



Organizational information systems competences in small and medium-sized enterprises

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ABSTRACT

We used resource-based theory and evidence from empirical studies to evolve a framework of IS competences in small and medium-sized enterprises (SMEs). The framework significantly improved our understanding of internal IS expertise in SMEs. We used relevant IS competence and SME literature, as well as empirical data from SME case studies. Our set of twenty two IS competences were organized around six macro competences. Each competence refers to a specific ability at the organizational rather than the individual level and they cover a broad range of activities, such as those associated with recognising business opportunities, IS planning, accessing IS knowledge, defining requirements, software and hardware sourcing, applications development, and managing relationships with IS suppliers. The framework was tested against prior literature, including studies of IS adoption, IS success, and entrepreneurial competence. Each competence was fully explained and discussed using evidence from the case studies. The framework creates a comprehensive set of IS competences that can be used in both SME practice and research.

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1. Introduction

SMEs play an important role in the economy of most countries and many IS studies have focused on them since the introduction of micro-computers in the early 1980s. When compared with large enterprises, SMEs usually have a simpler structure with less specialised tasks with poor human, financial, and material resources. Most SMEs have low levels of internal IS expertise, although this varies by industry sector. While there are many high-tech SMEs, many have no IS department, no staff with formal IS training, and no IS manager [6]. In part, to make up for the lack of internal expertise, many SMEs have turned to external experts (consultants).

The lack of IS knowledge and expertise has had consequences for SMEs. For example, many have not engaged in or been slow to adopt e-commerce [8]. A low level of organizational readiness has been offered as one of the reasons for this. Organizational readiness includes the level of knowledge about the Internet by managers, as well as having the technology required in developing

an e-commerce website, etc. [9]. However, there is evidence that some SMEs have been able to develop an internal level of IS expertise, particularly by gaining IS project experience over the years and by employing internal IS experts. Thus it is no longer appropriate to assume that all SMEs have low levels of internal IS expertise. Furthermore, internal IS expertise is important for IS success in SMEs [2,3].

We wished to improve our understanding of internal IS expertise in SMEs. Recent resource-based literature was used to provide insights into the contribution of organizational skills, knowledge, and other resources. A review identified five typologies of IS resources and competences. A major limitation of the typologies was that all had been developed from experiences gained in large organizations, while there is considerable empirical evidence of differences between SMEs and large firms. For example, the motivation of owner managers has often been to seek autonomy and independence, and that strategy and planning were typically short term in an SME [1]. Also, owner managers often dominate the firm and it typically has an informal structure.

As a result of the many differences between SMEs and large firms, many authors have argued that techniques and models from large firms do not apply to SMEs. Also, few models of strategy making for large firms were applicable to small firms. Furthermore, small businesses need a different type of organizational theory.

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SMEs are often resource poor, and resource based theory indicates that they will need different competences to cope with scarce resources. They may also have to rely more on external resources and thus a different set of competences are required, particularly externally focused ones. Furthermore, organization theory indicates that SMEs have a flatter/simpler structure and thus, internal co-ordination is less of an issue as there is close proximity between all staff, including owners and employees. Hence SMEs have less need for an internal competence that links IS staff with others, as in some frameworks [16]. This also touches on the concept of internal power, where politics within the firm can be a common source of concern within large organizations. Such issues are typically less important in SMEs, because the owner-manager(s) wield great power. However, SMEs can be in a relatively weak position compared with large firms when dealing with external providers, e.g., software vendors. Thus SMEs may need different competences to manage this effectively.

Thus, although our literature review identified five typologies of IS resources and competences, it seemed likely that some aspects would be different for SMEs. Furthermore, no studies had examined the applicability of the existing typologies in the SME environment. However, some research of SMEs has used resource-based theory and demonstrated its value in studying SMEs, including IS management involvement and IS technical knowledge and skills. Our study therefore attempted to create a resource-based typology for SMEs.

For our study, SMEs were defined as independent firms with up to 500 employees. The European Community defines *micro* companies (from 1 to 10 employees), *small* firms (from 11 to 50 employees), and *medium-size* companies (from 51 to 250 employees, but it used to be 500 employees). In 2008, the American Small Business Administration defined a small business as a firm that was independently owned and operated, and had 500 or fewer employees for most manufacturing and mining industries. However, in a few industries it permitted up to 750, 1000 or 1500 employees, while wholesale trade industries must have less than 100 employees.

2. Resource-based theory and IS adoption and success in SMEs

Resource-based theory was developed to explain how organizations achieve and sustain competitive advantage. It focuses on the idea of costly-to-copy attributes of the firm as an essential way to achieve superior performance. According to resource-based theory, resources that are valuable, cannot be easily purchased, require a long learning process or are the result of the corporate culture, are more likely to be unique to the enterprise and difficult to imitate by competitors.

Resource-based theory has gained prominence in recent years as there is growing evidence that a resource-based approach may help in understanding how IS resources can influence firm performance [11,13]. The concepts of resource, competence and capability have been extensively discussed and a wide range of definitions can be found [7,12]. However, there is a lack of consensus about these concepts.

We followed the definitions of resources, competences and capabilities adopted by others [12]. *Resources* were defined as “stocks of available factors owned by the firm”. Thus they can include knowledge, financial, and physical assets. *Capabilities* refer to “a firm’s capacity to deploy resources, usually in combination, using organizational processes, to affect a desired end”; thus a capability can be a “meta-level construct”, reflecting the ability of a firm to deliver a product or service, such as highly reliable service, product innovation, or manufacturing flexibility. *Competences* involve the ability to develop, manage and deploy resources in support of a capability. They are thus a set of skills and technologies, while capabilities are the strategic application of competences. This perspective is consistent with that of other authors looking at IS competences in SMEs.

SMEs need a range of skills, including IS, business, and general management skills. In addition, organizational processes are needed to exploit such skills (see Fig. 1).

Many SMEs lack managerial IS skills and even technical IS skills. These skills are more likely to be heterogeneously distributed amongst SMEs than in larger enterprises, which typically have a large IS department. The lack of resources or

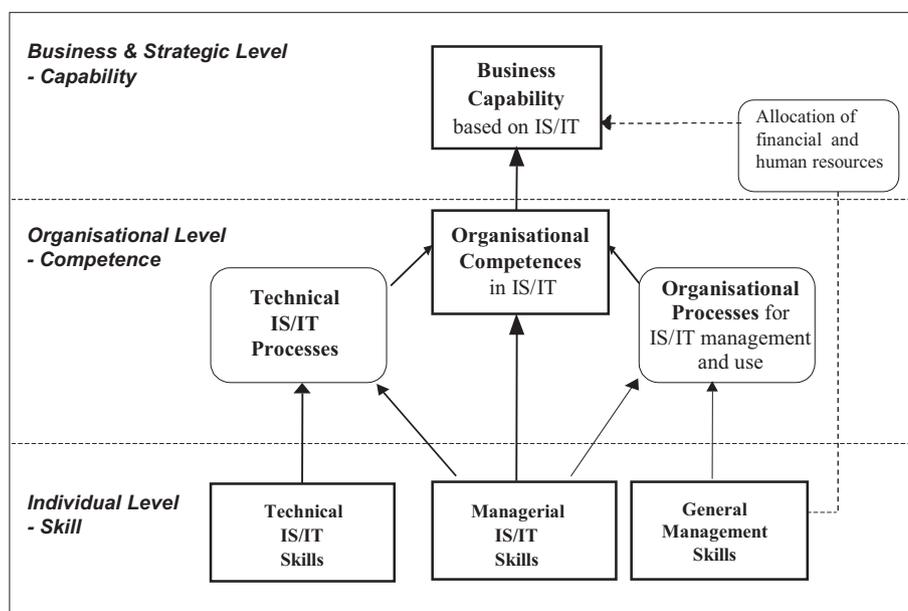


Fig. 1. A resource-based model to understand the successful adoption and use of IS/IT in SMEs. Adapted from Caldeira and Ward [3].

limitations in accessing resources by SMEs increases the relevance and application of the resource-based perspective of the firm to analyze IS competences in SMEs. Unlike larger enterprises, technical IS skills in an SME can be a source of competitive advantage.

3. Frameworks and typologies of IS resources and competences

Our literature review identified five frameworks of IS resources or competences. The major dimensions of each of these are listed in Table 1. They are separately referenced here as:

- I. G. Bassellier, B.H. Reich, I. Benbasat, Information technology competence of business managers, a definition and research model. *Journal of Management Information Systems*, 17(4) (2001) 159–182.
- II. D. Feeny, L. Willcocks, Re-designing the IS function around core capabilities, *Long Range Planning*, 31(3) (1998) 354–367; D. Feeny, L. Willcocks, Core IS capabilities for exploiting information technology, *Sloan Management Review* (Spring, 1998) 9–21.
- III. J. Peppard, J. Ward, Beyond strategic information systems: towards an IS capability, *Journal of Strategic Information Systems*, 13 (July 2004) 167–194; J. Peppard, R. Lambert, C. Edwards, *Whose job is it anyway?: organizational information competencies for value creation*, *Information Systems Journal*, 10 (2000) 291–322.
- IV. V. Sambamurthy, R. Zmud, At the heart of success: organizationwide management competencies, in: C. Sauer, P. Yetton (Eds.), *Steps to the Future: Fresh Thinking on the Dynamics of IT-Based Organizational Transformation*, Jossey-Bass Publishers, San Francisco, 1997, pp. 143–163.
- V. M. Wade, J. Hulland, Review: the resource-based view and information systems research: review, extension, and suggestions for future research, *MIS Quarterly*, 28(1) (2004) 107–142.

It is important to note that these studies have used different terms and definitions. For example, Bassellier et al. [I] focused on the competences of individual managers, while the unit of analysis for the other studies was the organization. Some of the studies at the organizational level were broader than the others. For example, Peppard & Ward [III] focused on competences, while Wade & Hulland [V] focused on IT resources, which they defined as a broader concept that included IS infrastructure, e.g., hardware, and software. To Wade & Hulland, capabilities were a firm's resources.

While others started from scratch, the Wade & Hulland typology was based on a synthesis of 24 IS papers that had used resource-based theory; these included [II], but not the others. As a result, the Wade & Hulland typology was broad and intended to reflect all types of IS resource. The aim of being comprehensive meant that Wade & Hulland did not restrict their typology to IS resources that were particularly important for organizational success, as did Feeny & Willcocks. The Wade & Hulland typology also included resources like IS infrastructure, which they felt

would not typically create competitive advantage. For example, Feeny & Willcocks argued that project management was a broad capability, not specific to IS. They also made little mention of the need to manage in-house development and maintenance, and change management, which have been identified by others as key to IS success and were included in Wade & Hulland. Instead, Feeny & Willcocks presented a set of core capabilities essential for a high performance IS function; this is the only one to include the concept of leadership, but their nine capabilities emphasised supplier relationships. However, by being more narrowly focused, they provided extra detail about some specific resources or competences.

The work of Bassellier et al. focused on IT competences of individual managers rather than on organization-wide competences. They viewed IT competence from a knowledge perspective, including both explicit and tacit knowledge as needed to perform well. In contrast, Sambamurthy & Zmud focused on IT management competences, with the firm as the unit of analysis rather than the individual. They argued that IT management competences were likely to be relatively stable over time. The 2004 typology of Peppard & Ward is shown in Appendix A.

An important difference between the Wade & Hulland and Peppard & Ward typologies is their underlying philosophy. The work of Wade & Hulland is based on resource-based theory and the authors refer to their work as a *typology of IS resources*, while Peppard & Ward referred to their's as *competences*, which they see as different from resources. To Peppard & Ward, IS resources are combined to create IS competences. Despite this difference, the content of the two sets overlaps significantly, although they have been organized using two very different frameworks. Some similarities include: IS planning and change management, alignment, relationships with suppliers and IS development. With the exception of IS infrastructure, all of the Wade & Hulland resources were addressed by the Peppard & Ward framework, and vice versa. A strength of the Peppard & Ward framework is that it provides an extra level of detail, i.e., they defined six macro-competences and their many sub-dimensions. Each macro-competence contains related but distinguishable competences. Experience of its application showed that this was valuable to organizations in both assessing specific issues and then acting to address inter-related sets of inhibiting competences.

4. Methodology

The literature indicated that firms possessed many types of IS resources and that many competences were needed for IS success. However, as much of this was for large organizations, the following research question drove our research: What IS competences are relevant to SMEs?

The five typologies provided a valuable base for the next stage of our project: to create a framework that was relevant to SMEs. This involved many steps. As the initial step could influence the

Table 1
Summaries of resource-based IS typologies.

[I]	[II]	[III]	[IV]	[V]
Technology Applications	IT governance/leadership	Formulate strategy	Business deployment	External relationships management
System development	Business systems thinking	Define the IS contribution (IS strategy)	External networks	Market responsiveness
Management of IT	Relationship building	Define the IT capability (IT strategy)	Line technology leadership	IS-business partnership
Access to IT knowledge	Designing technical architecture	Exploitation	Process adaptiveness	IS planning and change management
Experience	Making technology work	Deliver solutions	IT planning	IS infrastructure
Cognition	Informed buying	Supply	IT infrastructure	IS technical skills
	Contract facilitation		Data centre utility	IS development
	Contract monitoring			Cost effective IS operations
	Vendor development			

process, the empirically derived Peppard & Ward framework was selected, because:

- it was relatively recent and referred to competences, rather than resources or knowledge and was the most comprehensive;
- the 26 competences provided a level of detail that was useful as a research tool, compared with the other frameworks that had less than 10;
- it had been developed from a synthesis of prior research, including two of the other typologies in our study and an extended empirical study involving 12 organizations in a range of different industry sectors. The framework is an organization-wide framework, rather than focusing on only the IS department. This made the framework particularly relevant to SMEs who typically have no IS department. Furthermore, compared with the other frameworks, the Peppard & Ward framework was developed using a combination of research methods, including prior literature, case studies involving action research and focus groups with managers from a range of organizations. Peppard & Ward subsequently revised some of the competence titles and descriptions, based on the practical application of the framework in more organizations, to enable the competences to be more readily understood by business managers; thus we used the terminology of this later (2004) version.

Creating the new framework involved a number of steps where different sources were considered. This involved a process of repeated comparative assessments where revised versions of the framework were created after considering each new source:

- Step 1 started with the original 26 Peppard & Ward competences. We asked: how relevant is this competence to an SME and can it be explicitly identified? About half of the competences were retained with some refinement of the definitions. For example, the staff development competence (6.5) of Peppard & Ward referred specifically to IS staff. The competence was deemed relevant to SMEs but, as many have no IS staff, it was revised to refer to all staff. Some competences were combined and one was split into two. For example, competences 2.3 and 2.4 were combined to form one involving business process management. Three competences were combined (1.2, 2.5 and 3.2) to create one that dealt with IS innovation. The original competence on sourcing strategies (3.3) was split in two to deal with software sourcing strategies and IS acquisition processes.
- Steps 2 and 3 appraised the extent to which the revised framework contained and retained the competences included in the initial framework using the work of Sambamurthy & Zmud and Feeny & Willcocks. The framework was amended specifically to recognise a competence of particular importance to SMEs: 4.4 inter-organizational collaboration.
- Steps 4 and 5 were similar but compared the framework with Bassellier et al. and Wade & Hulland. For each, we addressed the question: does it add anything to the revised framework? As well as refining competence definitions, this step added the two competences: 2.4 accessing IS knowledge, and 4.3 project management.
- Step 6 involved examining empirical data from our 22 case studies. The case notes were examined in two different ways. First they were analyzed to seek evidence on the proposed IS competences and how they influenced IS adoption and successful deployment. Second the case notes were analyzed to see if they indicated any additional IS competences, i.e., those that were not already in the framework.
- Step 7 focused on a review of the newest version. We asked: does this incorporate the set of competences of Peppard & Ward in some way? In addition we looked for any overlaps between

competences or omissions based on other frameworks or the case studies.

Finally, literature was examined to see if it raised any new issues and thus check that the framework was complete.

Our empirical data came from 22 SMEs from three different studies: 9 firms based in Portugal, 9 in the United Kingdom and 4 in New Zealand. Firms operated in several industries and included manufacturing and service firms. All enterprises had less than 450 employees and annual turnover below 30 million euros. The firms represented a broad range of SMEs in terms of IS success, not just SMEs that had been successful with IS (see Appendix B). Three similar research projects, in three countries, were conducted separately and then integrated and analyzed. The firms were not randomly selected. Instead, firms were selected to cover different levels of IS adoption and success in order to understand the relevance of IS competences in achieving successful IS deployment through analytical generalization. IS impact was used as a surrogate measure of IS success and measured using an earlier SME instrument.

Most of the empirical data was collected through semi-structured interviews, including open-ended questions with entrepreneurs, CEOs, managers, IS people, and key IS users. The interviews were recorded. A short questionnaire was also used to collect data in a consistent way; this was structured and coded for analysis using our framework, plus other items such as IS success factors and IS practices. Since most data was semi-structured from open-ended interviews, the interviewee was free to introduce into the discussion any issue that he/she considered relevant. This reduced the probability of the phenomena under study being explained by other variables than the ones reported by the interviewees and identified in data analysis. Data was analyzed in an attempt to identify causal relationships and find supporting statements.

5. Organizational IS competences in SMEs

From our analyses we created a new framework which consisted of 22 competences, as shown in Table 2. Many of the competences were similar to those of Peppard & Ward, but many are new and include ideas from the other frameworks and our case studies. As a result, the framework is more comprehensive than its predecessors.

5.1. Macro-competence 1 – business and IS strategic thinking

This set of competences affect an organization's ability to identify and evaluate the need for IS in providing opportunities to develop a better business strategy and to manage the IS activities effectively, including establishing an appropriate IS organization and defining roles, responsibilities and policies. The macro-competence “formulate strategy” in Peppard & Ward's framework was replaced by “Business and IS strategic thinking” to recognise the informality of strategy in most SMEs.

5.1.1. Competence 1.1 – IS innovation

This involves assessment of the firm's ability to recognise business opportunities available from the use of emerging hardware and software products. Some SMEs are more innovative than others, with a manager or managers always on the lookout for new ways to differentiate or improve their firm's performance. For some managers, IS is part of this innovative thinking and reflects his or her personal characteristics of imagination and creativity. As the CEO of one of the most successful firms implementing IS said: “the cost of investing in technology is low and the important thing is the ability to change, to differentiate”. However, in many SMEs,

Table 2

A framework of organizational IS competences in SMEs.

Macro competence	Competence	The ability to...
1. Business and IS strategic thinking	1.1 IS innovation	recognise business opportunities from current and emerging hardware and software applications. Ideas can come from IS suppliers, employees, competitors, clients, consultants or other businesses.
	1.2 Business case and investment criteria	define a business case and establish appropriate criteria for decision making on IS investments.
	1.3 Including IS in business strategy	incorporate current and new IS into plans for the business, including an IS budget or a willingness to invest in IS.
	1.4 Information governance	define information management policies and review the effectiveness of IS within the organization, including IS value, policies, roles and responsibilities of general management and any IS staff.
2. Define IS contribution	2.1 IS alignment	change (or stabilize) the IS programme according to business priorities to ensure IS plans are integrated with organizational needs or business strategy.
	2.2 Business Process Management	design and improve business processes of the organization.
	2.3 Define IS requirements	define appropriate business requirements for software applications.
	2.4 Accessing IS knowledge	identify appropriate people (within or outside the firm), organizations, and secondary information sources (e.g., internet, books, conferences, etc.) to seek guidance on IS issues.
3. Define the IS strategy	3.1 Software sourcing strategies	define appropriate software sourcing strategies, for example: package acquisition, in-house development, contract-out, outsource.
	3.2 IS acquisition processes	establish criteria and processes to evaluate supply options and contracts with IT suppliers.
	3.3 Technology infrastructure requirements	identify and develop appropriate hardware infrastructure requirements.
4. Exploitation	4.1 Benefits management	explicitly identify, plan and evaluate the benefits derived from IS investments and use.
	4.2 Managing change	make the business and organizational changes required to maximise the benefits of IS adoption. It requires top management commitment and often top management involvement, to involve others.
	4.3 Project management	manage project scope, resources and time, through planning, organizing and controlling, usually involving multidisciplinary teams.
	4.4 Inter-organizational collaboration	develop collaborative alliances and work with business partners (e.g., customers and suppliers) to enable external IS integration.
5. Deliver solutions	5.1 Applications development	develop or customise in-house software applications that satisfy business needs.
	5.2 Implementation and integration	implement and integrate IS that satisfies business needs.
	5.3 Apply and use technology	use computers and develop IS skills by managers and other users in the organization.
	5.4 Business continuity and security	provide effective recovery, contingency and security processes to prevent risk of business failure.
6. Supply	6.1 Manage IS supplier relationships	develop value added relationships between the business and IS suppliers (external and internal), including service level agreements and contract management (performance monitoring, problem resolution and negotiating amendments).
	6.2 Information asset management and maintenance	ensure technology, data and application assets are effective. This requires that they are reviewed and maintained. It includes, for example, controls and procedures for the use of IS, costs, operational policies for network management and data quality.
	6.3 Staff development	recruit, train and deploy appropriate staff and ensure technical, business and personal skills meet the IS needs of the organization.

managers give little thought to how new uses of IS could affect their business strategy. The firms that were more successful with IS adoption and use were constantly looking at new IT techniques and how to incorporate them into the business processes of the firm. As the Vice-president for operations of a mould manufacturing firm, stated: *“Sometimes I think we are more innovative than large multinational enterprises. They see these technologies (IS) as interesting, they have them, but then they do not use them properly”*. Major sources of ideas are competitors, firms in other industries, and firms in other countries.

5.1.2. Competence 1.2 – business case and investment criteria

After identifying a potential opportunity for IS, some firms can formally evaluate this and translate it into a full business case. However, most SMEs tend to do a very informal evaluation and do not use a formal process or set of criteria to evaluate IS investments. Investment criteria typically focus only on the hardware and software, and not the full costs of training and maintenance. Benefits are often operational, but some managers seek strategic advantage. As one IS person stated *“I tend to be able to*

spend more or less what money we need, as long as they see the benefits”. The evaluation process often involves discussions with others outside the firm, e.g., vendors, other users, and visiting other organizations.

5.1.3. Competence 1.3 – including IS in business strategy

This involves the ability to incorporate current and new IS into plans for the business, including an IS budget or a decision to invest in IS. Although strategy formulation is typically informal, many SMEs do create formal plans on an annual cycle. These are revised and sometimes only created on an *ad hoc* basis; e.g., when a new opportunity occurs. Many plans include a budget for new IS investments. A key benefit of formalising the plan is that all senior managers become aware of developments and have an opportunity to comment on and question this investment. Often a manager champions an IS project and argues its case with fellow managers. At one UK engineering firm these discussions were typically carried out at their monthly management meetings. At other firms, much of the discussion took place when managers met informally, e.g., for a tea break. Sharing ideas and convincing others is important so that IS

initiatives become part of the plans for the business. As the managing director of a foundry employing 90 staff commented “We have a written business plan. IT was an integral part of it”.

5.1.4. Competence 1.4 – information governance

This entails firms defining information management policies and reviewing the effectiveness of IS within the organization, including IS policies, roles and responsibilities of general management and any IS staff. Some SMEs formally review many aspects of the firm on a regular basis. For example, one electrical engineering firm with 40 staff had an annual retreat for the senior management team where they asked ‘how are we doing?’ and ‘what do we need to do next year?’ The retreat included IS staff and thus IS was reviewed at least annually company-wide. However, most SMEs only review IS when things go wrong, and the review tends to be limited in scope. Although few of the SMEs studied have defined their information management policies in a formal way, most assign IS roles and responsibilities to managers and staff. As a result, most SMEs have at least one person with IS as one of their major responsibilities.

5.2. Macro-competence 2 – define the IS contribution

This set involves translating the business strategy into investments in IS that achieve both performance improvements and meet information needs; this includes change plans to achieve full value from the investments. A key aspect is to synchronise the IS investments with the business priorities.

5.2.1. Competence 2.1 – IS alignment

This requires the firm to stabilize, adapt or even change its IS investments and plans to reflect the business priorities. Speed is a key element as some SMEs are able to realign IS relatively fast. Some are quicker to recognise the need for change, but many are slow to change, because they rely heavily on packaged software and are reluctant to make a major change or take risks when investing in new IS. Also, in many SMEs, IS is the responsibility of one of the senior managers and IS developments are biased towards his or her area of the business, so that other business areas are almost ignored.

5.2.2. Competence 2.2 – business process management

This depends on the firm’s ability to design, rethink, and improve business processes through the use of IT. Firms that are most successful in IS adoption are generally looking for business performance improvements and consider IS as a way to increase productivity. They are able to redesign business processes to include IT. In one manufacturing firm, business processes were significantly and successfully redesigned when 3D CAD/CAM was introduced into the organization. There was an understanding from the start that the new technology would require new people and new business processes.

5.2.3. Competence 2.3 – define IS requirements

A firm must be able to define appropriate business requirements for software applications. Many SMEs find that they need a new system, e.g., for computer aided design, but can only do so at a high level. As a result, they often find it difficult to select the best of possible application packages, or to specify their needs in the development of tailored software. When seeking a job tracking system, a plastics manufacturer stated: “We looked at existing software and decided that they would force the firm to change its ways. We wanted to have a system that was designed around our ways rather than having to change the company to suit it.” Although managers from some SMEs visit and discuss specific packages with other users/firms, they often fail to recognise these limitations and implications.

5.2.4. Competence 2.4 – accessing IS knowledge

This requires the identification of appropriate people, organizations, and secondary information sources (e.g., internet, conferences, etc.) to obtain guidance on IS issues. This is particularly important in SMEs as most have relatively little experience with IS. Furthermore, many SMEs “get confused” when looking for IS guidance, i.e., they are overwhelmed by technology and advice about it. As a result, they fail to find someone who is able to help them in language they can understand. This problem is compounded by a lack of affordable advice, combined with a reluctance to pay for consultants. The managers of the most successful SMEs adopting IS create business networks and use them effectively. These may include someone with specialist IS knowledge, like an IS consultant. In addition, managers use written sources of information to seek guidance on IS issues. This typically includes use of the Internet as well as business magazines.

5.3. Macro-competence 3 – define the IS strategy

To complement the set of competences needed to identify the best IS investments the organization needs to define the information and application architectures, technology infrastructure and IS resources it needs to enable the resources to be successfully bought and/or implemented.

5.3.1. Competence 3.1 – software sourcing strategies

This requires the ability to define appropriate software sourcing strategies, for example: package acquisition, in-house development, contract-out, etc. Most SMEs buy packaged software as it is widely available and relatively cheap. However, it is not appropriate for all firms, particularly those that are early adopters or wish to use IS differently. The CEO of a textile manufacturing company that showed moderate success with IS adoption and use, said: “I believe that a firm that wants to develop software should get software developed externally but it must have at least one IT person. The role of this person should be: contact software houses, provide IT training, and solve users’ problems”.

5.3.2. Competence 3.2 – IS acquisition processes

This requires the establishment of criteria and processes to evaluate supply options and contracts with IS suppliers. Although some SMEs tend to stick to a preferred software supplier, many seek out a good deal when acquiring software. This places them in a position where they have to evaluate both the software and the suppliers. Both evaluations are important and a poor or unlucky decision can lead to problems. Managers tend to focus on the software and often fail to evaluate the suppliers. Only the most successful firms using IS effectively had generic but informal criteria for selecting their IS suppliers. Some managers relied heavily on the views of existing users. In addition, contracts have become common and some SMEs seek legal guidance. Most of the SMEs studied did not feel completely comfortable in selecting IS vendors. In one of the cases, a wine producer with 170 employees and 30 million euros turnover, selected an ERP but the user managers found that technical support was poor: “The software has big problems in terms of support. When we started, there was only one firm distributing the product in this country. However, their knowledge of the package was very poor. . . . The package is good, but nowadays support is very difficult to find. . . if I call someone from Belgium or Barcelona they are very good but it is expensive”.

5.3.3. Competence 3.3 – technology infrastructure requirements

Identifying and developing appropriate technology infrastructure requirements is not usually a formal process in SMEs, as most rely heavily on external advice about IS infrastructure. Few have sufficient knowledge of IS architectures. As the manager of a

successful engineering firm put it “*We use a local company. . . we discussed it with them, agreed on a spec and they went and built it (a file server) – when it goes wrong they’ve got to come and fix it*”. Many firms that showed positive levels of IS satisfaction could present simple ‘maps’ of the applications, information and technology and IS integration.

5.4. Macro-competence 4 – exploitation

Most organizations concentrate on processes to develop IS assets, but to achieve IS advantages, it is important to have effective use processes. Such competences therefore relate to the organization’s ability to increase the benefits from effective use of information and application investments.

5.4.1. Competence 4.1 – benefits management

Although several SMEs evaluate the costs and potential benefits of IS investment, little or no formal benefits planning and evaluation takes place. A proper benefits management approach requires more mature IS management and financial control than is present in most SMEs. Managers were sometimes surprised with the benefits that they achieved by using IS. However, very few tried to manage the process in a way that ensured the achievement of the planned benefits.

5.4.2. Competence 4.2 – managing change

This depends on an SME making the business and organizational changes to increase the benefits of their IS. The firms that were successful in IS adoption understood that top management interest was critical to enable the achievement of business and organizational change. In an engineering firm, the managing director gave a monthly talk to all staff and often this included IS issues. Cases of resistance to change were identified in many of the firms. It was one of the major problems in less successful firms. The CEO of a firm that manufactures cement pipes and had moderate success with IS adoption, explained this as follows:

At the beginning, people did not react well to IT adoption. They felt they were being controlled. . . . After IS training, people started to understand better what the system was and that the objective was not to control people, but materials in the warehouse. . . I do not believe a project like this [would succeed] without a complete involvement of the CEO. . . . When people complain it is necessary to say: “I already told you it must be done in this way, and that is all!”; “do not tell me that!”; “not today”, etc. . . Then, what will happen is that after a while you will find that everyone was agreeing with the new system from the beginning.

5.4.3. Competence 4.3 – project management

This includes managing project scope, resources, and time, through planning, organizing, and controlling, usually involving multidisciplinary teams. Many SMEs, particularly engineering firms, adopt a project management approach throughout the firm, e.g., to design a machine or a building for a customer. Thus, a major IS acquisition becomes a project for the firm, which is managed using their normal business processes. Many SMEs possess little project management expertise or follow a very informal project management approach and they then rely heavily on their software supplier in running a project.

5.4.4. Competence 4.4 – inter-organizational collaboration

This involves the ability for an SME to develop collaborative alliances and work with business partners (e.g., customers and suppliers) to enable IS integration. Many SMEs have large organizations as their customers who demand that they use,

and thus become part of, an IS network in order to reduce costs and delivery times. The owner of a UK precision engineering firm commented: “*our three major customers were all asking us to adopt and use CAD data as they are now designing all their components using CAD*”. Thus this competence focuses on collaboration with customers and non-IS suppliers to create an external IS network.

5.5. Macro-competence 5 – deliver solutions

An organization needs to be able to convert requirements into working IS assets (business solutions) that perform according to specification and can be integrated effectively with other systems and processes.

5.5.1. Competence 5.1 – applications development

Although many SMEs have comparatively limited financial resources, some have developed their manufacturing applications in-house because they could not find software in the market that was an adequate fit with their specific needs. In a textile manufacturing firm, the entrepreneur was proud of his real-time software system, and set up a software house to develop and sell it to firms in similar industries. Financial resources were typically not an important issue. Firms often found a way of developing systems at low cost. For many firms, customisation of a package was the key to success but this required someone with IS expertise working alongside those with a detailed knowledge of business requirements. One IS professional commented “*better to stick with a package and maybe improve it a little*”. Successful firms tried to improve their business processes through IS. These firms developed software applications in-house or in an associated enterprise.

5.5.2. Competence 5.2 – implementation and integration

This is a technical competence at the operational level and includes technology installation, data conversion, and user training. Most SMEs rely on external suppliers to install any new hardware and software. The supplier then provides some initial, brief training to at least one person within the firm. The most successful implementations were under the control of the CEO or another senior manager, who often would be directly responsible for that area of the business. This manager follows the installation, liaises with suppliers, and involves other staff and managers as needed.

5.5.3. Competence 5.3 – apply and use technology

There are two important requirements:

- the competence directly impacts a firm’s ability to adopt IS. If the staff has low hands-on skill levels or little willingness to use IS, then adoption is significantly handicapped.
- the right attitude towards IS through user experimentation and the acquisition of additional IS skills must be encouraged. Managers can act as good role models for other managers and staff. SMEs that are successful with IS tend to have managers and staff who utilize many different IS applications and expand their use of IS. As stated by the administration manager of a metal welding firm, “*we have no IT manager but there are 6 or 7 others who are regular users, keen, and creative*”.

5.5.4. Competence 5.4 – business continuity and security

This involves providing effective recovery, contingency and security processes to prevent risk of business failure. Business continuity and security did not seem to be a significant issue in the SMEs studied. Typically, many firms have one individual who takes responsibility for regular backups, including taking files off-site. However, many SMEs rely heavily on external expertise to manage network security as few firms have a person with that expertise. Few SMEs have plans for a major disaster like a fire, so there is significant potential for improvements in this area.

5.6. Macro-competence 6 – supply

This is a set of operational competences that allow the organization to create and maintain its technology resources and applications through effective management of the IS supply chain and internal and external IS resources.

5.6.1. Competence 6.1 – manage IS supplier relationships

This is intended to develop value added relationships between the firm and its IS suppliers, including service level agreements and contract management (performance monitoring, problem resolution and negotiating amendments). This competence goes beyond making sure that a system is implemented successfully. It focuses on the relationship of the SME with its IS suppliers and the desire for a relationship that works well for both the SME and its supplier. Ideally, the SME would gain access to new versions as well as trigger improvements to meet their specific needs. Trust is a very important factor. It can sometimes be based on personal relationships or family ties. Some firms are better at managing IT acquisition. For example, one firm had an IS academic as a shareholder. Thus: “*We started to deal better with that strange world, because suppliers understood that we knew what we were looking for.*”

5.6.2. Competence 6.2 – information asset management and maintenance

This requires that the firm’s technology, data, and application assets are regularly reviewed and maintained at a high level of performance. It includes, for example, controls and procedures for the use of IS, costs, operational policies for network management and data quality. While some SMEs employ an IS professional in a network administration role, many firms do not have a person with formal IS training. Instead they rely on a member of staff to keep their systems running. As a result, many SMEs have weak procedures for IS asset management and maintenance. Often improvements to procedures arrive too late, e.g., after a small crisis. Some SMEs pay for a six-monthly or annual review of their processes.

5.6.3. Competence 6.3 – staff development

This deals with the organization’s ability to recruit, train and deploy appropriate staff and make sure that technical, business and personal skills meet the IS needs of the organization. While some SMEs have an IS specialist, many have not. Furthermore, many SMEs are reluctant to provide formal training, e.g., through seminars or courses. The managing director of an engineering firm commented “*We knew that the whole IT thing was growing at an enormous rate ... and we needed somebody in the organisation who understood it in some depth.*” Another firm, a mould manufacturer, had its own training centre. Some managers regularly attend seminars. However, most SMEs rely on members of staff to take the initiative by attending courses in their own time or learning about IS from magazines or the Internet. In the more successful firms, managers or staff provide informal training to others within the firm. The most enlightened SMEs encourage managers and staff to take advantage of seminars or courses offered by local business development agencies and other organisations.

6. External validation of the framework

SME-based literature was used to test the content of the IS competences framework. The framework would be deemed to be incomplete if the literature identified variables and issues that were not included in the framework. The areas of IS adoption and IS success were chosen as this literature has identified many factors that influence IS use, including a lack of resources or competences. If the framework was to be comprehensive then these influences

were expected to be found in our framework. In addition, it was tested against the broader area of entrepreneurial competence.

6.1. IS adoption literature and the IS competences framework

Various factors influence IS adoption by SMEs, including e-commerce. A recent review identified a broad range of factors, including some termed *internal*, i.e., factors that the firm could influence [4]. Eight of these mapped well onto the IS competences framework. For example, their ‘role of management’ reflected enthusiasm (4.2), and interest in IT and e-commerce skills (5.3). Their ‘leadership qualities’ focused on managers being innovative, pro-active, and entrepreneurial, as reflected in the business and IS thinking competences (1.1, 1.2 and 1.3). Other factors addressed by the review were: e-commerce driven (1.1, 1.2), e-commerce strategy (1.2 and 1.3), human (4.3), IT skills (5.1), e-commerce skills and experience (5.1, 5.2, 5.3, 6.2) and e-commerce infrastructure (5.2, 5.4). The factor that did not map well onto the framework was *financial*, which was deemed to be outside the scope of IS competences, as it referred to the availability of capital.

Other recent IS adoption literature focused on inhibitors to SMEs adopting business process management [5]. Of the set of five inhibitors, two (financial resources, and manager/staff time) were outside the scope of the IS competences framework. One inhibitor focused on a lack of support for IS from senior management (1.1, 1.2), another on a lack of IS knowledge and expertise amongst staff (5.3).

6.2. IS success literature and the IS competences framework

Many studies have focused on factors that influence IS success. This research mapped well onto the IS competences framework. For example, studies of small firms in Singapore examined top management support for IS by focusing on CEO involvement in IS projects [14]. This particularly reflected the business and IS strategic thinking competences (1.2, 1.3) as well as the exploitation competences (4.2, 4.3). User’s IS knowledge reflected the ability to apply and use IT (5.3). Technical capability involved the ability to develop or customise in-house software (5.1).

The IS success literature also identified factors that were outside the scope of the IS competences framework. In particular, the IS success literature included external expertise in the form of consultant effectiveness and vendor support [15]. In addition, financial resources were included as a resource. None of these were deemed to be internal organizational IS competences.

6.3. Entrepreneurial competences and the IS competences framework

While our analysis focused on the IS literature, the IS competences framework was further analyzed by examining a broader framework, i.e., one that included the competences of entrepreneurs [10]. This set of 45 competences was based on the behaviour of individuals rather than firms. Although it is focused on individuals, the typology was deemed to provide another opportunity to check the completeness of the IS competences framework as managing IS could be viewed as *managing the firm’s total IS business* rather than entrepreneurship as *managing the whole business*.

The 45 competences were grouped under seven headings: opportunity, relationship, conceptual, organizing, strategic, commitment, and supporting. All of these competences are similar to those in the IS competences framework, with four showing significant similarities. For example, their opportunity competence is similar to parts of the IS strategic and business thinking competences, particularly those of IS innovation (1.1) and defining a business case (1.2). Significant similarities can also be found for relationships (2.4, 4.2, 4.4, 6.1), organizing (1.3, 1.4, 4.3, 6.2), and strategic (1.1, 1.2, 1.3, 1.4). The degree of similarity between the

two frameworks was less for the other three entrepreneurial competences of conceptual (1.1), commitment (1.3, 4.2), and supporting (6.3). This lack of similarity in part reflects a focus on individuals rather than the firm. For example, competence in managing time and evaluating oneself are at the individual level, while project management (4.3) and governance (1.4) are at the organizational level.

To summarise, an examination of prior SME-based IS literature failed to identify any new concepts that could be expected to be included within an IS competences framework for SMEs. Furthermore, significant similarities were found between the framework and a set of entrepreneurial competences.

7. Discussion

Our major contribution was in providing a framework that included a comprehensive set of organizational IS competences specifically relevant to SMEs. Our framework united earlier work using a resource-based perspective to describe required IS competences for SMEs.

We argue that IS competences cover a broad range of topics that have already received considerable attention. For example, they include competences that reflect all stages of the systems development life cycle: recognising opportunities, IS planning, defining requirements, software sourcing, applications development, change management, implementation, and use. The framework also integrates some competences related to IS topics that have received less attention, including accessing IS knowledge, benefits management, inter-organizational collaboration, and staff development. Our framework built on earlier work and proved robust when tested against practice.

As a result, the framework is more comprehensive than its predecessors: it made full use of prior work and overcame the weaknesses of earlier frameworks. Our new framework provides more detail about each competence and this should make it easier for practitioners and researchers to use and apply it consistently.

Finally, while many of the competences have been shown to apply to large firms, our framework was created for the SME context. While the framework was aimed at providing help to all SMEs, it is probable that some SMEs will possess more IS competences than others. Furthermore, it is expected that some will require a greater range of IS competences in order to achieve their business goals.

7.1. Implications for research

The major implication of the IS competences framework for research is that it provides a comprehensive and coherent framework for all to use when examining and comparing IS adoption and use in SMEs. The framework could be used to identify which IS competences had the most influence on firm performance and indicate areas that SMEs need to address to increase their

performance. Thus SMEs could develop IS resources that support and enhance core competences at the firm level.

The competences framework identifies many new ways that managers can provide support for IS, e.g., by recognising business opportunities, defining a business case, accessing appropriate people, managing change, project management, and managing supplier relationships. Thus the breadth of coverage of the competences framework could make it a valuable tool and help researchers become more precise and consistent in their descriptions and use of terms.

7.2. Implications for practice

Our research suggests there is a relationship between IS competences and IS success, thus an SME would benefit from using the framework to undertake an IS competence assessment before investing in new systems or starting a major IS project. Such a review could identify areas that the firm needs to address and avoid it making unwise or unsuccessful investments. The firm could actively seek to address any particular weakness, e.g., increasing its IS knowledge by training, engaging a consultant, etc. Thus our framework could assist in organizational development in SMEs.

Because many SMEs have very limited IS competence, Governments or business organizations could increase the economic contribution of SMEs if they establish ways of identifying significant gaps that limit the deployment of modern IS in SMEs. This framework could help understand which approaches are likely to be most effective in developing the essential competences across the spectrum of SMEs and reduce barriers to IS adoption.

7.3. Limitations

A limitation of the study is that we selected a set of five existing frameworks rather than start from scratch. Although we tried to examine all existing frameworks, others may exist that could have influenced the final framework. Also, other researchers could have interpreted the earlier studies in a different way or a different starting framework could have resulted in a different final position.

Another limitation is that it is impossible to test and validate such a framework. Thus, others may identify gaps in our framework: it may not be complete, despite our attempt to incorporate important content and then test it against evidence from a broad range of SMEs and other literature that had not been used in creating the framework. The IS competences framework has its own limitations; it will not be suitable for use in all situations. In particular, it focused on SMEs and makes no claim of being applicable to larger organizations. The framework is also focused on the area of IS rather than other organizational competences and is aimed at identifying and describing competences as abilities at the organizational level rather than for individuals or an IS department.

Appendix A

The 26 Peppard and Ward IS competences [12].

1. Formulate strategy	1.1 Business strategy	Ensure that business strategy formulation identifies the most advantageous uses of information, systems and technology.
	1.2 Technology innovation	Incorporate the potential of new and emerging technologies in long term business development.
	1.3 Investment criteria	Establish appropriate criteria for decision making on investment in information, systems and technology.
	1.4 Information governance	Define information management policies for the organization and the roles and responsibilities of general management and the IS/IT function.

Appendix A (Continued)

2. Define the IS contribution (IS strategy)	2.1 Prioritization	Ensure that the portfolio of investments in application and technology produce the maximum return from resources available.
	2.2 IS strategy alignment	Ensure that IS development plans are integrated with organizational and functional strategic plans.
	2.3 Business process design	Determine how IS can deliver "best practice" in operational processes and organizational activities.
	2.4 Business process improvement	Identify the knowledge and information needed to deliver strategic objectives through improved management processes.
	2.5 Systems and process innovation	Carry out relevant R&D into how IS/IT can be used to create new ways of conducting business and new products and/or services.
3. Define the IT capability (IT strategy)	3.1 Infrastructure development	Define and design information, application and technology architectures and organization structures and processes to manage the resources.
	3.2 Technology analysis	Understand technology trends and make appropriate recommendations for organizational acquisition of technology and associated resources.
	3.3 Sourcing strategies	Establish criteria and processes to evaluate supply options and contract with suppliers.
4. Exploitation	4.1 Benefits planning	Explicitly identify and plan to realize the benefits from IS investments.
	4.2 Benefits delivery	Monitor, measure and evaluate the benefits derived from IS investment and use.
	4.3 Managing change	Make the business and organizational changes required to maximise the benefits without detrimental impact on stakeholders.
5. Deliver solutions	5.1 Applications development	Develop/acquire and implement information, systems and technology solutions that satisfy business needs.
	5.2 Service management	Define service arrangements and performance criteria to match business requirements including project management.
	5.3 Information asset management	Establish and operate processes that ensure data information and knowledge management activities meet organizational needs and satisfy corporate policies.
	5.4 Implementation management	Ensure that new processes and way of working are designed and implemented effectively in conjunction with new technology.
	5.5 Apply technology	Deploy new/changed technology in the most cost effective mode to deliver application benefits.
	5.6 Business continuity and security	Provide effective recovery, contingency and security processes to prevent risk of business failure.
6. Supply	6.1 Supplier relationships	Manage contracts and develop value added relationships with suppliers.
	6.2 Technology standards	Develop and maintain appropriate standards, methods, controls and procedures for the use of IT and associate resources.
	6.3 Technology acquisition	Develop and apply procurement policies and procedures for the organizational acquisition of infrastructure components and specialist technology/services.
	6.4 Asset and cost management	Ensure technology, information and application assets are effectively maintained and cost of acquisition and ownership are understood and managed.
	6.5 IS/IT staff development	IS/IT staff development – recruit, train and deploy appropriate staff and ensure technical, business and personal skills meet the needs of the organization.

Appendix B

Characteristics of the firms involved in the case study research.

Case	Industry	Number of employees	Turnover (million euros)
P1	Mould manufacturer	450	25
P2	Home textiles	130	7
P3	Apparel industry	125	6
P4	Cement pipes	200	14
P5	Apparel industry	290	12
P6	Apparel industry	160	15
P7	Wine producer	60	10
P8	Footwear manufacturer	250	9
P9	Wine producer	170	30
UK1	Plastic moulding	40	7
UK2	Welding	30	4
UK3	Electrical engineering	180	20
UK4	Mechanical engineering	40	15

Appendix B (Continued)

Case	Industry	Number of employees	Turnover (million euros)
UK5	Sheet metal fabricators	30	15
UK6	Hose manufacturer	25	15
UK7	Steel fabricators	15	5
UK8	Sheet metal fabricators	30	20
UK9	Foundry	90	30
NZ1	Apparel manufacturer	80	5
NZ2	Computer servicing	5	5
NZ3	Transport services	90	5
NZ4	Radio station	30	1.5

References

- [1] G. Beaver, Management and the small firm, *Strategic Change* 12, 2003, March–April, pp. 63–68.
- [2] M.M. Caldeira, J.M. Ward, Understanding the successful adoption and use of IS/IT in SMEs: an explanation from Portuguese manufacturing industries, *Information Systems Journal* 12 (2), 2002, pp. 121–152.
- [3] M.M. Caldeira, J.M. Ward, Using resource-based theory to interpret the successful adoption and use of information systems and technology in manufacturing small and medium-sized enterprises, *European Journal of Information Systems* 12 (2), 2003, pp. 127–141.
- [4] S. Chau, P. Turner, Stages or Phases? Insights into the utilisation of e-commerce based on the experiences of thirty-four Australian small businesses, Chapter 8 in: M.G. Hunter, S. Burgess, A. Wenn (Eds.), *Small Business and Information Technology*, Heidelberg Press, Victoria, Australia, 2005, pp. 93–112.
- [5] S. Chong, Business process management for SMEs: an exploratory study of implementation issues in the Western Australian wine industry, in: *Proceedings 17th Australasian Conference on Information Systems*, ACIS2006, Adelaide, December, 2006.
- [6] P.B. Cragg, Benchmarking information technology practices in small firms, *European Journal of Information Systems* 11 (4), 2002, pp. 267–282.
- [7] G. Dhillon, Organizational Competence for Harnessing IT: a case study, *Information & Management* 45 (5), 2008, pp. 297–303.
- [8] T. Eikebrokk, D. Olsen, An empirical investigation of competency factors affecting e-business success in European SMEs, *Information & Management* 44 (4), 2007, pp. 364–383.
- [9] E.E. Grandon, J.M. Pearson, Electronic commerce adoption: an empirical study of small and medium US businesses, *Information & Management* 42 (1), 2004, pp. 197–216.
- [10] T. Man, T. Lau, Entrepreneurial competencies of SME owner/managers in the Hong Kong services factor: a qualitative analysis, *Journal of Enterprising Culture* 8 (3), 2001, pp. 235–254.
- [11] W. Oh, A. Pinsonneault, On the assessment of the strategic value of information technologies: conceptual and analytical approaches, *MIS Quarterly* 31 (2), 2007, pp. 239–265.
- [12] J. Peppard, J. Ward, Beyond strategic information systems: towards an IS capability, *Journal of Strategic Information Systems* 13, 2004, July, pp. 167–194.
- [13] T. Ravichandran, C. Lertwongsatien, Effect of information systems resources and capabilities on firm performance: a resource-based perspective, *Journal of Management Information Systems* 21 (4), 2005, pp. 237–276.
- [14] J. Thong, Resource constraints and information systems implementation in Singaporean small businesses, *OMEGA* 29 (April (2)), 2001, pp. 143–156.
- [15] J. Thong, C. Yap, K. Raman, Top management support. External expertise and information systems implementation in small businesses, *Information Systems Research* 7 (2), 1996, pp. 248–267.
- [16] M. Wade, J. Hulland, Review: the resource-based view and information systems research: review, extension, and suggestions for future research, *MIS Quarterly* 28 (1), 2004, pp. 107–142.



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