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Complete List of Authors:	Zhang, Lihong; Liverpool John Moores University, Akwei, Cynthia; Liverpool John Moores University, Zhang, Yufeng; Birmingham University,
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Dr Lihong Zhang*
Senior Lecturer in Operations and Innovation Management
Liverpool Business School
Centre for Stakeholder Research (CESTA)
Liverpool John Moores University
John Foster Building, 98 Mount Pleasant
Liverpool, L3 5UZ, UK
email: L.Zhang@ljmu.ac.uk
Tel: +44 (151) 231 3827
Fax: +44 (151) 707 0423

Dr Cynthia Akwei
Senior Lecturer in Strategic Management
Liverpool Business School
Liverpool John Moores University
Redmonds Building Liverpool, L3 5UG, UK
email: c.a.akwei@ljmu.ac.uk
Tel: +44 (151) 231 3808
Fax: +44 (151) 707 0423

Dr Yufeng Zhang
Senior Lecturer in Operations Management
Birmingham Business School
University of Birmingham
Edgbaston, Birmingham B15 2TT, UK
Tel: +44(0)121 414 6695
Email: zhangys@bham.ac.uk

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Abstract

This paper explores how engineering companies develop and integrate solution-based capabilities for complex 'one-off' or small-batch production. Although there is extant literature on developing a standalone service, product and process capabilities, an integrated solution-based capability for effective execution of complex 'design-build' projects is currently underdeveloped. For such firms to be successful in delivering complex solutions, there is the need for organisational structured routines and processes which we conceptualise as complex solution-based capabilities (CSC).

The study was based on a multiple case study using in-depth semi-structured interviews with managers and engineers. Primary data collected were complemented by documentary evidence, for triangulation and validity. The data were analysed using thematic analysis to develop a framework of CSC. The findings show that the case study companies have developed and integrated CSC through organisational routines and processes of make-to-concept approach, value creation, and strategic coordination. Implications and future research are discussed.

Keywords: complex solution capability, make-to-concept, value creation, strategic co-ordination, complex engineering systems

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1. Introduction

Building and integrating innovation capabilities in a production and operations system is key to a company's sustainability (Laosirihongthong, Prajogo and Adebanjo 2014). Capabilities leading to competitive advantages, also known as unique or core competences, are often embedded in functional areas (Prahalad and Hamel, 1990; Javidan, 1998; Quinn, 1999) and dynamically dispersed across supply chains. Developing CSC is increasingly regarded as an organisational design issue and not simply a matter of assembling a bundle of resources, because organisational capabilities involve complex patterns of coordination (or routines), cooperation and integration between people and other resources (Grant, 1991; Teece, Pisano and Shuen 1997; Winter, 2003). Risk-taking activities and initiatives should be allowed, and failures tolerated, in order for innovation-oriented structure and culture to thrive (Gibb, 2007; Handfield et al. 2009).

Dynamically developing and systematically integrating solution-based capabilities is pivotal for complex 'design-build' projects (Davies, 2003; Flowers and Henwood, 2008). Unlike pure product- or service-oriented businesses, solution-based companies often undertake contracted projects and deliver at one-off or very small batch levels (Hobday, Rush and Tidd 2000). The uniqueness of the solution to the local application environment and very complicated nature of interaction between customers and suppliers necessitate changes (e.g. adaptations) to take place at the multi-level of the individuals, the organisation and the environment (Slappendel, 1996). Facing such a complex 'design-build' project situation, companies have to allow – and even actively seek – development changes to be absorbed in the whole process of creating and delivering solutions in order to create value (Söderlund, 2002). This is particularly important for engineering-intensive organisations driven by engineering's intrinsic natures of relying on intangible engineering know-how, emphasising effective problem-solving, requiring adaptation and cross-boundary collaboration (Koen, 2003; NAE, 2004; RAEng, 2010; Zhang and Gregory, 2011).

This paper examines how a company's solution-based production system and network is structured and positioned in order to develop and integrate complex innovation capabilities for managing complex contract-based 'design-build' projects. In particular, we ask: what do solution-based companies share in common in operations planning and executing innovative risk-taking activities? The rest of the paper is organised as follows. In the next section, we provide a review of prior literature to develop a conceptual framework. This is followed by a description of the methods for data collection and analysis. Next, we present the results and discussion, and conclude by discussing the implications and limitations of our study.

2. Literature Review

Operations and innovation management scholars have conceptualised capabilities as intended or actual operational strengths contributing to an organisation's competitive performance (Hayes et al. 2005; Voss, 2005; Cetindamar, Phaal and Probert 2009). Capabilities leading to sustainable competitive advantages, also known as unique or core competences, are critical to businesses, directly contribute to customer value, and are often embedded in different functional areas (Prahalad and Hamel, 1990; Javidan, 1998; Quinn, 1999). Building solution capacity for successful innovation has been highlighted in research (Nair and Boulton, 2008; Oltra et al. 2005; Voelpel, von Pierer and Streb 2006; Sharkie, 2003; Wallin, Parida and Isaksson 2015; Frow et al. 2015).

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Companies either manage improvement in new product development (Nilsson-Witell et al. 2005), enhance internal consistence among their design activities (Spina, Verganti and Zotteri 2002), develop inter-firm networks (Smart, Bessant and Gupta 2007), or create knowledge for sustainable competitive advantages (Sharkie, 2003).

A company's competencies may be developed in a variety of ways: through functional performance management, through scrutinising its assets – both tangible and intangible – or by systematically building up its learning behaviour. These specific strategies seem mutually effective and complementary, given that many companies are often resource-constrained and knowledge-limited. This requires the right balance between the exploitation of existing competencies and the development of new ones (Hughes, Hughes and Morgan 2007). Over time, some companies are more successful at achieving this balance than others; the reason for this is that they manage to build, integrate and reconfigure organisational competencies and resources. Building dynamic capabilities for innovation is pivotal for companies that are involved in solution-based operations and complex system-development projects (Davies, 2003; Hobday, Rush and Tidd 2000; Hamel and Prahalad, 1990; Teece, Pisano and Shuen 1997). For these companies, core competencies appear to be in a state of flux rather than merely accumulative.

Some studies recommend a holistic approach to integrating innovation processes and regard innovative solution-based capability as a *built-in* element (Amit and Zott, 2001; Nair and Boulton, 2008; Oltra et al. 2005). Others focus on materialising specific innovations, such as New Product Development, Service Innovation and Complex Project Execution, and see problem-solving for customers as a *bolt-on* process (Spina et al. 2002; Nilsson-Witell et al. 2005; Smart, Bessant and Gupta 2007; Goffin and New, 2001; Stock and Tatikonda, 2004; Voelpel et al., 2006). This approach tends to consider innovation as performance-oriented. For example, innovativeness may be prioritised against other operations objectives such as cost, quality, speed, delivery and flexibility (Nair and Boulton, 2008). Still others direct our attention to an entrepreneurial *grass-rooting* culture whereby individuals take risks to identify and create opportunities, explore and exploit new ideas, and turn these new ideas and opportunities into wealth creation (Hughes, Hughes and Morgan 2007; Handfield et al. 2009; Culbertson et al. 2007; Mckelvie et al. 2007; Michaelides, Morton and Liu 2013).

It is useful to focus on one aspect or process of operations in order to foresee the impact of operations on and implication of innovation, since this facilitates bottom-up learning. However, there are occasions when and where some important issues are overlooked. For example, in the complex solution implementation case (Flowers and Henwood, 2008), there exists a process whereby a number of activities and relationships that interface between developers and adopters. The interface process can be thought of as two sets of embedded flows: information flows and resource flows. Developers and adopters negotiate the inflows and outflows of both information and resources. This is the arena where new ideas and new opportunities emerge. Most capability studies tend to narrowly focus on either the development process, or the adoption process or the outcome (Racela, 2014). This has unnecessarily limited our understanding of the overall environment and the complex interactions in design-building a solution-based production system.

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For the purpose of this study, we consider three theoretical perspectives for solution-based companies to develop and integrate their innovation capabilities into complex operations planning and control systems, as outlined below.

2.1 MTC Solution

The first perspective seeks to understand solution delivery as a *make-to-concept* (MTC) solution (Zhang et al. 2011). The successful transformation of creative ideas into useful solutions involves customers and suppliers in the co-design and co-process (Racela, 2014). MTC solutions therefore focus on the needs, wants and values of the customer as drivers for the development of an integrated solution. The design of a solution is closely interlinked with the company's customers and the external supplier's specific local context (Sato, 2014; Wallin, Parida and Isaksson 2015). Designing integrated solutions goes through different developmental phases and represents a complex process (Clayton, Blackhouse and Dani 2012) which requires a high variety of distinct knowledge bases, intense user and other supplier involvement, stretching the boundaries of the organisations involved in the production and delivery of the MTC solution (Sato, 2014).

Again, the innovation capabilities for a standalone product, process and services are not sufficient for developing complex integrated solutions (Gosling et al. 2015; Wallin, Parida and Isaksson 2015). Due to the high level of ambiguity and the necessity for integration of organisational departments, the needs and requirements of customers cannot be fully identified before the design of concepts; therefore, the MTC solution is largely iterative and uncertain (Alonso-Rasgado, Thompson and Elfström 2004; Clayton, Blackhouse and Dani 2012; Wallin, Parida and Isaksson 2015), and system specifications, no matter how sophisticated and well-developed, are only for reference and they have to be reconsidered and adapted to the local unique application of the environment within which the integrated solution is designed (Zhang, 2013).

2.2 Value (Opportunity) Creation

A second perspective is a 'built-in' value and opportunity creation process. We argue that this perspective focuses on a holistic and integrated organisation thinking which happens at the organisational level through creative thinking approaches such as brainstorming, organisational support and climate at a broader level, but these are performed with greater efficiency that adds value to the firm's products or service (Racela, 2014). Voelpel et al. (2006) suggested that a value-creation process consists of six key elements comprising orientating, believing, implementing, leveraging, expanding and mobilising. In developing CSC organisational elements, they are not assigned to individual processes such as marketing, operations and finance, rather the process involves a high level of interaction between different departments and teams, customers and suppliers (Morelli, 2003; Wallin, Parida and Isaksson 2015). It also includes knowledge about innovation itself and how to implement it together with knowledge about other business issues such as knowledge about relevant technology, the local market and regulations (Voelpel et al. 2006). To have a consistent and systematic approach to developing integrated solutions, engineering-based companies must have a life cycle view to offer inclusive activities (Laosirihongthong, Prajogo and Adebanjo 2014; Wallin, Parida and Isaksson 2015) apart from just the after-sale services.

A project life cycle can be seen as a flow of specifications. A specification process is participated in by multiple players, from top management to brand/marketing, to R&D and to manufacturing. The complexity of project interfaces, anticipation and feedback requires effective communications between internal and external stakeholders. This feedback therefore creates value and opportunities for developing complex innovative capabilities (Nellore et al. 1999). The relationship between the development of specifications and the progress of the project life cycle is an area to which previous studies contribute little.

Different processes are used to create complex innovative solutions. One such process is the 'open specifications' or 'open scopes', which consists of organisational interfacing, system configuration, and project change control. The process deals with changes made or suggested from project stakeholders. Changes create opportunities for new business and innovation. Although sometimes these changes introduce risk into the successful completion of projects, the development of specifications can be considered as a main influence in project stage iteration (Zhang, 2013). Intervention methods are suggested for management to take control of the specification flow. Nellore et al. (1999) developed a three-stage model for specification management. In the first stage, customer requirements are elaborated, which involves intra and inter stakeholders in various activities for data acquisition and this can sometimes be prolonged and complicated (Cooper, 1998). The second stage focuses on solutions generated from both internal and external stakeholders in the process of engineering and managing these customer requirements. Virtual agreement must be reached on adjustments between these requirements and their solutions (Zhang, Bryde and Meehan 2011). In the third stage, subsystem and component specifications (most of them non-standard) need to be validated - internally through engineering, manufacturing and procurement and externally via system integration, on-site testing and operations. Creating value and opportunities gives firms the ability to develop new ideas for solving problems, process improvement, technological change and market exploitation; however, how these are achieved in complex projects needs to be examined (Racela, 2014).

Opportunity creation perspective refers to a consideration of the merits that an entrepreneurial approach can bring to operations and innovation management (see, for example, Handfield et al. 2009; Howorth et al. 2005; Spear, 2006; Amit and Zott, 2001; Michaelides, Morton and Liu 2013). Entrepreneurial thinking occurs when individual stakeholders such as managers and engineers seek out opportunities. This may be the reason why most previous studies focused their effort on individual behaviour (see, for example, Howorth et al. 2005; Gibb, 2007) rather than collective or pluralistic behaviour (Spear, 2006). Organisational entrepreneurship is seen as being increasingly important since stakeholders often need the right atmosphere in order to interactively generate insight and information that assist in timely decision-making (Handfield et al. 2009; Michaelides, Morton and Liu 2013). It is from this point we start to see the rationale to undertake a study on how an organisation's structure and infrastructure impact on entrepreneurship. In particular, what type of enterprise culture and structure are needed for innovation capability building for a solution-based company?

2.3 Strategic coordination

Coordination is a central element for developing and integrating complex innovation solutions since many stakeholders are involved in the process, pursuing multiple interests, and influencing the outcomes in the development of integrated solutions

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(Vezzoli, 2010; Smart, Bessant and Gupta 2007; Michaelides, Morton and Liu 2013). Coordination is seen as individual efforts and the interlinkage of different parts of an organisation to achieve explicit common goals (Blau and Scott, 1962; Van de Ven, Delbecq and Koenig 1976). Several coordination strategies in organisations have been explained in extant literature (Daft and Macintosh, 1981; Daft and Lengel, 1986). Most research on strategic coordination focuses on the uses and impacts of individual coordination strategies, which are explained through activities such as task uncertainty and equivocality (Adler, 1995), task frequency, task heterogeneity, and causal ambiguity (Zollo and Winter, 2002), task interdependence and goal conflicts (Andres and Zmud, 2002). Coordination strategy provides a useful concept to assess the variety and complexity of different coordination practices and their importance in different organisational settings (Dietrich and Kujala, 2007, Kreye, Roehrich and Lewis 2015). Coordination strategies are analysed in different ways. Some authors analyse them using three distinct dimensions in coordination (McCann and Galbraith, 1981): formality, cooperativeness, and centralisation. Formality dimension relates to the use of either vertical or horizontal communication channels, cooperativeness relates to extended shared decision-making, and centralisation, the locus of decision-making autonomy. Others differentiate between organic coordination strategy, which consists of informal, cooperative and decentralised activities (Kreye, Roehrich and Lewis 2015), and mechanistic coordination strategy, which focuses on formality, controlling and centralisation (Andres and Zmud, 2002; Dietrich and Kujala, 2007).

For example, Bailetti et al. (1998) identified coordination structure as a strategy for developing complex products. A coordination structure is a configuration of actors made up of individuals, groups and units in an organisation that have interdependent responsibilities to create, modify and use any array of shared work objects. This is based on responsibility interdependencies rather than task interdependencies. It uses three indicators: actors, shared work objectives and associations, and four coordination modules, which have merits for effective and efficient development of complex products. The four coordination modules are: information communication, integrating changes over time, cognitive mapping and management tools. The four modules are closely related to the stages in the complex project life cycle. Although the modules are applied separately, it can be inferred that specifications serve as an intermediating process (Bailetti et al. 1998).

At the first stage, opportunity specification, customers, business champions and product champions work together to develop customer requirements, product concepts and resources. At the second stage, system development, specification officials and architects coordinate the development of product specifications and system design. At the third stage, detailed design, design teams communicate to develop interface specifications and component designs. Finally, at the stage of system integration, the system test group, the system integration group and other functions, such as manufacturing, work together to finalise the systems and update specifications accordingly. The whole process is also influenced and shaped by the company's strategic direction and network-based support (Smart, Bessant and Gupta 2007). This re-enforces the view that an innovative and enthusiastic organisation is willing to commit its creativity and energy, and invest in extensive links to include other stakeholders who can help with the knowledge and resource flows.

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Previous research in complex systems often focused on technological novelty (Davies, 2003), but largely failed to examine other novel aspects of complex projects. Research into specification management will help to reveal these other novelties and how corporate, business and operations strategies are developed to tackle these 'first time' issues. Although several studies (such as Michaelides, Morton and Liu 2013; Davies, 2003) have explained coordination strategies, many of the existing studies fail to provide holistic, coordinated strategies for developing and integrating CSC. Therefore, in this study we focus on strategic coordination between both internal and external stakeholders, examining the types of strategic coordination and how they impact on the development of CSC.

(Figure 1) summarises what has been discussed in the literature to reflect on the study of organisational entrepreneurship and link this to three process/system components: the MTC framework, the Value/Opportunity Creation and the Strategic Co-ordination. The integration of these three perspectives from the literature contributes to the development of CSC and serves as a theoretical foundation for using different approaches, rather than restricting our investigation to one single approach.

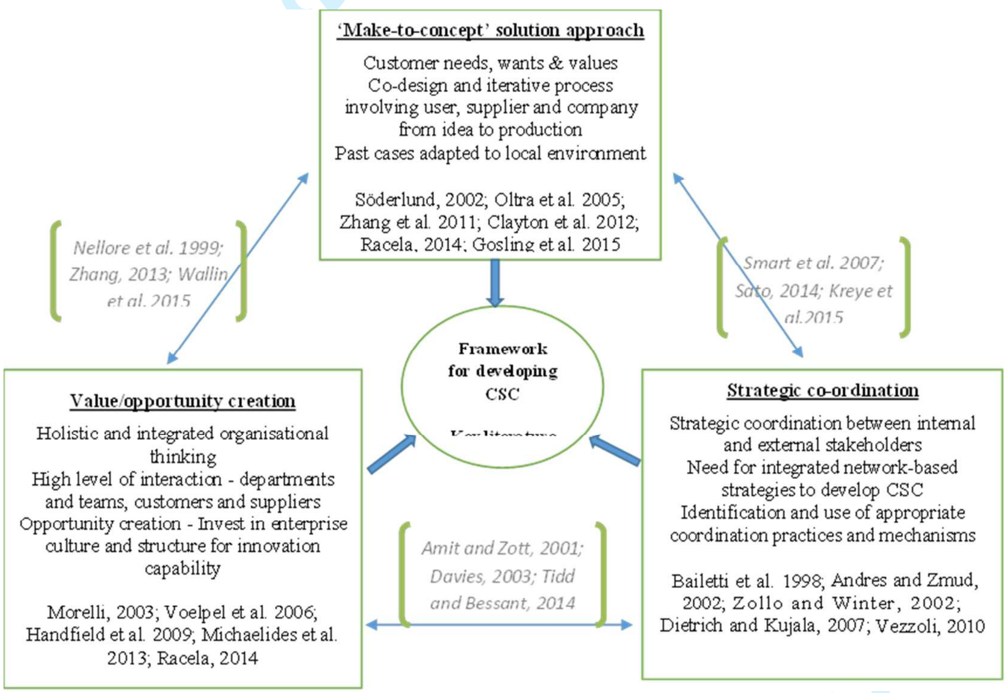

Figure 1 The complex solution-based capability framework

3. Research design

This multiple-case study adopted purposive sampling (Silverman, 2011), which allowed us to identify deep-seated meanings and compare the data to enrich our understanding of complex solution-based innovation capabilities. Three companies were selected for the study due to their ability to give information rich in the phenomenon under study (Patton, 2002; Yin, 2009). The companies are engaged in the contracted design and delivery of standalone complex engineering systems. This made a systematic observation possible over the dual management process of production and innovation. High-tech and intensive engineering companies such as automobile manufacturers were ruled out because of their business nature of large-scale production and even mass-customisation. The companies selected for study engage in business-to-business provision of one-off or small batch capital goods of high value technology. All of these technology-based companies have operated for at least 10 years in the areas of their engineering expertise; this enabled observation of their sustained operations and innovation capabilities.

SAIC (System Automation and Information Company) was founded in the 1950s and had a staff of around 6,000 people at the time of investigation. It had diversified its business by including drive systems, robotics, packaged control devices, global technical and business services, and engineered systems and services (ESS). ESS was one of the main functional departments in SAIC. It designed and developed solutions for various business customers to set up or upgrade manufacturing systems and business processes with automation technologies and products. It also provided on-site repairs and maintenance and other asset management services. Most of the application systems were located in the UK and these covered a wide variety of manufacturing and engineering sectors such as food, beverages, automotive, chemicals, air transportation, railways, and metals. Staffed by 60 people and supported by other SAIC departments, ESS delivered about 200 contracted projects a year. Typical order value was between £100-200k.

PPL (Power and Plant Ltd) was founded in the USA in the 1870s and had recently been acquired by a giant engineering company headquartered in South Korea. The UK-based business employed 3,500 staff around the world at the time of investigation, and operated as three main European divisions: Technology Centre, Manufacturing Base and the Energy Solution Centre (ESC). ESC designed and developed energy-generating and energy-transfer systems for business clients. Most contracted projects were resourced, sub-contracted and therefore coordinated and delivered from overseas operating offices and companies in mainland China, Vietnam, Taiwan, the USA and India. Most projects were tailored to customers' requirements and application environment. Staffed by 500 people, ESC generated a revenue of about £300 million annually.

PAT (Power and Automation Technologies) was formed in the 1980s as the result of a series of continuous and global M&A activities undertaken by its parent company. It currently employed 3000 people and operated at 20 locations in the UK. PAT specialised in the area of high-, middle- and low-voltage electrical technologies and was (sub-) contracted in the system design and development of precise engineering and measurement. One of its five lead centres in Europe, the Instrumentation and Analytical Systems (IAS), was responsible for the research and development of middle-voltage technologies that were seen as the core business of the company. Staffed by 600 people, IAS networked with 13 business centres and many other application groups around the world. The company's operations and innovation mission is to maintain and sustain its technology leadership in the design and implementation of complex engineering systems. A typical project that tailored their core technology to the varying local solutions was valued at between £1 and £5 million.

Semi-structured interviews were used as the main data collection strategy to generate explanations and opinions regarding innovation capabilities in a contracted development project environment of complex high-tech engineering. Interview topics focused on the

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broad areas of how the company should be structured and positioned to sustain and integrate emerging technologies, cope with project changes and encourage engineering innovations. Between 15 and 17 interviews were conducted with each company (i.e. solution centres) situated in the UK. Most of these were adapted to the project-specific situation and the interviewee's background. People interviewed were programme (or system/department) directors, lead engineers (e.g. technology managers) and group leaders (i.e. local business managers).

In addition to the interviews scheduled on site, internal programme meetings were observed where and when projects were reviewed and technical experts were mobilised and relocated between centres, groups and projects. Two projects from each centre were specifically examined with the interviewees to illustrate and understand the "make-to-concept" practice. We also had opportunities to view each company's documents during visits to the centres. The details of the projects (procurement, technology, etc.) included the value and life cycle of the contract, the cost structure, the reason and rate of changes, the interaction of project stakeholders and, most importantly, the role of the company's framework, specification process and programme co-ordination decisions. In addition, people from marketing development, asset management, human resources, legal department, company's documentation and single contact references were consulted, as well as materials (e.g. product catalogues and solution-based application cases) on each company's website.

Template analysis (King, 1998) and analytical induction (Johnson, 1998) were used to organise the key evidence found in the interviews and other data, to triangulate and generate the concepts. For each fact and analysis made, a second researcher critically viewed the process to see if he/she would or could arrive at the same or similar conclusions. The emerging concepts were then presented at two workshops in the UK to confirm the findings and generate further insights.

As stated at the beginning of this paper, three elements were explored that emerged in the case study companies: capability framework, value creation and strategic co-ordination. For the capability framework, we based our discussion on the information provided in the company's document termed 'Strategic Framework'. This accords with the stance taken by Oltra et al. (2005) that a vision or collective understanding is better configured by categorising from real organisational topics – a taxonomic approach. The other two elements – value creation and strategic co-ordination – were particularly informed by the studies of Amit and Zott (2001) and Smart, Bessant and Gupta (2007). The data analysis was conducted as prescribed by Miles and Huberman (1994), thereby facilitating the identification of emergent issues and establishing certain patterns whereby entrepreneurial project stakeholders enquire of and respond to each other during the process of developing customer requirements and system solutions. These issues and patterns were sub-categorised and discussed under the elements of capability framework, value creation and strategic co-ordination.

4. Findings

(Table 1) illustrates, in a summary form, the results of our in-depth, case study-based analyses of these capability-building issues. We consider these as 'building blocks' and label them as 'Approach to MTC solutions', 'Value/Opportunity Creation' and 'Strategic Coordination'. We combine empirical evidence and reflection with regard to the literature concerning innovation and operations capabilities in order to provide an

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understanding of how solution-based engineering companies integrate and sustain their solution-oriented capability in their system design and operations surveillance. We believe that the findings help to answer the central question of 'How do the case-study companies build up their key solution-based competences for creative and risk-taking activities and driving forces?'

4.1 Key elements of solution-based capability: Approaches to MTC

Tidd and Bessant (2014), Amit and Zott (2001) and Smart, Bessant and Gupta (2007) suggest that companies need to build-in capability rather than buy it in because the capability is contingent upon a company and inter-firm network. The empirical data provide supporting evidence that the configuration and evolution of a company's (operations) strategy influences the mobilisation and allocation of expertise and resources. The companies studied in this research have developed a strategic framework of MTC (make-to-concept) to guide the development of capabilities.

SAIC used the phrase "complete solution" to direct, accommodate and condition their design and development of customer-tailored systems. The solution approach requires that the company is able to communicate with customers and translate customers' needs "from ideas to production". In a complex "make-to-concept" situation, customers' needs may vary subtly but significantly. There is no such thing as an 'average customer' to look after. Customers' needs may also change as they follow-up the solution process and interact with suppliers and other stakeholders. Because the solution is unique in both outcomes and development processes, the solution-based company needs to be ready and willing to deal with any changes and unexpected events. It was an everyday case for SAIC that items to be developed needed to be clarified step by step. Customers might simply say to the company: 'This is not what we want. Do it another way.'

> Company-wide, when we sell our solutions to the customers, we are not only selling a one-stop shop project, we are selling a lot of value-added services from the company. When we develop a proposal, we try to emphasise the many benefits the customer gets from coming to us: project management, on-site start up services, asset management, embedded engineering, a lot of additional values. (Sales Manager)

SAIC arranged its core competences into four strategic areas, namely integrated system and technology architecture, value-added services and expertise, standardised (and therefore brand) components and parts, and global operational supply combined with local application(s) capability. These strategic areas were creatively translated into detailed solutions to meet specific customer requirements. The translation of broad capabilities into concrete solutions essentially rested with entrepreneurially oriented personnel drawn from not only inside but also outside the company. Managers and lead engineers interviewed all pointed to the processes of project review and preview that represented constant opportunities for exploring and exploiting new ideas and new technologies in system automation.

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Table 1. Solution capability attributes of case-studied companies

	Make-to-concept approach	*Value/Opportunity creation*	*Strategic coordination*
SAIC *(System Automation and Information Corp.)*	• A complete solution slogan/label of 'from ideas to production (system)' and asset management. • Anchoring elements: 1. integrated architecture; 2. value-added services and expertise; 3. standardised products; 4 global supply and local capability. • Using previous business cases to categorise expertise, experience, solutions and sectors: 1. modularity and flexible applications; programme management; third-party scheme and solution ownership; parent's lead brands in industrial automation.	• Identifying and investing in (i.e. formalise/visualise) key processes that spot and deliver value for customers: a dedicated specification process that enables project interactions and interfacing at multiple levels: organisational interfacing, system configuration, project change control. • Other processes: business intake process; project supervision; manufacturing as routine process; infrastructure.	• Dedicated expertise resources, org structures and interfaces: ESS (Engineering Systems and Solutions): internal and external functioning, asset management. • Change control • Third-party scheme • Project portfolio • Access to global supply chain – 90% sourced from within the parent company.
PPL *(Power and Plant Limited)*	• A label of 'Total power and energy solution' • 'Creation is better than prediction': Using business cases that have been successfully delivered to illustrate MTC approach and showcase their complex project competence with staff, customers and suppliers. • Integrated core elements that ensure a quality development of business solution: 1. focused manufacturing and contracted engineering; 2. global operations and localised business; 3. core technologies and project experiences; 4. solution process improvement.	• Mainly specification process: organisational interfacing, system configuration, project change control. • Other processes to engage, enable and accommodate innovations: capture and execution, deliverables-based planning, process and key parts' design, materials and services, commercial management, and document and control.	• ESC (Engineering Solution Centre): internal and external functioning, international coordination. • Change control • Orange book • Order book • Access to global supply chain – 75% sub-contracted to international suppliers from China, India, Japan, South Africa, etc.

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PAT (Power and Automation Technology)	• 'Power and productivity for a better world'. • Customised solutions for customers based on PAT's leading technologies and engineering capabilities, based on a range of reference solutions in various areas of applications. • An open ICT-enabled platform to bring together internal engineering teams, suppliers, and customers for value co-creation.	• Product portfolios/groups • Engineering flying faculty • Business annual conferences • Common information platform • Project specification process	• A network of corporate research centre, programme centres, lead centres and support centres. • Change control via group leaders and technology leaders • Dedicated single interface • Technology leadership through program directors and lead engineering.

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A small-scale survey conducted within SAIC where 12 projects were examined indicates that between 40-70% of these debriefing, updating and co-ordinating activities were spent on solution specification-related issues. Questions that were frequently asked in the solution centre concerned 'what we have got, what we are lacking, where we can find this, this and this to satisfy the requirements set in the contract and project, etc.' (System Manager). The mechanism of translating key capability inputs into solutions that were competitive and feasible was agreed by the interviewees to be critical. This requires a strategically well-shaped framework in place which anchors creative risk-taking activities and experienced specialists in an efficient and effective way.

Similarly, PPL developed an approach to 'total energy solution' in the energy business industry. Their business philosophy of 'creation is better than prediction' saw the value of creating opportunities for innovation at all levels. To them the market cannot be forecasted, but by interacting with customers and suppliers business solutions can be generated. They systematically used this mind-set to nurture relationships with clients, end users, suppliers and suppliers' suppliers. 'Make-to-scope' or make to open system specification is a good depiction of their solution-based business:

> The ideal thing is that you have a standard design. You sell and supply a standard design. That's what a mass production-type market does. It fully engineers the products. We are sort of semi-mass, where we're trying to get as much as we can if the category maps allow us to do so. What we do is to provide a reference design which matches what the client really wants. Sometimes two [boiler] systems look similar, but they are not the same. There is no such thing as a standard design. We cannot provide such standard designs. (ERP Manager)

PPL strived to achieve a 'world-class' level of capability across four different areas. These were focused manufacturing and contracted engineering, core technologies and project expertise (e.g. project management and financing), global operations adapted to localised businesses, and constant improvements to solution development processes. These strategic elements combined to provide not only a vision of, but also a detailed guide for, dynamic allocation of business activities and resources in the UK, China, India and the USA. In order to develop energy and power solutions for their specific customers and be competitive, resources around the world were mobilised and allocated via mechanisms such as tender/bid processes, project review, fortnight co-ordination meetings, document control and deliverable issues. Temporary offices or groups were often created to manage contingent issues so as, for example, to maintain close contact with bespoke customers and suppliers. These mechanisms represented a variety of opportunity-seeking and apparently risk-assessing processes. Together, and along with the four key capability elements, they provided a prompt communication and co-ordination function between globally scattered resources and activities.

The development of specific capability frameworks in the case study companies was inevitably the result of each company's adaptation to its business environment (Slappendel, 1996; Tidd and Bessant, 2014; Söderlund, 2002; Oltra et al. 2005). For example, SAIC and PPL both had strategic ingredients for combining their global operations infrastructures with local application abilities. What SAIC did was to source (on average) more than 80% from its parent-owned companies, emphasising in-house global sourcing. SAIC generated about 90% of its local business from the UK market. This was partly because its parent company had 13 other regional headquarters around

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the rest of the world, and partly because the technologies for information and control systems that it developed potentially had a wide range of industrial applications (e.g. automotive, electronic, chemical, oil and gas, and pharmaceutical). The process of globalisation and localisation had resulted in ESS's capability to handle a variety of industries, technologies and businesses. Specification processes that were essentially and repetitively used for seeking and discussing new ideas were formally developed. Meanwhile, the framework reinforced joint efforts to solution development between ESS and other SAIC departments such as marketing, asset management, system consultancy and training centres. Expertise and resources which were entrepreneurial by nature were constantly utilised and mobilised in order to clarify customers' requirements and enquiries, initiate and envisage options, and validate until final solutions.

By contrast, PPL outsourced or subcontracted around 75% to external suppliers around the world. Its business and/or project offices were scattered around the world in countries such as the UK, China, Taiwan, the USA and South Africa. This international representation enabled PPL to respond simultaneously to the rapid development of energy and power technology and materials together with changing environments and shifting customer requirements. As explained by the interviewees, competition in the energy generation market was fierce. PPL chose to concentrate on developing coal-fired technologies since the company's capabilities were traditionally linked to fossil-based power generation. This was clearly depicted in its capability framework as a guide for creative activities and links. Because of this trajectory constraint, its business was geographically spread, with repairing and maintenance services in the UK, plant upgrading in the USA and new-build projects in Asia. Related to this strategic alignment was the decentralised design of functional performance management. For example, for new fossil-fuelled projects, technological expertise was allocated in Shanghai (China) while the system and process design and the technology-guiding group remained in the UK to co-ordinate the integration of technologies and configuration of sub-systems that were sourced from around the world. Towards the end of system development, the detail and test specification staff based their activities in Shanghai to co-ordinate design activities that were outsourced to Chinese design institutes and provided on-site guidance for the installation and pilot tests of the whole energy system.

- Make to concept (MTC)solution
- Use of slogans/labels to reinforce the complete/total solution MTC approach
- Focus on customer needs, wants & values for customised solutions based on engineering capbilities
- Co-design and iterative process involving user, supplier and company from idea to production
- Use of previous successful business cases to inform new solution development

4.2 From strategic capability to solution provision: Value creation process

The strategic elements in the case-study companies provided good examples of how to link innovation capabilities and leverage these capabilities (Amit and Zott, 2001; Veolpel et al. 2006; Sharkie, 2003; Smart, Bessant and Gupta 2007). In particular, the fieldwork yielded clear evidence that specification management represents a crucial value/opportunity-creation process where and when ample opportunities are created for

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entrepreneurial staff to generate new ideas and identify pitfalls for many complex solutions. According to the interviewees, a well-developed specification process would accommodate discussion and decision-making activities that were shared by staff from different departments. These activities were non-routine and concerned, for example, organisational interfacing, system configuration and unexpected project changes. The specification process allowed the company constant and on-going interaction with customers in specific application environments. For example, in the case of technology integration and system configuration, SAIC staff avoided providing state-of-the-art technologies because it was expensive to replace entire intermediate technologies that were predominant in the customer's manufacturing system. To adopt brand-new technologies would require a considerable amount of careful 'backward' system integration and training. That increased technology uncertainty and a lot of work would be required to find hidden problems.

For similar reasons, PPL rarely introduced cutting-edge technology in new-build projects. Technology trajectories in PPL justified a strategy of validating and refining new technologies first in an established energy system, such as those in the UK or the USA, where customers had developed their own capabilities to manage technical and operational complexity, and where close working relationships had been established to facilitate mutual understanding. For example, in the project examined, the design of a total solution was once seriously hampered by the fact that one of its initial consortia partners, a European turbine manufacturer, withdrew during the tendering stage. In order to save this project from failure, PPL persuaded its customers and suppliers to agree to incorporate a Japanese turbine supplier and adapted its solution (system) design to the new partner.

One of these adaptation activities was triggered by changes to or adaptations of steam and water conditions. The client specification contained the steam and water conditions for various load situations against which the boiler had originally been designed. These figures were based on preliminary heat balance and turbine cycle data, and the specification allowed for price adjustment in the event that the actual contract turbine data exceeded certain tolerances. Since a Japanese turbine was selected, its associated steam and water conditions breached some of these specified tolerances. These 'revised steam conditions' necessitated PPL to make some modifications to the boiler heating surfaces. Correspondently, the client was advised to introduce some changes to the original contract specification and to reassess the impact.

In addition to the client change, PPL managed changes from its suppliers and those arising internally during design and implementation processes. For example, in order to restore gas velocities lost by the increased steam water temperature, the division wall in the boiler rear pass had to be re-positioned to achieve a 44% to 56% split. Since there was slightly more heating surface in the primary super-heater side of the boiler rear pass, the net effect was a small increase in the heating surfaces of both these banks. Only a small cost (US$ 58,000 per boiler) was thus involved. The increased steam pressure also led to an increase in the thickness of some of the re-heater components concerning, for example, safety valves. A 'rule-of-thumb' calculation indicated the increase in cost up to US$ 90,000 per boiler. This also meant a considerable amount of re-working on the main process design, interface changes, project financing, foreign exchange, supplier selection and project timing. This resulted, *inter alia,* in an increase in engineering person-hours by 300, equivalent to US$ 30,000.

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PAT, the market leader in middle-voltage products and services, had a similar specification process starting from concept design, application design, etc., right through implementation stages. Client specifications started with the group managers who were in charge of the local products' portfolio and project budgeting and resources. All the contracts signed would state something like 'partnership', meaning the system lifetime management for the system to be developed. Because of this nature of opportunity and value creation, the group managers tended to be well back-grounded from a local application environment and they tended to stay in the job for much longer than the technology managers, who flew around the world to ensure the development and application of the core technology.

PAT held annual conferences where and when potential and existing customers and suppliers gathered to present ideas and share opinions. This investment in social capitals enabled networks to be maintained and enhanced, and trends to be shared and clarified. PAT was able to start to see what its operations system would be like, say, in five or 10 years' time in order to satisfy future business customers; what management capability they needed to develop now before it was too late. In addition to this broad social planning and control system, PAT invested in a 'common information platform'. This computer game-like intranet system operated in eight places around the world to accommodate innovative ideas and suggestions. Thousands of suppliers and customers had registered to interact to clarify points and suggest new ideas. This greatly helped with the conception of the new applications around the world and optimisation of technologies, activities and materials.

Evidence from the case study companies also indicated that new or hidden capabilities were developed or unleashed when specifying and articulating customers' requirements. For example, SAIC had recently established two departments responsible for asset management and automation consultancy respectively. The purpose was to ensure that solutions provided to existing and potential customers had been devised to include more business opportunities than merely offering the application of information and control systems. SAIC particularly saw as core competences its ability to co-develop URS (user requirement specifications) as well as FDS (functional design specifications). Automation consultancy resources were then created and deployed to help customers to manage their bid and proposal processes. The knowledge generated through this assessment and evaluation process was thus fed back to the whole organisation, thereby greatly enhancing the mobilisation and allocation of, for example, ESS engineering resources. Interviews with SAIC staff revealed the perception that most solution-based projects were undertaken with no specific start or end points because the customer, SAIC and its suppliers were involved in the solution specification process in an ongoing fashion. As the System Co-ordination Manager explained, 'What we're trying to tell our customers is that you are specialists in your business, or manufacturing technology or whatever. Why not let us manage your business processes, your assets, because we are good at it, and so that you can focus on your core area of business and be more competitive'.

The above illustrations indicate that entrepreneurial and open innovative behaviour can be double-edged with regard to innovation-based business (Amit and Zott, 2001; Nilsson-Witell et al. 2005). There needs to be a descriptive management in place to help to find various hold-up problems and prioritise issues in the project development

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process. With specification management, conventional management tools such as WBS and CPA can be effectively applied to real-life project planning and control, and to spot these and other hidden and unstable bottlenecks. These bottlenecks may be organisational, commercial, technical, managerial or social in nature.

4.3 Programme management: Strategic co-ordination

The in-depth case studies provided evidence of strategic co-ordination of a changing project portfolio, order book keeping and business proposal cataloguing. For example, ESS delivered around 150 projects in 2001, with infrastructural support from the rest of SAIC. Risk-taking activities were acknowledged and failures were not unusual. For each project undertaken successfully, they had bid for two to four other business proposals. For each of these proposals of varying content and volume, many other order invitations were received or requested. The ESS Department Manager, Systems Manager and Services Manager were responsible for constantly reshuffling ESS and SAIC personnel and non-human resources to best serve their customers, co-ordinate competing projects or conflicting project objectives and exploit emerging business opportunities.

Likewise, the chief operations officer from PPL headed a small team of people comprised of Project Directors, Regional Directors, Technology Director, Manufacturing Director and Procurement Director. The steering board decided and reviewed project organisations, and identified benefits and stakeholders. ESC then defined issues and assessed risks at project and company level and provided quality and configuration management. Projects of varying size covering different applications were grouped to ensure effective coordination, for example, the name of ‘New Build’ for turn-key projects in Asian and developing countries and HRSGs (heat recovery steam generators) for upgrading existing industrial systems in the USA.

To PAT, programme management was the central responsibility of the Vice President, who was interviewed and who chaired the research council. The council was composed of the directors who were each in charge of a research centre or a regional programme. There were eight such corporate research centres and 13 programmes scattered around the world. They were technology development focused and operated to promote and mobilise engineering expertise and coordinate the advancement and application of the chosen technologies.

PAT management and employees shared the vision that innovation is the bloodline and it come from everywhere. PAT had established over 1000 support centres interacting directly with customers and suppliers. This allowed and nurtured a bottom-up innovation to be grounded/realised. That was welcomed by engineers, business managers, suppliers and customers, because they knew what they needed and what

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would work. There is no doubt that the technologies that PAT had mastered had a great range of applications and thus a huge potential to exploit the economy of product repetition. On the other hand, the technology in question needed a big degree of adaptation in order for the application system to work properly and trouble-free in the local production and consumption environment. This meant that between 30-70% of the project specifications previously authorised and materialised would need to be rewritten/modified.

This created opportunities for innovation at the material level: components, parts – even the entire system to be delivered. This kind of innovation also meant risks in quality, delivery time and cost, and this was the source of many 'fights' between group managers and technology managers who had different and even conflicting targets. Few good working relationships were reported in this regard. To deal with this, PAT invented a single interface system that functioned 'separately' from these abovementioned managers: a group of people acted internally and externally as the single contact point – a planning and control system at the company level that enabled and ensured the 'design-build' operations performed at the application level.

Programme Management (or Management of Project Portfolio) was introduced and developed by the case study companies to manage changes that were sourced both externally and internally. Very often in 'make-to-concept' manufacturing, benefits, activities and conflicts cannot properly be defined within the framework of single projects. Some projects completed in SAIC did not make a profit but did help the company to gain important industry-specific experience and to break into a new market. The projects examined in PPL were undertaken at a very marginal profit estimate because the company under-ran its aggressive business and operations capacity at that time. The existing project capacity needed to be redeployed in order to smooth the company's cash flow and to retain specialist resources of strategic importance.

Under the framework of programme coordination, a broad set of mechanisms such as planning and control systems, contractual and commercial debates, and negotiations, project reviews and specification management evolved or were created between project stakeholders, among core teams, and with infrastructures. Specification management in particular was utilised by the case study companies to shape entrepreneurial behaviours and project outcomes. The foundation and consolidation of solution-based centres (i.e. ESS in SAIC and ESC in PPL) engendered and enabled, for example, specification resource coordination across project timescales and proposal scopes.

Interviews with employees from the participating companies demonstrated that a single project has a definite start and finish point, but complex solutions or solution-driven business only has a vision of the 'end state' and no clearly defined path to get there. Projects as small as in SAIC (that is, projects of less than £10,000) and as big as in PPL (in relation to projects of more than £200 million) are very often interdependent in terms of expertise and engineering resource sharing, procurement and outsourcing portfolio. This corresponds with the findings of Smart, Bessant and Gupta (2007) in that most complex projects are inter-firm based. Interviewees also indicated that it is unlikely for individuals to see the whole picture of the solution development process and take the advantage to its full potential within the life cycle of a project or during the period of business proposal development. The very asymmetrical flow of creativity in terms of knowledge and money, for example, raises a strategic performance issue

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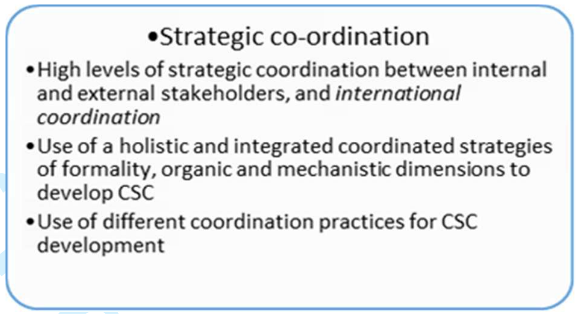
concerning when and where to create values and how to collect these values (Amit and Zott, 2001; Voelpel et al. 2006; Nair and Boulton, 2008). This case study reveals that both a programme management approach involving managing projects together with an organisational approach concerning solution centres such as ESS and ESC in the case study companies would provide a platform and a number of mechanisms to encourage risk-taking and creative activities, to accommodate entrepreneurial failures and to balance between project profiting and learning.



5. Discussions

The first insight that can be generated from the preceding analysis is that, although capability frameworks may look similar to each other, there indeed exist many subtle differences across companies, in terms of originality and interpretation. For example, SAIC and PPL both emphasised the reality of global sourcing, but each viewed and explained its practice in a dramatically different way to the other. This was probably due to the fact that SAIC purchased automation components, parts and materials – no matter how complicated and specific the integration appeared to be – predominantly (around 85%) from its parent company – in-sourcing globally, while 75% of PPL's contracted projects were sub-contracted to their external suppliers around the world. In addition, it was noted that PPL's capacity framework was a direct result of the company-wide exercise on BPR (business process re-engineering), together with a road map of business operations, which facilitated a more 'bottom-up' learning approach with some radical consequences. In contrast and according to the interviewees, SAIC documented its solution framework alongside organisational restructuring events which featured incremental and recurrent actions typified by a 'top-down' change with slow-burning effects. This accords with the findings of Howorth et al. (2005) that there needs to be a multi-paradigmatic approach in order to understand and guide an entrepreneurial process in complex innovation. In this regard, the findings tend to favour a taxonomic approach (as against typological methods) in conceptualising a company's innovation capacities (i.e. innovative operations strategy in Oltra et al.'s term, 2005) and in reflecting a company's macro- and micro-cultures for entrepreneurial behaviours (Gibb, 2007).

Core competence theory has conventionally emphasised the internal interaction of resources and competences (Prahalad and Hamel 1990; Javidan 1998). For example, a company's competitive advantages can be sourced and obtained via consolidating and co-ordinating internal consistency between design and purchase activities (Spina et al. 2002). More recent research recommends an inter-firm approach as the leeway for resource creation and capability building (see, for example, Smart, Bessant and Gupta 2007). Our study provides evidence for both theories. One of the four capability elements in SAIC, "Integrated Architecture", depicted a dynamic and fine balance

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between modular internal activities and external flexible application. According to the interviewees, there were many interfaces at several levels in a complex automation system. Any (internal) changes in a part or subsystem would mean a likely change in the way information was passed around and this would demand an exhaustive re-defining of a whole project. A complex automation solution project was interfaced technically within the case study companies. For example, the integration of SAIC customers' and suppliers' systems and sub-systems resulted in a number of intended and unexpected changes. In dealing with these changes, entrepreneurial and risk-taking activities together with opportunity-seeking and creative thinking were vital requisites within SAIC. In a similar vein, PPL's case reveals an evolutional and contingent development of innovation capability. Dynamic capability building approaches view this organisational entrepreneurship (Handfield et al. 2009) as a learned result and hard to imitate. The embeddedness and contingency of capability elements demand that companies actively seek to build and develop these capability elements and translate them in a unique and creative way so that they maximise the opportunities for their business. In this way, companies can also improve their value-creation process and minimise any failures that stem from entrepreneurial behaviour.

Our second insight points to the fact that specification processes in solution-based companies may represent the key area and be rich soil for entrepreneurial performance and, thus, for knowledge and value creation. This is because a specification process for a complex contracted project cuts through both functional and impulsive activities, internally and externally. In the case of SAIC, specification management expands to cover proposal generation, project execution and asset management. This contributes to the discussion of business modelling theory (Amit and Zott, 2001), since specification processes can be easily bounded as the unit of analysis. By 'specification process' we mean that a complex project is delivered not to particular requirements but to an 'open' specification that is constantly shaped by project stakeholders.

Open system specifications are most practical when and where the customer's need is to be further clarified and located during the project life cycle. Emergent issues and impending information that result from project interactions and project changes (that is, solution evolutions) create a situation for new activities to be defined and planned for the next stage. As the status of system specifications varies from 'open' to 'as built', it is intended in the research that the specification process engenders opportunities for project stakeholders to interact and move forward. Previous studies (e.g. Spear, 2006) have emphasised social networks as key in obtaining and allocating resources and in utilising and articulating shared perspectives and paradigms in a dynamic, on-going way. Our study confirms their studies in that, *firstly*, at different stages of specification development, there are different entrepreneurial activities and they require diverse entrepreneurial skills and attributes; and, *secondly*, a specification process/system determines the nature and type of opportunities for entrepreneurial individuals to deal with knowledge inflows and outflows, information and resources across project and organisational boundaries.

A further insight gleaned from the research recognises the importance of asymmetrical flows of creative outcomes. Examples from the case study companies include successful and profitable projects on the one hand, and less quantifiable projects which enhanced the companies' in-house learning and external reputation. In this respect, we would concur with Amit and Zott (2001), who distinguish between business

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models for value creation and revenue models for value appropriation. Our study, however, suggests two possible sources of uncertainty. One is related to project-specific failure. Both case study companies experienced situations where and when they found they could not carry on system development as specified in the contract. The other is time-related uncertainty. The one-off nature of solution-based operations may mean that complex applications are similar but scattered. The gap between the previous application and the next one sometimes may be too long for both system developers and adopters to keep fresh relevant experience and insight. This will obviously affect a company's cash-flow. The interview with the Technology Director from PPL identified this as an issue: the company struggled to outsource specific engineering expertise, while at the same time leaving 'in-house' specialists with nothing to do.

Stakeholders involved in complex inter-firm-based projects may well experience a situation of 'make-to-concept'. This necessitates creative and risk-taking spirits and activities in the development and implementation of solutions for bespoke customers. Our empirical data show that most entrepreneurial behaviours can be double-edged and there exists an issue of where, when and how to harvest values of what. For this, we argue for the joint effect of key elements (that is, the capability framework, value creation and strategic co-ordination). These key elements have to be developed in a build-in manner to respond to the ever-changing business environment (Tidd and Bessant, 2014; Slappendel, 1996; Spina et al. 2002). We suggest that, in order to maximise opportunities and minimise failures, an open and discrete management style is desirable in order to enact and enable each of these building blocks as 'mini-mechanisms' and to create a 'mega-mechanism' as a whole.

6. Conclusions

This paper investigated how solution-based companies develop their structure and infrastructure elements in order to gain and exploit innovation capabilities in managing complex engineering systems. It discusses key issues that have emerged from a comparative case study and argues for an integrated approach to the 'make-to-concept' businesses in complex projects.

Our study attempted to explore entrepreneurial processes to augment the relevant research literature. We initially considered the distinction between a solution-oriented enterprise and other mass-production businesses. This has consequences for how companies build-up their capabilities, since innovation processes are firm-specific, complex and contingent. Nevertheless, we found it instructive and useful to have developed a framework incorporating three different theoretical perspectives in order to gain insights into the innovative operations process. In more detail, a built-in perspective seeks to integrate a company's innovation resources from individuals, organisational structures and environments. A 'bolt-on' approach focuses a company's innovating effort upon specific processes (for example, R&D and quality management). Enterprising activities cut through these above two strategies and emphasise strength of relationships and opportunities. These three aforementioned perspectives are essentially complementary to each other and have predominantly influenced the creation of the research questions and sampling data management.

We argue that organisational entrepreneurship is part of a structural and infrastructural approach developed to encourage entrepreneurial culture and activities in order to rationalise risk-taking and to tolerate failures in a complex venture business.

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Nevertheless, companies need to seek mechanisms that best maximise opportunities for value creation and accumulation which minimise the chance of unnecessary risk or failure. This contingency, in a real-life project, refers to complex interfacing changes that sometimes have unknown impacts. Based on our research, we posit three primary mechanisms for companies to assist in the design and operation of their complex solution-oriented projects. These comprise *capability framework*, *value creation* (that is, specification management) and *strategic programming*. Together they can form a ‘mega-mechanism’ that entrepreneurially functions to fulfil innovative tasks alongside ‘routine’ operations.

The paper represents a preliminary attempt to understand innovation capability issues in solution-oriented complex innovation milieus. It raises a number of questions and issues for further research. These relate particularly to how project stakeholders specify complex bespoke systems before, during and after complex projects; how flows of information and resources are co-ordinated across participating firms and ‘clustered’ projects; how solution-based values are defined, generated and measured; and, finally, what degree of competitive advantage can be obtained and sustained and at what levels?

To practitioners, the research has provided plenty of evidence to uncover a close relationship between specification management and programme management. Because of the nature of complex projects and open specifications, conflict and tension between external and internal participants is inevitable. Shared and limited resources, interdependent assignments, diverse technical and cultural backgrounds, stressful life cycles, and narrowing marketing windows all increase the potential for conflict to occur during the best of projects and in the most ‘blended’ team. It is in this sense that the research recommends solution-providing or -receiving companies make full use of their specification process to develop and demonstrate their (solution-based) project leadership.

The introduction of the CSC framework and other co-ordination mechanisms will certainly enable the development of abilities to manage effectively the conflict typically associated with time restrictions, resource limitations and knowledge constraints. Managed properly, conflict can enhance team productivity, stimulate innovative thinking, and ensure a higher-quality product. Through the continuous and constructive resolution of conflict, it is possible for solution stakeholders to gain a broader perspective and understanding of the problem by addressing a wider array of issues. By encouraging rather than suppressing the expression of divergent opinions, managers create a reservoir of alternatives from which a solution may eventually evolve, together with their business links and local and niche markets.

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Response letter

Dear Sabry, (Title)

Firstly, many thanks for your feedback on the original paper and for the comments of the reviewers, which were all very helpful and constructive in guiding our revision of the paper.

We have undertaken an end-to-end revision and, by doing this, we think we have addressed all issues raised by the reviewers. We include our responses in details below to help to track the changes we have made:

1. English and other related issues: "… It requires proof reading. … there are a number of spelling and grammatical errors in the paper. It needs to be proof read carefully. Examples are: … " (R2)

Response: all English grammatical mistakes, typos and spelling errors are corrected including those pointed out by the reviewer and what we later found during self-reading-through. A native English speaker and professional service was then paid to have proof-read the whole paper which includes references, the table and the figure, among all other sections.

2. Structure and presentation: "… would encourage the author to better guide the reader through their paper … a paragraph on how the paper is structured … highlights the implications of their paper for managers …" (R1). "It would be nice to include a few more figures/tables to explain concepts." (R2)

Response: a diagram (i.e. Figure 1) has been created to (summarise and) illustrate the three CSC components discussed in the literature. The diagram helps to accommodate the key literature and depict the links between these key components and their links to the concept of organisational entrepreneurship. We have also included three small boxes in Section 4 to summarise empirical findings. We then modified Table 1 by taking away the row of 'Relevance to selected literature' mainly because all these key studies have been displayed in Figure 1. The last paragraph in the Introduction has been rewritten to provide a clearer 'road map' for the audience. Towards the end of Conclusions two paragraphs have been added to recommend for practitioners.

3. Relevant publications from PPC: "The authors could spend more attention work being published in PPC and closer relate their paper to discussions in this journal." (R1) "…there were no references to PPC papers." (R2)

Response: we have gone through the journal publications and narrowed down to four studies that were recently published in PPC and related these to the discussion of our paper. They are now included in the new references list which has been generated in accordance with PPC style.

We look forward to receiving your feedback on the revised paper in due course.

Kind regards,

Cynthia, Yufeng and Lihong

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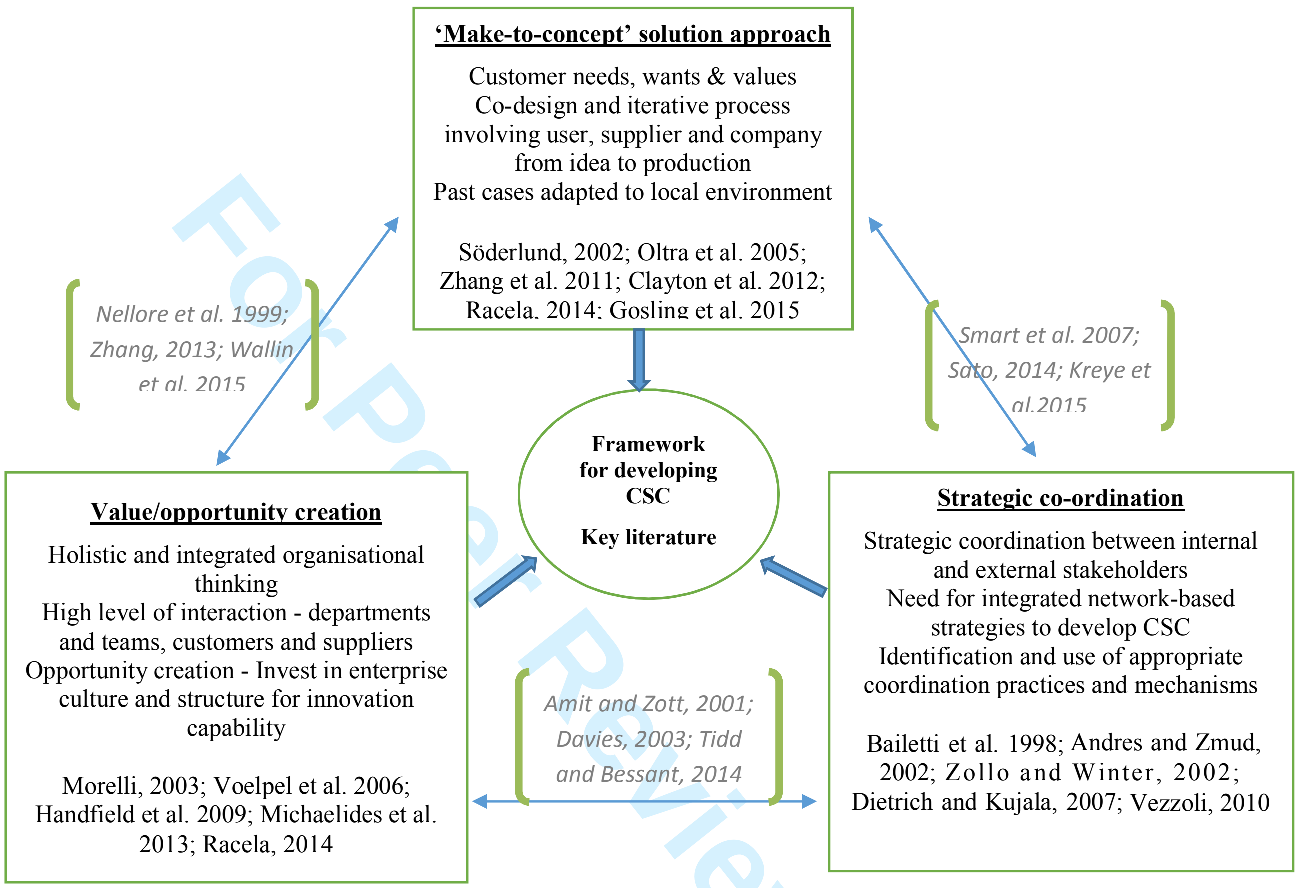

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Table 1. Solution capability attributes of case-studied companies

	Make-to-concept approach	*Value/Opportunity creation*	*Strategic coordination*
SAIC *(System Automation and Information Corp.)*	• A complete solution slogan/label of 'from ideas to production (system)' and asset management. • Anchoring elements: 1. integrated architecture; 2. value-added services and expertise; 3. standardised products; 4 global supply and local capability. • Using previous business cases to categorise expertise, experience, solutions and sectors: 1. modularity and flexible applications; programme management; third-party scheme and solution ownership; parent's lead brands in industrial automation.	• Identifying and investing in (i.e. formalise/visualise) key processes that spot and deliver value for customers: a dedicated specification process that enables project interactions and interfacing at multiple levels: organisational interfacing, system configuration, project change control. • Other processes: business intake process; project supervision; manufacturing as routine process; infrastructure.	• Dedicated expertise resources, org structures and interfaces: ESS (Engineering Systems and Solutions): internal and external functioning, asset management. • Change control • Third-party scheme • Project portfolio • Access to global supply chain – 90% sourced from within the parent company.
PPL *(Power and Plant Limited)*	• A label of 'Total power and energy solution' • 'Creation is better than prediction': Using business cases that have been successfully delivered to illustrate MTC approach and showcase their complex project competence with staff, customers and suppliers. • Integrated core elements that ensure a quality development of business solution: 1. focused manufacturing and contracted engineering; 2. global operations and localised business; 3. core technologies and project experiences; 4. solution process improvement.	• Mainly specification process: organisational interfacing, system configuration, project change control. • Other processes to engage, enable and accommodate innovations: capture and execution, deliverables-based planning, process and key parts' design, materials and services, commercial management, and document and control.	• ESC (Engineering Solution Centre): internal and external functioning, international coordination. • Change control • Orange book • Order book • Access to global supply chain – 75% sub-contracted to international suppliers from China, India, Japan, South Africa, etc.

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PAT (Power and Automation Technology)	• 'Power and productivity for a better world'. • Customised solutions for customers based on PAT's leading technologies and engineering capabilities, based on a range of reference solutions in various areas of applications. • An open ICT-enabled platform to bring together internal engineering teams, suppliers, and customers for value co-creation.	• Product portfolios/groups • Engineering flying faculty • Business annual conferences • Common information platform • Project specification process	• A network of corporate research centre, programme centres, lead centres and support centres. • Change control via group leaders and technology leaders • Dedicated single interface • Technology leadership through program directors and lead engineering.

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Table 2 Make to concept (MTC)solution

• **Make to concept (MTC)solution**
• Use of slogans/labels to reinforce the complete/total solution MTC approach • Focus on customer needs, wants & values for customised solutions based on engineering capabilities • Co-design and iterative process involving user, supplier and company from idea to production • Use of previous successful business cases to inform new solution development

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Table 4 Value/Opportunity creation

• Value/Opportunity creation
• Holistic and integrated organisational thinking • High level of interaction between different departments and teams, customers and suppliers • Opportunity creation • Project specification process • Investing in enterprise culture and structure for innovation capability

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Table 4 Strategic co-ordination

• Strategic co-ordination
• High levels of strategic coordination between internal and external stakeholders, and *international coordination* • Use of a holistic and integrated coordinated strategies of formality, organic and mechanistic dimensions to develop CSC • Uses different coordination practices for CSC development

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