangible and intangible), and capabilities (loosely understood as the skills of the organisation).[1] The key assets for the project-based professional services firm are considered to be its staff, knowledge, financial resources and its reputation. In order to offer new products and services, different types of capabilities have to be accumulated. These include functional and organisational capabilities in addition to specific project capabilities such as effective bid and project management (Davies and Hobday, 2005). Capabilities are partly embodied in the staff of the organisation. Reputation gained through successful project outcomes is an important resource which is not only important for winning new work, but also for attracting highly skilled staff. Other types of project-based organisations may also depend crucially on further types of resources such as: machinery and equipment in the case of a construction firm, or a land bank in the case of a housing developer. The present paper does not include these as we want to concentrate on the simplest form, where the issues about capability development and innovation are most prominent.

ASSET STOCKS		
Resources		**Capabilities**
Tangible	***Intangible***	**functional, organisational and project capabilities**
staff, financial resources, project backlog	reputation, knowledge	

Divisions within a project-based firm, between projects, and projects and the central organisation can be pronounced (Gann and Salter, 2000). The resources in project-based firms are often not controlled centrally. Decision-making structures in project-based professional service organisations often leave considerable discretion to project managers and baron-like group leaders, restricting central control (Gann and Salter, 2003). Hobday (2000) identifies the coordination of processes, resources and capabilities across the organisation as an inherent weakness in a project-based organisation. Knowledge can be held by individuals or groups of staff and might be explicit and tacit. These characteristics will influence the permanence and accessibility of the knowledge base (Davies and Hobday, 2005).

[1] The usage of the central terms capabilities, competences, resources, and assets in this literature is unfortunately not unified – it resembles a "terminological soup" (Foss, 1996). Our use of the terminology is not intended to capture all the features of the discussion in the strategy literature, particularly the distinctive characteristics of the higher-level capabilities/competences (i.e. the "core competence" of the competence or the "dynamic capability" of the dynamic capabilities approach).

Resources and capabilities accumulate and deplete over time. The asset stock at present is the sum of all the inflows minus all the outflows in the past (starting from its initial value). In the diagrams resources are shown as boxed variables.

3.2 Work acquisition and workload

Project based firms rely crucially on winning new projects and devote substantial resources to achieving this. In the case of services delivered in the form of projects this is particularly challenging due to the variable demand for these services, and the potentially low probability of bidding success (Gann and Salter, 2000) combined with the non-storable nature of a service. In addition to market demand, reputation gained from previous projects is an important factor in bid success for project-based firms, since projects – differently from the output of manufacturing firms – can not be inspected before purchase. Reputation is not safe; it erodes over time or can be lost through high profile failures (Gann and Salter, 2000). If contracts are won they add to the stock of projects to be started and eventually to workload. As tasks are accomplished, workload reduces; workload is therefore also a stock variable (and marked with a box in the diagrams). Managing workload is important. The lessons Wheelwright and Clark (2000) drew for new product development are also relevant for project-based firms: the mix and volume of projects has to be controlled as overload results in insufficient attention to be given to individual projects, prevents making use of unexpected opportunities and, importantly, impacts on capability development.

Cause	**Effect**	**Polarity**	**Meaning (all else being equal!)**	**References**
changes	workload	+	Changes of project specifications by clients increase workload.	Cooper, 1980; Lyneis *et al.,* 2001
complexity of new projects	complexity of projects	+	If the complexity of new projects increases, so will the complexity of the portfolio.	logical relationship
desired complexity of new projects	complexity of new projects	+	The company can (depending on opportunities) determine the complexity of new projects.	Hobday, 1998; Davies and Hobday, 2005
excellence of completed project	reputation	+	Excellence of completed project results in improved reputation.	very plausible relationship
loss of reputation	reputation	-	Reputation is gradually lost over time because past achievements are forgotten or considered irrelevant.	Gann and Salter, 2000
project completion	reputation	+	Completed projects increase reputation.	very plausible relationship

rate				
reputation	attractiveness to highly skilled employees	+	Highly qualified experts prefer to work for companies with a good reputation.	very plausible relationship
reputation	complexity of new projects	+	A good reputation allows the company to acquire more complex work.	very plausible relationship
reputation	work acquisition	+	Reputation increases the amount of work than can be acquired.	very plausible relationship
resource allocation on project level	time allocation to acquisition	+	The more resources are allocated away from the central level of the organisation the more can be spent on work acquisition by project teams (keeping "share of project level time allocated to acquisition" constant).	logical relationship; see also Hobday, 2000; Sapsed, 2005
share of project level time allocated to acquisition	time allocation to acquisition	+	A higher share of time allocated to acquisition implies that more time is available for acquisition.	logical relationship
time allocation to acquisition	work acquisition	+	The more time is allocated to acquisition the more work will be acquired	very plausible relationship
work acquisition	workload	+	The acquisition of new work results in an increase in workload.	logical relationship

3.3 Project execution

Capabilities enable project execution; a higher level of capabilities will result in more rapid and more successful project completion. Project execution however is not a mechanical or entirely predictable process. Projects are often very difficult to standardize; due to a variety of internal and external factors, projects frequently run behind schedule. A sense of crisis and "fire-fighting" is a frequent occurrence in projects and often part of the culture of project-based organisations. The activities of project staff – frequently in the form of individual heroics – to deal with such crises, however can have the unintended consequence of exacerbating the problem. The vicious work time cycle (caused by crises and constant interruptions) identified by Perlow (1999) and the under-use of beneficial project management and process innovations due to the initial time investment required (Repenning, 2002) are

examples of situations where the actions to deal with time pressures decrease productivity within the organisation. Furthermore, project modelling studies from a system dynamics perspective (Cooper, 1980; Lyneis, *et al.,* 2001) have shown how time pressures lead to quality problems in execution and increased rework. Under-resourced projects result in excess rework and project overruns; the strategies to acquire new work can, exacerbated by this mechanism, result in workload fluctuations with further consequences for resource availability (Bayer, *et al.*, 2005). 'No project is an island': projects are history dependent and organisationally embedded open systems whose performance is influenced by their relationship to competing activities and the norms and routines of the organisation (Engwall, 2003). Projects compete for resources – overruns in time and excess resource consumption will impact other projects carried out in the organisation – constraining also the resources for innovative problem solving in other projects, and the amount of time available for less pressing (but important) activities such as those related to knowledge management.

Cause	Effect	Polarity	Meaning (all else being equal!)	Basis
complexity of projects	financial resources	+	More complex projects will attract higher fees.	very plausible relationship
complexity of projects	project completion rate	-	The complexity of projects will slow down project completion.	very plausible relationship
innovative problem solving	excellence of completed project	+	Innovative problems solving within projects results leads to better project outcomes.	very plausible relationship
project completion rate	financial resources	+	The completion of projects results in income and adds to the financial resources of the organisation.	very plausible relationship
project completion rate	workload	-	As projects get completed the workload drops.	logical relationship
quality of project execution	excellence of completed project	+	The better the quality of project execution the better is the project outcome.	very plausible relationship
quality of project execution	project completion rate	+	A higher quality of project execution results in a higher project completion rate (due to a reduction of rework).	Cooper, 1980; Lyneis *et al.,* 2001
resource allocation on project level	time allocation to execution	+	The more resources are allocated away from the central level of the organisation the more can be spent on project execution.	logical relationship
share of project level time allocated to acquisition	time allocation to execution	-	A higher share of time allocated to acquisition reduces the time available for execution.	logical relationship
time allocation to acquisition	time allocation to execution	-	The share of time allocated to acquisition activities reduces the time available for project execution.	logical relationship
time allocation to execution	project completion rate	+	The more time is allocated to execution, the faster the work will be accomplished.	very plausible relationship
time pressure	quality of project	-	The quality of project execution will suffer if	Perlow, 1999; Cooper, 1980;

	execution		time pressures increase	Lyneis *et al.,* 2001
workload	time pressure	+	An increase of the workload results in higher time pressures.	very plausible relationship

3.4 Innovation and capability building

Innovative problem solving in project-based organisations occurs mainly in the context of actual client projects and only rarely in dedicated research projects (Gann and Salter, 2003). Therefore exploration occurs often in the context of project execution, and not separately from exploitation. Research by practitioners in the context of project execution is typically important in project-based firms. (Groak and Krimgold, 1989) Opportunities for systematic problem solving are very limited. Time pressure has been identified as the main factor in limiting innovative activities within project-based firms, with cost and the number of projects undertaken as further barriers to innovation (Gann and Salter, 2000). The latter barrier could be explained both by its indirect effect on the time available for innovation, and by the distracting impact of the diversity of projects. Time is also required to transform experience into explicit knowledge (Schön, 1983). Innovation can be impeded by limitations in technical knowledge (Gann and Salter, 2000). The ability to build new capabilities is based on prior knowledge and experience (Penrose, 1959).

As with manufacturing, capabilities are accumulated as an organisation gains experience. However, this experiential learning curve is supplemented by capability accumulation influenced by the 'type' of projects. More complex projects present learning opportunities which are not found in standard projects (Rockart, 2003). Due to the limited role of dedicated learning activities (i.e. not in a project context), the accumulation of capabilities for more complex problem solving; or for problem solving in new areas, depends crucially on learning opportunities in client projects. Processes for translating what has been learned initially in a specific project into a repeatable solution (in order to reap economies of repetition and recombination) become therefore important. (Davies and Brady, 2000)

While individual projects draw on central resources in project execution, the building of central resources will need to draw on the knowledge accumulated on the project level (Gann and Salter, 2000). Project-based firms strive to ensure that the knowledge gained in a project becomes available to subsequent projects and the organisation more widely. Project-based firms frequently implement knowledge management systems in order to ensure that the knowledge gained within a project becomes available to subsequent projects. (Brady et al 2002) However, achieving this is not always straight forward and the learning success achieved with some types of knowledge management systems remains often quite limited (Gann and Salter, 2000). Ensuring that learning occurs from projects can be fraught with difficulties (Middleton, 1967, DeFillippi, 2001). The decentralised organisational structure of a project-based firm can provide a disincentive for knowledge capture. Putting effort into capturing knowledge and making it available to others in the organisation might not be seen as a worthwhile activity for time-constrained project teams.

Cause	Effect	Polarity	Meaning (all else being equal!)	Basis
attractiveness to highly skilled employees	skill of new employees	+	The skill level of new recruits will be higher if the company is attractive to highly skilled employees.	logical relationship
capabilities	innovative problem solving	+	Already available capabilities support innovative problem solving in the organisation.	Teece, Pisano, Shuen, 1997; Patel and Pavitt, 1997
capabilities	project completion rate	+	Higher capabilities increase the speed with which work can be accomplished and projects can be completed.	very plausible relationship
central control	knowledge capture	+	A higher degree of central control ensures that procedures to capture knowledge from project and make this knowledge available across the company are adhered to.	Middleton, 1967; DeFillippi, 2001
central resource allocation	learning from central research	+	Allocation of resources to the centre allows carrying out dedicated central R&D activities enabling learning.	very plausible relationship
complexity of projects	learning opportunities in complex projects	+	Complex projects provide more opportunities to develop advanced capabilities.	Rockart, 2003
financial resources	central resource allocation	+	Higher financial resources allow more spending by the centre.	logical relationship
financial resources	resource allocation on project level	+	Higher financial resources allow more spending on the project level.	logical relationship
innovative problem solving	capabilities	+	Innovative problems solving within projects results in capability accumulation.	Gann and Salter, 2000
knowledge capture	loss of skills	-	Knowledge capture activities (e.g. through better and more easily	Brady *et al.,* 2002

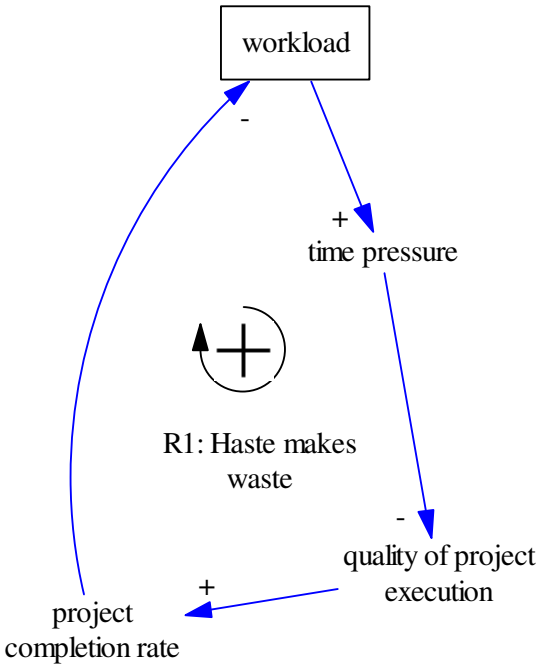
			accessible documentation) increase retention of knowledge in the organisation.	
learning by doing	capabilities	+	Learning by doing adds to capabilities.	Groak and Krimgold, 1989
learning from central research	capabilities	+	Learning from central research increases capabilities.	very plausible relationship
learning opportunities in complex projects	capabilities	+	Learning in complex projects increases capabilities.	Gann and Salter, 2003
loss of skills	capabilities	-	Capabilities are lost due to forgetting, staff attrition etc.	Nelson and Winter, 1982
obsolescence	capabilities	-	The level of (useful) capabilities reduces as capabilities become obsolete.	logical relationship
share of resources allocated to centre	central resource allocation	+	The higher the share of resources allocated to the centre, the more money will be available to the centre.	logical relationship
share of project level time allocated to acquisition	time allocation to execution	-	A higher share of time allocated to acquisition reduces the time available for execution.	logical relationship
skill of new employees	capabilities	+	Higher the skills of new hires add to an increased capability level.	logical relationship
time pressure	innovative problem solving	-	Time pressures reduce innovative problem solving activities.	Gann and Salter, 2000
time pressure	knowledge capture	-	Time pressures reduce knowledge capture activities.	Schön, 1983
workload	learning by doing	+	The more projects are completed the more opportunities exist to accumulate experience and to learn.	Prencipe and Tell, 2001

4. Analysis

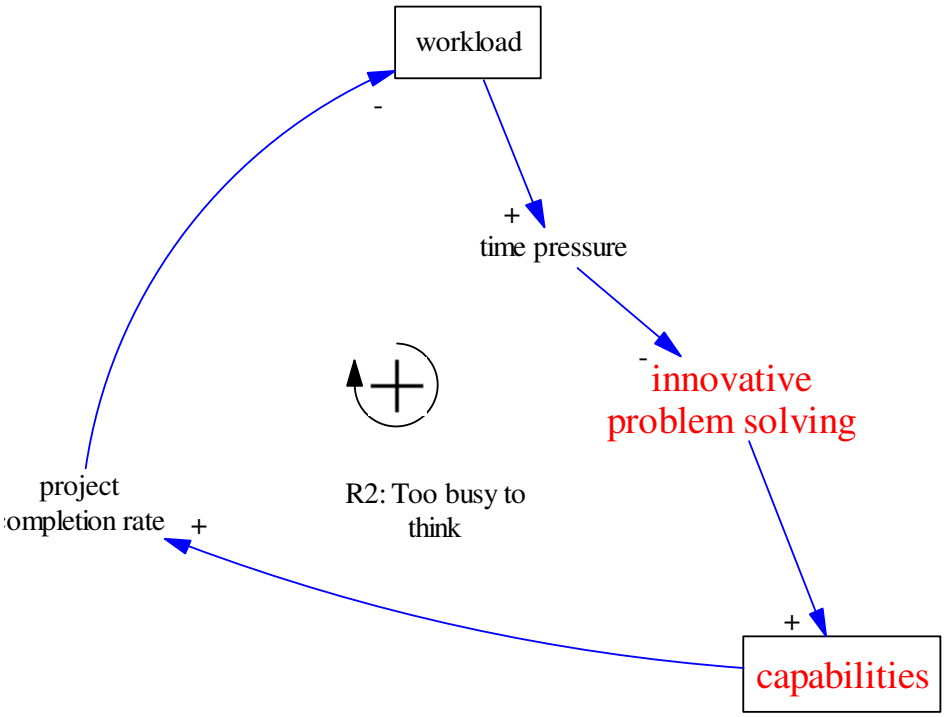
The causal relationships between resources and other key variables of the project-based firm are described in the tables above, and can be visualised as a map (see appendix). This map shows the many feedback loops active in a project-based organisation.

The following discussion analyses some of the main feedback loops which influence the behaviour of the project-based firm in regards to capability accumulation. In this analyse we use "time pressure" as a focusing device to select feedback loops for detailed attention. This choice is informed by the finding in the literature on project-based firms that time pressures are not only intimately intertwined with the culture of project organisations and the mode of project execution (cf. Perlow, 1999), but also a key factor in rework generation and failures of project execution (Cooper, 1980), the factor limiting the ability to innovate (Nam and Tatum, 1997; Gann and Salter, 2000) and a factor reducing knowledge capture activities (Schön, 1983).To facilitate analysis, we examine selected feedback loops separately (keeping all other variables constant) in this section before we then discuss the consequence of their interaction for managing a project-based firm in the next section.

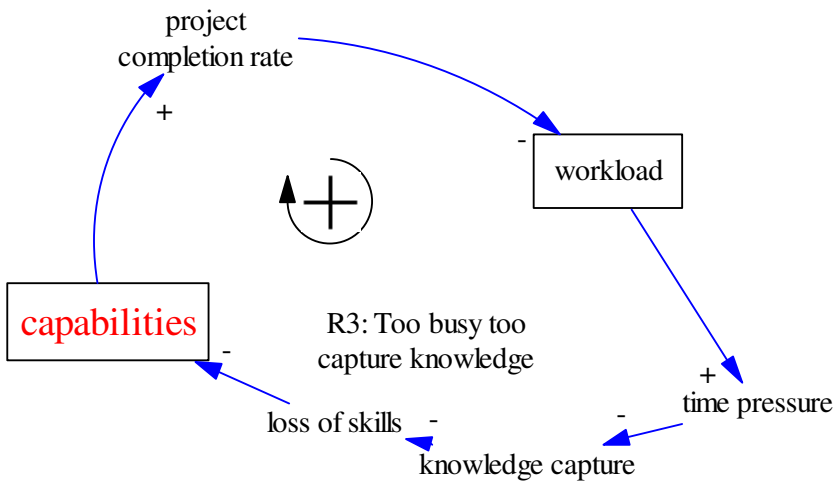
1. Excessive workload results in time pressure which harms the quality of project execution. As work gets rushed more mistakes are made and more rework is required. As a consequence of the lower quality of project execution, the rate with which projects are completed is reduced. Consequently, workload is not as much reduced as it otherwise would have. Thus, this reinforcing feedback loop counteracts the normalisation of an excessive workload level.



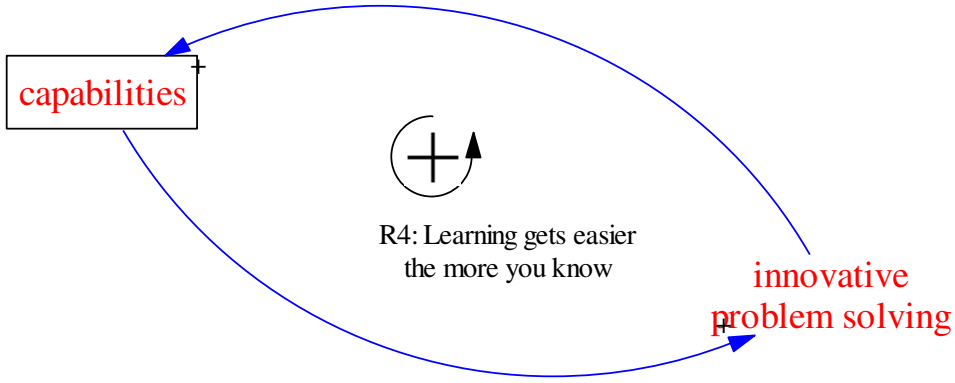
2. Time pressure prevents innovative problem solving and therefore slows the acquisition of advanced capabilities. As the stock of capabilities available is consequently lower, it will therefore take longer to complete projects. The organisation is “too busy to think”; too busy to develop the capabilities which would help to manage the workload better.



3. Under time pressure organisations neglect the capture of knowledge from projects, resulting in a loss of capabilities, as project teams disperse. This is another reinforcing loop counteracting the development of capabilities which would allow the better management of workload.



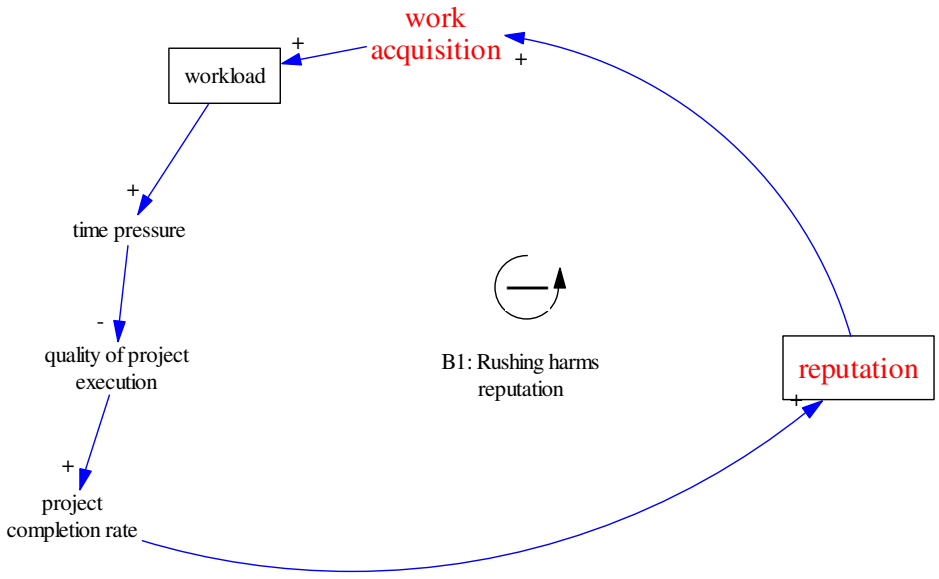
4. More developed capabilities allow the organisation to undertake innovative problem solving which results in further capability accumulation. This is a further reinforcing feedback loop.



These reinforcing feedback loops are a familiar occurrence in many project-based organisations where fire-fighting and time famine (Perlow, 1999) is common. Reinforcing loop 3 "Too busy too capture knowledge" is exemplified by the case of the project-based division (PBD) of a pan-European company analysed by Davies and Hobday (2005, p.134) where *"despite good individual project performance, in the previous two years the high-pressured work environment had left little space for formal training or staff development, either in technical or commercial areas. It was apparent that many of the formal and informal activities associated with organisational learning and improvement (e.g. post-project reviews, technical mentoring and informal communications) were not being performed. Lessons learned from particular projects were not shared formally because there were no structures or*

incentives for cross-project learning or communications. It had become hard to learn from project to project, leading to worries within PBD over its long-term effectiveness."

In addition to the reinforcing feedback loops discussed above, there are also counteracting balancing loops which tend to drive workload back into equilibrium. However, this may certainly come at a cost. A balancing feedback loop counteracts the effect of excessive workload. As the project completion rate drops (due to quality problems) the intangible resource reputation drops over time as well. This causes the company to secure less new work and workload normalises as a consequence – with the unwelcome consequence of diminished reputation.



This type of analysis can help to identify short-term costs (in terms of resources and potentially reputation) from taking on too great a volume of projects, or projects that are too complex, as well as the trade-offs between exploitation and exploration. Similarly, the relationship between reputation and winning more complex projects with better learning opportunities (and better access to skilled labour) or the effects of financial success on the availability of resources for learning can be investigated.

A company specializing, for example, in simple projects might rarely be able to move to highly complex projects because opportunities to acquire new skills are lacking. Both capability accumulation and reputation (which constrains winning projects and subsequently acquiring capabilities) act as barriers to rapid change. A vicious circle can result in companies remaining locked into a particular application area, or in simple and low complexity projects. Breaking out of such traps can be difficult in project-based environments if resources for capability development, distinct from the current project load, are not available and time pressures are high. Consequently,

there can be different paths of evolution (e.g. high and low complexity projects) between which companies cannot easily switch.

5. Discussion

The feedback lops analysed in the previous section interact with each other and with other influences laid on in the map of relationships in the appendix. The interrelatedness makes managing such organisations difficult. Actions might have unintended consequences which often are not immediately visible. Concentrating on project execution without due regard to the consolidation of capabilities will harm the firm in the longer term, low quality project outcomes as result of a rushed job will harm reputation.

Of particular importance is to understand the 'fit' of project level knowledge to the potentially evolving requirements of the project-based organisation. Available capabilities shape the potential to win new projects with distinctive learning opportunities. As learning occurs predominantly within projects, the choice of projects is implicitly also a choice about learning opportunities and the direction of knowledge accumulation. The type and complexity of a project will influence whether more experience in an area; more advanced skills within a particular knowledge domain; or knowledge in new areas can be accumulated.

Resource allocation to a project determines the scope for innovative problem-solving within such projects. The strong potential for unforeseen developments in current projects and the variability of bid success add to uncertainty in workload planning. It is typical that market demand and local decision-making determine the type, size and complexity of projects. Therefore, the scope for learning and capability accumulation is often determined by activity at the local level, rather than by planning from the centre of the organisation. This limits the extent to which capability accumulation can be managed within project-based environments through conventional hierarchical management processes. Knowledge capturing activities, whose benefit might only be reaped by future projects, and potentially by other parts of the organisation, are often of low priority for project teams.

Under tight, ambitious deadlines, in unique projects where delay and disruption are typical features fire-fighting becomes a common activity in many projects. The time shortage in project environment militates against the investment of time spent in developing solutions which consider a broader account than the current crisis. While time restricts the ability to innovate in project-based firms, the risks related with excess time are less relevant in project-based environments than in manufacturing. Project-based firms are often under such severe time constraints that the danger that "pet projects" and unfocused (and therefore ultimately unsuccessful) innovative activities are undertaken is small. The focus on projects and the close client relations ensure in addition that innovative activities remain concentrated and targeted.

The accumulation process of resources and capabilities introduces a strong element of history dependence: the reputation and the knowledge gained in past projects influence work acquisition, execution and learning in the present. Lock-in into

particular types of projects can occur and the path of capability development can be severely constrained, significantly more so than in non-project organisations where often more substantial resources can be made available for dedicated learning not directly connected to current work. Therefore, overcoming the capability barriers for new areas of work or more complex work is difficult. Project-based firms are likely to be even more limited than other companies to change course and acquire radically new or far more advanced capabilities.

Work acquisition practices are the key lever to steer the course of capability development and innovation in project-based firms. The type of work currently carried out affects future potential to develop capabilities and skills to innovate. This limits the growth of the firm and development of its strategic resources. The type of work currently carried out is determined by the firm's approach to acquiring work and the strategic choices that are made in winning orders. This sets limits on the firm's ability to win better work that could create learning opportunities to build capabilities that assist the firm to innovate and develop its reputation. However, the control decision makers have over this lever is limited by the dependence on the external environment in respect to the demand for projects, the uncertainties in winning work and the discrete, often large size of projects which can give the unmanageable event of bid success a large influence over the future development of capabilities within the firm. Control over the development of the knowledge base and therefore the potential to develop innovative solutions and migrate into new and more advanced areas of work is therefore necessarily imprecise and limited.

6. Conclusions

This paper has focused on the dynamics of capability accumulation in project-based organisations. Understanding these dynamics provides an appreciation of some of the challenges faced by project-based organisations in managing innovation. The paper has provided a model for considering ways in which knowledge develops and how new knowledge can be consolidated in changing environments. It has identified key issues and levers available to managers in developing capabilities in dynamic environments.

Learning in project-based organisations occurs first and foremost within the context of projects. The speed and focus of projects can lead to targeted learning, but the contribution of this accumulated knowledge at the project level to the strategic requirements of the wider organisation and its performance over time remains uncertain. Project-level knowledge must be captured and made accessible in order to be available across the organisation. The loss of valuable knowledge and obsolescence can threaten the organisational knowledge base, particularly in complex and rapidly evolving knowledge areas. The relative autonomy at the project level in project execution often acts as a disincentive for the transfer of this knowledge to the organisational core. There is a problem in linking learning within project processes to learning in core business processes in project-based firms. Time pressures are a consequence and a cause of the challenges of project execution, innovation and learning in project-based firms. Our model illustrates the problem and can help to develop strategies for overcoming these challenges.

No such strategy will be a “magic bullet” solving all the difficulties of managing a project-based organisation. Moreover, project-based organisations vary widely in their characteristics, markets and capabilities and will therefore benefit form different strategies. There are, however, some lessons which will be useful for managers to consider. Managers need to avoid being trapped in a market segment and sophistication level of projects that is not beneficial for the development of the firm. It is difficult to move into new markets requiring capabilities in different areas or of higher sophistication. Any such move will need to incremental as projects in which capability accumulation can happen need to be acquired. The selection of new work becomes therefore a key issue overload has to be avoided as well as areas and types of projects which are beneficial for future development of capabilities be selected. Incentives for knowledge sharing from individual projects needs to be in place for the firm as a whole to benefit from capabilities acquired in individual projects. An alignment of incentives on the project team level with the goals of the organisation is also required in regards to acquisition and execution: doing the best for individual client, project or project team might put stress on the organisation, affect – for example through resource competition – other projects, harm the development of organisational capabilities and negatively impact the performance of the firm.

To further the understanding dynamics of innovation in project-based firms a conceptual integration between what happens on the project-level and the level of the organisation is required. While an organisational level analysis from a resource-based view can help to elucidate the performance of the organisation as well as the performance over time if a dynamic view is adopted which examines the building of resources over time, this analysis will remain necessarily somewhat unsatisfactory. The relative autonomy of project teams in conjunction with the inherently unpredictable and risky nature of project execution makes it highly desirable to complement the organisational level analysis by an analysis of the project-level. Particular and explicit attention needs to be given to the time pressures evident on the project level. Project management focuses on the planning use of resources and time on project level in order to influence the performance of individual projects. Such understanding of time pressures and project performance needs to inform a thorough analysis of the conundrum of innovation in project-based firms.

In this paper we have made some steps towards such improved understanding by utilising tools from system dynamics to analyse how the resources and capabilities in project-based firms are accumulated, how they are interrelated, and what role feedback plays in the dynamics of capability accumulation. This approach helped to develop a ‘language’ and a visual representation which could serve as a vehicle to engage dialogue, and facilitate strategic decision-making, in project-based organisations. Therefore, the approach could be used to form the basis of a tool for managers; allowing them to visualise the wider context, the causal relationships and the trade-offs inherent in their decision-making. This could be useful in respect to project acquisition and capability development, and help to avoid the trap to be caught in a vicious circle locking the company into limited knowledge areas. Ultimately, we aim to develop a toolkit which allows managers and project leaders in project-based organisations to better understand the trade-offs in time, and between activities and projects. This toolkit utilises a visual format to facilitate insightful discussions in the highly fragmented decision-making structures of project-based firms, in order to better align project-based learning and firm level business requirements.

The main academic contribution of the paper is conceptual. The paper is based on academic work on innovation in project-based firms, drawing upon evidence and insights from research in different project-based organisations in a variety of sectors. Future work to refine the framework and analysis proposed here could beneficially focus on the interaction between different levels of the organisation distinguishing the project and business level. This would allow for a better understanding of knowledge flows between periphery and centre and also of the influence issues of control have on the development of the capabilities within the – routinely severely time-constrained – project-based organisation. More advanced work, distinguishing between several project teams, could then investigate the question of coherence within a project-based organisation, in particular, with regards to the knowledge base available to different parts of the organisation, and the relative benefits of focus and diversification in the firm.

Further empirical work expanding and building upon the framework presented in this paper would be very valuable. In depth case studies could help to provide a better understanding of the relationships between the variables of the framework. Cross-sectional survey data could help to gauge the extent to which the relevance of the vicious and virtuous circles identified in this paper are of relevance across a range of industries.

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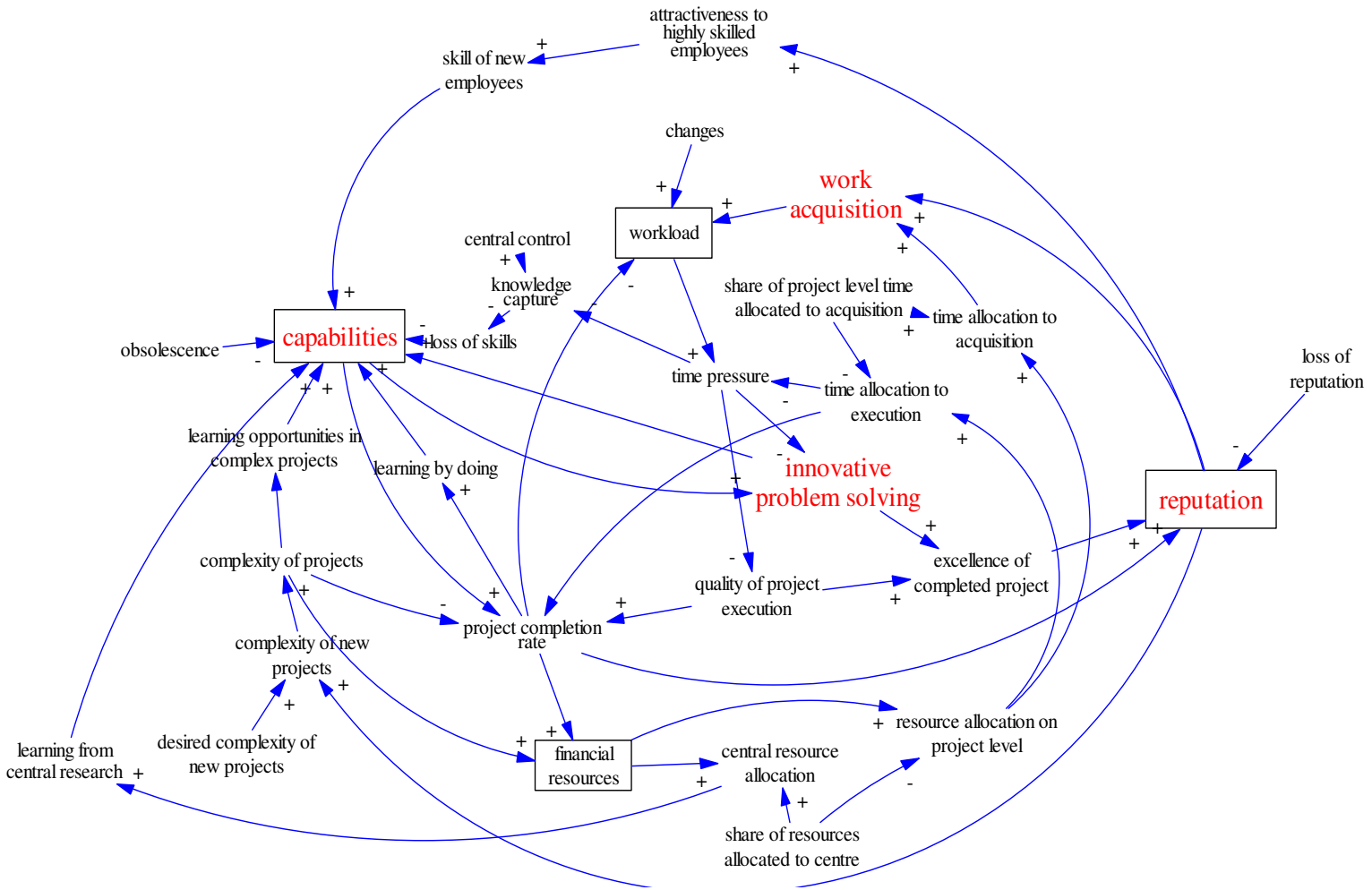
Appendix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work acquisition
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knowledge capture
share of project level time allocated to acquisition
time allocation to acquisition
capabilities
obsolescence
loss of skills
time pressure
time allocation to execution
loss of reputation
learning opportunities in complex projects
learning by doing
innovative problem solving
reputation
complexity of projects
quality of project execution
excellence of completed project
project completion rate
complexity of new projects
resource allocation on project level
learning from central research
desired complexity of new projects
financial resources
central resource allocation
share of resources allocated to centre