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Locating IT Competencies in a Learning Organization: A Case Study of the Development of Firm specific IT Resources at Analog Devices Inc.

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Abstract

The process by which IT competencies are created and applied to develop firm specific IT resources is not well understood. Previous research on the phenomenon has operated from the resource-based view (RBV); however, conceptual problems with resource-based theory have neither been noted nor addressed by IS researchers. This study acknowledges these problems and provides a solid conceptual foundation for future studies on the RBV. The primary contribution of this study is empirical, however, as it reports on the findings of an in-depth case study of Analog Devices Inc. and the experiences of end-users and IT professionals in developing and applying business and IT competencies to build strategic IT resources. The findings of this study illustrate that 'soft' IT competencies are firm specific and therefore constitute a source of rent. Significantly, it was business end-users who developed and applied them, not IT professionals, as would be expected. This paper also builds on extant theory by presenting a refined theoretical model of the institutional and organizational influences found to shape the creation, development and application of IT competencies and strategic IT resources in firms. This answers recent calls for such a model and acts to guide future research in the area.

Keywords

Resource-Based View, IT Competencies, IT Resources, Core Competencies

1. Introduction

Henderson and Venkatraman (1993) argue that sophisticated technological functionality does not secure competitive advantage for firms. They insist that organisational competencies lie at the source of sustainable competitive advantage. These are embodied in the firm specific knowledge of practitioners, which is employed to develop and leverage IT resources to enable organisational transformation. This view accords well with seminal thought in the resource-based view (RBV) of the firm—see, for example, Penrose (1957) and Nelson and Winter (1982)—and reflects the conventional wisdom in the IS field.

Two major problems exist concerning the focus of research on the resource-based view of the firm. The first is the paucity of in-depth research in organizations; the second is the theoretical weakness evident in prominent articulations of the RBV. Regarding the former, Nonaka and Takeuchi (1995) have noted the absence of process-based empirical research on competence creation, development, and application. They also criticize the top management focus of many studies and note the absence of “*a comprehensive theoretical framework that shows how various parts within the organization interact with each other over time to create something new and unique*” (Nonaka & Takeuchi 1995, p. 49). These comments indicate that while the RBV has much to say about the antecedents and outcomes associated with the application of competencies in organizational contexts, not much is known about the processes surrounding the creation, development and application of such competencies. This also applies to research on IT competencies and resources. For example, Andreu and Ciborra (1996) maintain that the relationship between IT leadership capabilities and other essential competencies requires in-depth investigation. Furthermore, Agarwal, Ross, and Samamurthy (1998) argue that the manner by which firms develop IT competencies is not clearly understood. Significantly, Bharadwaj (2000, p.188) illustrates that “[*t*he underlying mechanisms through which...superior IT-capability leads to improved firm performance...[are] by no means clear. Accordingly, she calls for a refined theoretical model to be developed that would encompass a role for IT capability based on the quality of IT resources and skills.

The second problem mentioned is of a conceptual nature. Nanda (1996) comments on the conceptual confusion surrounding the application of the RBV in the literature. Researchers have used terms like *firm resources*, *organisational capabilities* and *core competencies* interchangeably, while competing terms, such as *invisible assets*, *strategic firm specific assets*, and *dynamic capabilities*, have been introduced without due regard to clarity of, or consistency in, conceptual definition. It is clear from Nanda’s analysis that tautology and circularity of reasoning have been very much in evidence when researchers have presented their chosen definitions. This has been carried over to the IS field, where, for example, a much-cited conceptual overview of the RBV by Mata, Fuerst, and Barney (1995—following Barney, 1991) treated the concepts of capabilities and resources as synonyms, when clearly they are not.

The primary objective of this study is empirical and addresses the paucity of in-depth research on the process whereby organizations create, develop and apply IT competencies to create firm specific IT resources. The findings of an in-depth case study of one organization, Analog Devices Inc., and its experiences in developing and applying business and IT competencies to build idiosyncratic IT resources—Sales and Marketing Systems—are here reported. A secondary, but no less important, objective is the presentation of a refined theoretical model that can be employed in the study of IT competencies and which provides a solid conceptual foundation for future studies on the RBV in the IS discipline.

2. Towards a Refined Theoretical Model of IT Competencies

According to Penrose (1957), a firm is made up of an administrative function and a collection of productive resources, both human and material. However, Penrose argues that the key to a firm’s competitive advantage is the experiential knowledge and competencies that organisational actors bring to bear in leveraging valuable services from a firm’s bundle of

resources. Nevertheless, it is important to note, as Penrose emphasizes, that resources are tradable commodities and yield no rent in themselves; however, services, and the human competencies that leverage services from resources, are firm specific and difficult for competitors to imitate, they are, therefore, a potential source of rent. Recent treatments of the RBV have generally glossed over this important insight, however, this study recognises the importance of this point. Figure 1 presents a general theoretical model based on the seminal ideas of Penrose (1957) and Nelson and Winter (1982). Figure 2 provides a framework for understanding the model's chief components: this is based on extant research in institutional economics and sociology, organization studies, and in the IS field. Here, the related concepts of competencies and resources are clearly defined, differentiated, and dimensioned to remove ambiguity and increase theoretical validity. In considering the general model shown in Figure 1, a firm's history is said to influence its current portfolio of competencies and shape its bundle of tangible and intangible assets. Social actors apply their competencies in order to leverage services from firm specific and generic resources—IT professionals are here included. In leveraging a firm's intangible assets, such as individual experiential and technical knowledge (tacit and explicit), social actors are afforded further opportunities for learning, for developing additional competencies, and for enhancing existing portfolios of competencies. The development and application of new competencies in turn help make firm specific an organization's resources, thereby enabling it to deliver unique services to its customers. This, then, is the essence of the model.

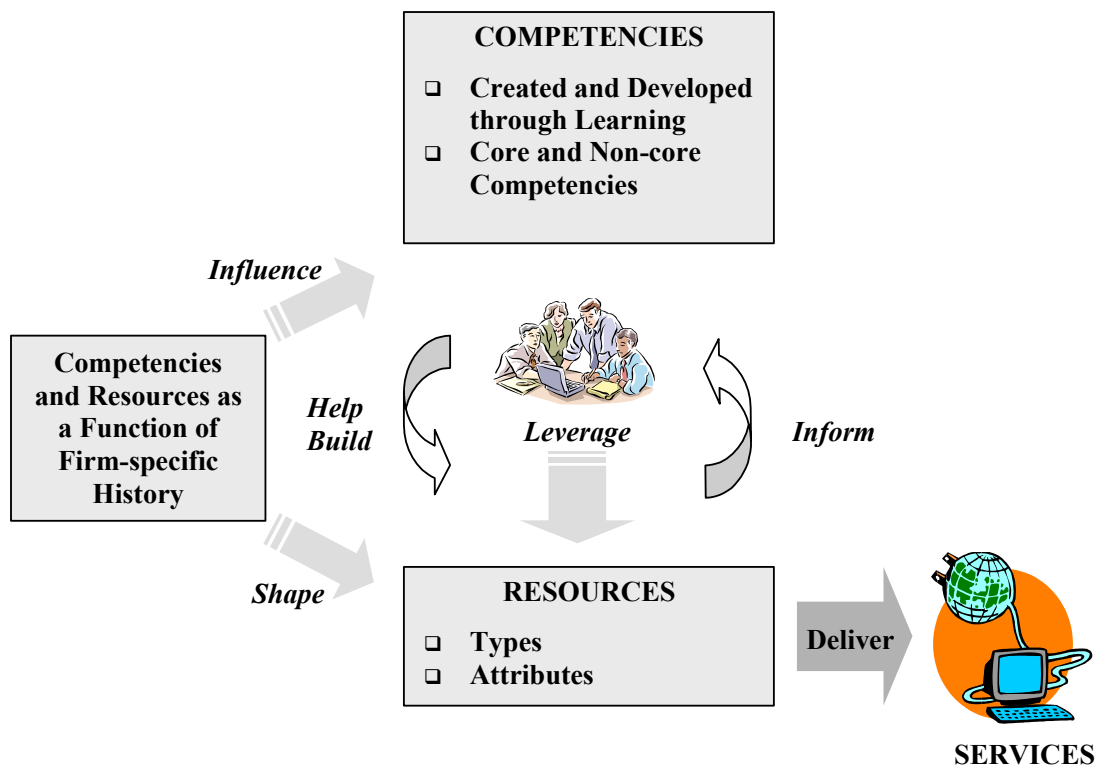


Figure 1 A General Resource-Based Model of Organizational Competencies

Organizational Competencies (Capabilities or Competences)
<p>Competence Creation and Development An organisation's core competence derives from:</p> <ul style="list-style-type: none"> • The collective learning of employees (Stata 1989, Nonaka & Takeuchi 1995, Andreu & Ciborra 1996) • The process involves learning by doing, by using, by failing, by studying, and by learning from customers (see Leonard-Barton 1995, see, also, Ross, Beath & Goodhue 1996) <p>Competencies are developed through:</p> <ul style="list-style-type: none"> • Communication, involvement, and a commitment to working across disciplinary, functional, divisional and organizational boundaries (see Leonard-Barton, 1995; Bharadwaj, 2000) • The internal development of firm specific competencies; assisted internal development, that is obtaining know-how from other firms or consultants; market procurement, that is purchasing specific information or capabilities in the market; inter-firm collaboration, to internalise, enhance, or build competencies; finally merger and acquisition (see Broadbent & Weill 1997, Feeney & Willcocks 1998, Bharadwaj 2000) <p>Core and Non-core Competencies</p> <ul style="list-style-type: none"> • Core capabilities are highly firm specific: Three types are suggested, market-access, integrity-related and functionally-related competencies (Hamel 1994) • Enabling capabilities are those deemed necessary for firms to enter the game (see Hamel 1994, Leonard-Barton 1995, Andreu & Ciborra 1996) • Supplemental capabilities are non-proprietary and imitable (Leonard-Barton 1995) <p>Nordhaug (1994) argues that individual competencies range in firm specificity from meta-, industry and intraorganisational competencies, which are task non-specific, to standard technical, technical trade, and highly firm specific unique competencies (Figure 3 illustrates this relationship graphically). Each type of competency results from the application of knowledge and skills, both of which may also be expressed in terms of firm specificity from meta-knowledge and skills to unique knowledge and skills.</p>
Organizational Resources (or Assets)
<p>Resource Types and Attributes Strategic resources are valuable, rare, imperfectly imitable, and have no strategically equivalent substitutes (Barney, 1991). Four fundamental types of resources or assets are suggested by Teece and Pisano (1998):</p> <ul style="list-style-type: none"> • Technical, complementary, financial and locational <p>Resources may intangible as well as tangible viz.</p> <ul style="list-style-type: none"> • Customer-related (customer loyalty, brand recognition, service network, service quality and installed base). • Channel assets (distribution network and dealer loyalty) • Process-based (technical know-how, physical technical systems, managerial systems functional experience, R&D routines) • Human assets (tacit and explicit employee knowledge and skills—these map onto Nordhaug's competence categories) • Culture-based (values and norms) <p>(See, for example, Penrose 1957, Nelson & Winter 1982, Barney 1986, Itami 1987, Nordhaug 1994, Leonard-Barton, 1995, Ross et al., 1996)</p>

Figure 2 A Framework for Understanding Competencies and Resources

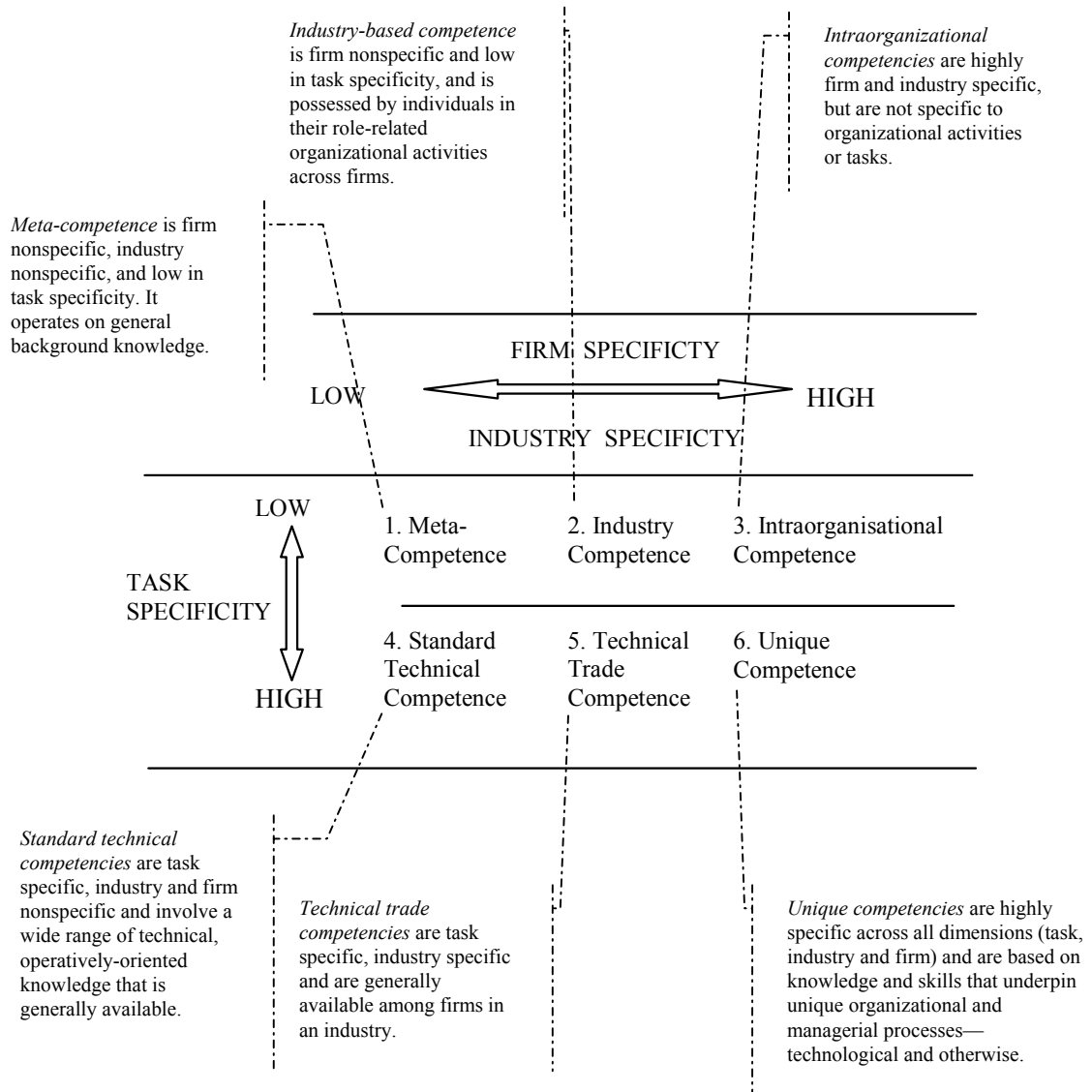


Figure 3 A Detailed Competence Typology (Nordhaug 1994)

3. A Constructivist Research Approach

This study’s objective is to deepen the field’s understanding of how organizations create, develop and apply IT competencies to build unique IT resources. In order to achieve this goal, empirical research is conducted to identify the firm specific conditions and factors that led to the creation, development and application of IT competencies at Analog Devices Inc.

This paper’s view of organizations as historical entities, whose firm specific routines and competencies are the product of collective learning maps well onto constructivist perspectives in institutional theory. Hence, a constructivist approach to research is adopted for the present study (Guba & Lincoln 1994). In keeping with prescriptions of the constructivist paradigm, and the hermeneutic method it employs, a qualitative, interpretive, case-based research strategy was adopted for the study (see Lincoln & Guba 1985 and Butler

1998). This strategy involved a *single instrumental case study* (Stake 1995) whose purpose was to obtain an understanding of the creation, development and application of IT competencies in Analog Devices Inc. Purposeful sampling was employed throughout (Patton 1990, Mason 1996). Research in Analog Devices Inc. took place at three sites located in Limerick, Ireland, Wilmington, Boston, and at the company's corporate HQ in Norwood, MA. Fourteen taped interviews were made with a cross-section of actors from relevant 'communities of practice', including the company's IT function. A range of informal conversations and observations took place over the duration of the study, and a wealth of documentary evidence and other artefacts were produced through the site visits.

4. Building Firm Specific IT Competencies in a Learning Organization: Sales and Marketing Systems at Analog Devices Inc.

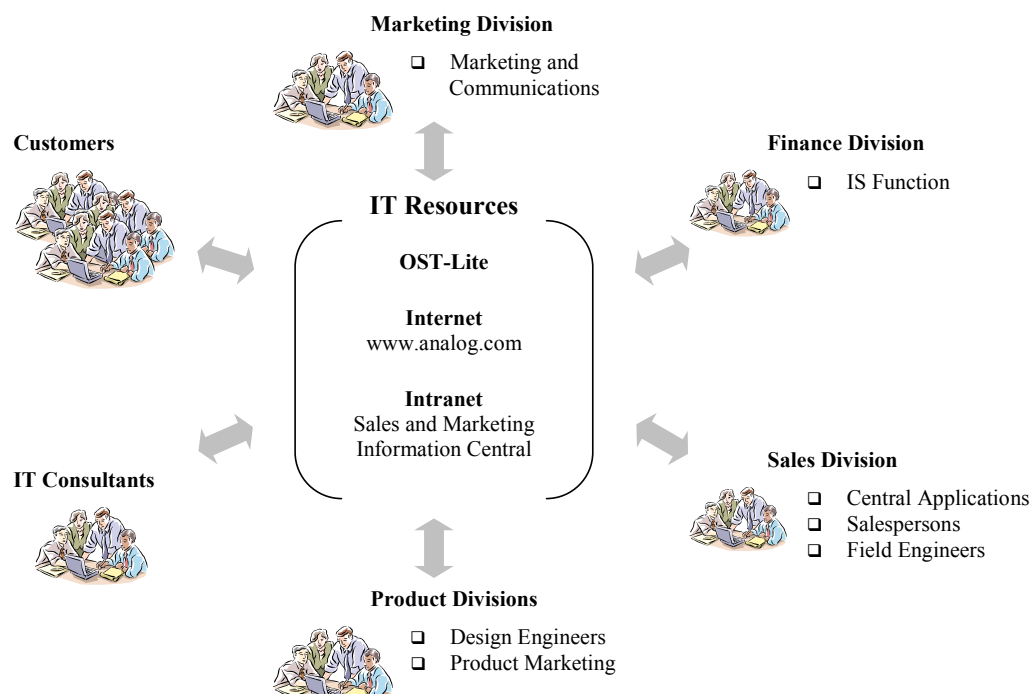
Until the mid-to-late 1990s, Analog Devices did not possess a strategic IT resource. True, it operated sophisticated mainframe-based IS in the 1980s and was an early adopter of SAP in the 1990s, but these were non-strategic management support, finance and accounting information systems. In addition, research and development engineers employed sophisticated UNIX-based CAD/CAM packages to design products; but, again, these systems did not confer upon Analog a competitive advantage, as competitors also possessed these technologies. Already a global player, the number and complexity of Analog's products grew steadily throughout the 1990s, as did its market segments and customer base. Thus, a change in Analog's business environment generated a need for innovative IS to support its core sales and marketing processes.

4.1 The Application of IT Competencies and the Development of Firm specific IT Resources at Analog Device's Inc.

It is noteworthy that Analog's IS function did not develop or possess a strategy for Analog's IT infrastructure at any time during the 1990s. Much comment has been made concerning the importance of alignment, in terms of strategic fit and functional integration, between business and IS (see Henderson & Venkatraman 1993). There was no formal 'strategic fit' or 'functional integration' at Analog, rather 'fit' and 'integration' was very much ad-hoc, as managers from the business community generally acted as both strategy planners and IT architects for the information systems that supported their core business processes. IT professionals, whether from the IS function or external consultancy firms, acted as IT infrastructure developers in the main and took their cue from the business community. The IS that were of strategic value to Analog's key business processes tended to end-user planned, designed and developed and, as such, were idiosyncratic to Analog's firm specific business process and structures: they were also, to a certain extent, undervalued by the IS function. One reason for this state of affairs was that while the IS function served the overall financial, accounting and operational end of the business pretty well, it struggled to gain the confidence and acceptance of the engineering 'communities of practice' who tended to do their own thing, with or without IS blessing. For example, Analog's senior management rejected a suggestion from the IS function that it implement a generic customisable package to support the company's sales and marketing processes. The general feeling on the business

side was that end-users knew best how to arrive at unique, firm specific solutions that supported rather

than replaced face-to-face communication with customers and colleagues. Nevertheless, the IS function played an important ‘supplemental’ and ‘enabling’ roles in the development of the corporate Internet application, as did the external business and IT consultants; however,



this system was primarily a product of the application of end-user business and IT competencies in its planning, implementation, and use.

Figure 4 Firm specific Sales and Marketing Systems at Analog Devices (IT Resources) and the Communities of Practice that Developed and Leveraged them.

Figure 4 represents the sales and marketing systems at Analog Devices with reference to the ‘communities of practice’ that developed and leveraged them. In the late 1990s, these systems formed the core of Analog Devices strategic IT resources, and included the company Internet website (www.analog.com); Central Applications’ Sales and Marketing Information Central Intranet website; and the Opportunities, Strategies and Threats system (OST-Lite). The first of these applications helped customers search for products and download detailed product data as PDF files. It also offered customers the ability to acquire product samples and make orders. In addition, it acted as a forum to market new products and as a mechanism to capture customer design engineers’ demographics, product interests, and planned future design initiatives. The Sales and Marketing Information Central Intranet website was a multipurpose in-house knowledge-management solution. This system provided detailed information to sales and field engineers, product line marketing engineers, and to application/product support engineers under the following headings: *What’s New*; *Product Lines*; *General Information*; *Marketing New Products*; *Applications*; and *Sales Bulletins*. Search facilities were also available to provide information on product pricing, product status, and to help cross-reference competitors’ products, and so on. Information on new products was distributed as downloadable PDF versions of the company’s core knowledge asset—the product data sheet. Finally, the OST-Lite application helped identify and record sales opportunities: these were then mapped to the goals and objectives of salespersons to

facilitate performance assessment. However, OST-Lite's chief role was one of capturing customer information that could be fed back to product line marketing engineers and senior sales managers so that strategic marketing decisions could be made by customer, product and segment.

The primary mechanism for product knowledge transfer to customers/design engineers was the data sheet. The data contained in new and existing product data sheets had the potential to influence multi-million dollar design-in decisions in customer R&D laboratories. It was therefore critical for Analog to ensure that data sheets were detailed, accurate and unambiguous. In essence, this entire process involved the translation of firm specific, unique knowledge into a format compatible with the standard technical knowledge and technical trade knowledge of design engineers. To do this, design/marketing engineers, Central Applications engineers, and field engineers drew on their own experiential knowledge and technical knowledge to help customer design engineers understand better the potential of individual and complementary products. When the traditional short form product catalogue and fax-back systems became unwieldy and inefficient, new informational conduits and repositories, such as multimedia CD-ROM, the Internet, and applications on the corporate Intranet, were developed, evolved and leveraged to deliver customer and product information internally and externally. However, it is significant that sales, field, application support and marketing engineers drew on their experiential knowledge of their own end-user developed systems to develop, implement, and employ corporate information systems, such as the Sales and Marketing Information Central, as conduits and repositories for their 'knowledge-informing data'.

4.2 The Institutional and Organizational Contexts that Led to the Creation and Development of Core IT Competencies at Analog Devices Inc.

Analog Devices Inc. possessed 'core competencies' in the innovative design and development of its products and in the acquisition and management of related assets—these were developed and acquired over time by company through its strategy of organizational learning (Stata 1989). However, 'core competencies' were also in evidence elsewhere, primarily in the company's sales and marketing functions, and especially in the manner in which these 'communities of practice' leveraged IT to service customer needs and strengthen Analog's position in the marketplace. Figure 5 provides examples of business and IT practitioner insights on the phenomenon of IT competencies and IT resource development at Analog Devices. The selected quotations are arranged in the form of dialogues that highlight the salient issues examined in the findings. (This acts to prime readers' interpretation and understanding of the following narratives). Figure 6 then presents an integrative overview of the institutional contexts that led to the creation and development of core business and IT competencies at Analog Devices. It also helps indicate the origin and locus of core and non-core business and IT competencies and the intangible and tangible resources that they create and operate on. The remainder of this sub-section highlights the outstanding issues that characterised the institutional and organizational environments at Analog Devices and which underpinned the success of business-led IS development in this company.

Analog Dialogues on IT Competencies and Resources

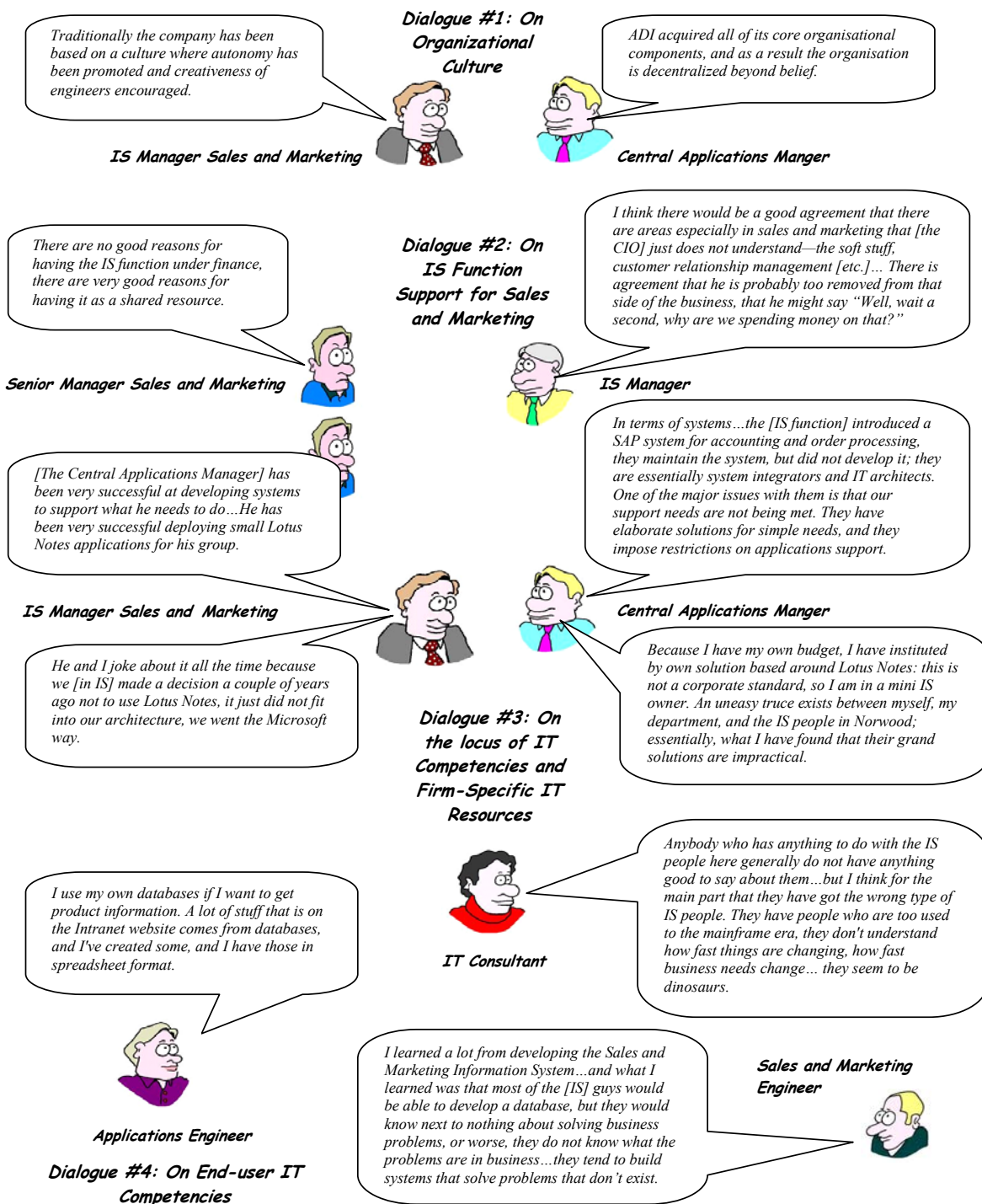


Figure 5 Different Perspectives the Development of IT Competencies and Resources at Analog Devices Inc.

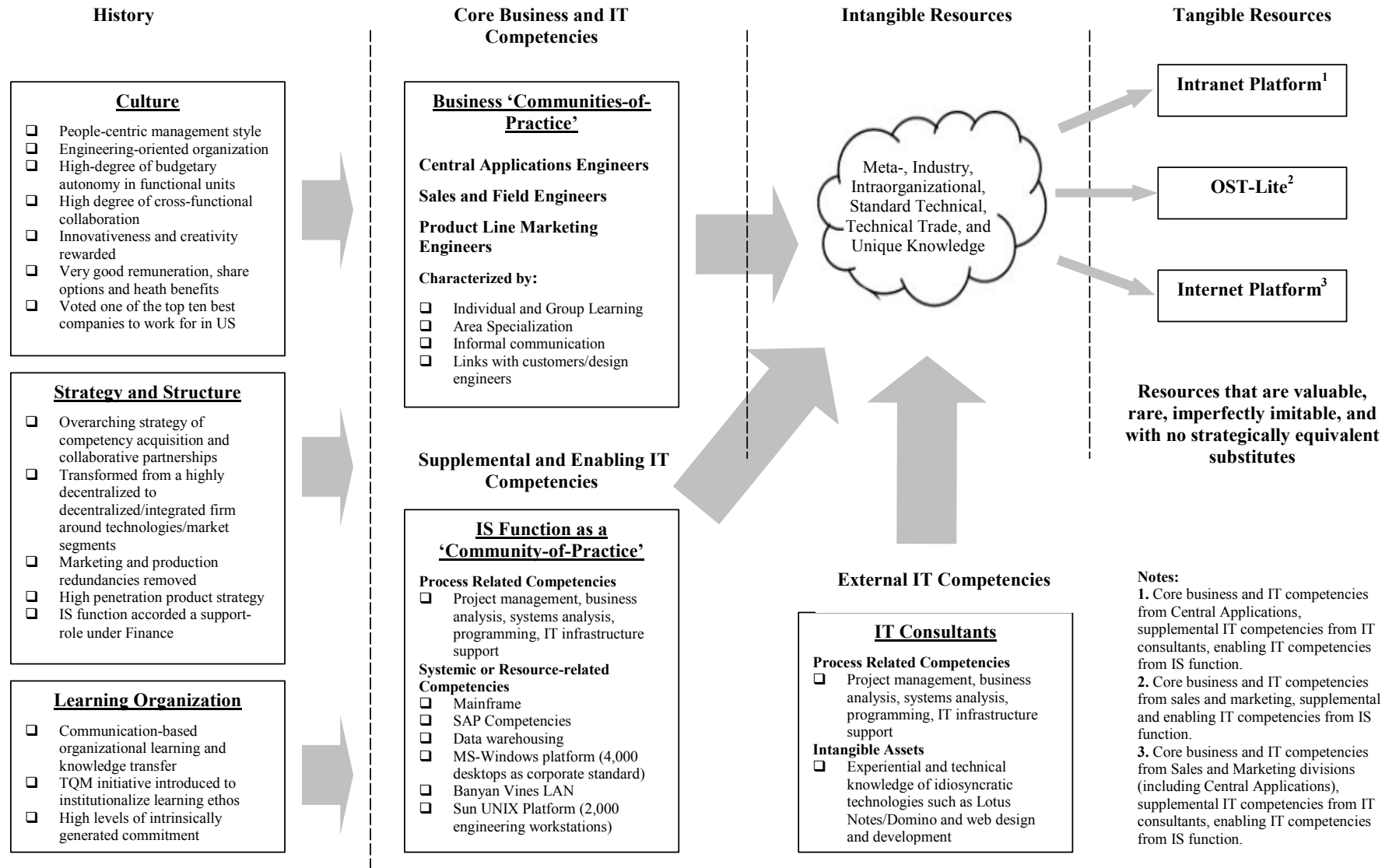


Figure 6 Institutional and Social Contexts in Shaping and Influencing IT Competencies and the Development of Firm specific IT Resources at Analog Devices Inc.

There are two primary reasons why engineers in Analog's sales and marketing functions needed to develop IT resources that helped create and maintain a dialogue with customer design engineers. First, such communication enabled Analog's product marketing engineers to anticipate market trends and customer demand for its existing range of integrated circuits and to help develop products that would meet future customer needs. Second, it provided opportunities for Analog to win important 'design-ins' to its customers' products and thereby secure lucrative revenue streams when those products went to market. Traditional communication mechanisms with customers took the form of face-to-face dialogues between Analog's sales and field engineers and design engineers at industry or trade seminars, or at specially arranged product seminars and one-on-one meetings at customers' sites. Also critical were the communication links between various functions within the company, as these provided the 'knowledge-informing data' for engineers working at the customer interface. Enabling dialogic communication links between managers and engineers at corporate marketing, division-based product marketing engineers, and customer-facing functions in the sales division, were of crucial importance here—the three systems described herein greatly enhanced such communication.

In the early 1990's, the network of communication links at Analog was uncomplicated, due to the manner in which the company was then structured. However, while the company's subsequent transformation in the mid-1990s simplified its structure, the organization's social matrix post-transformation made for more complex communication channels. This led to operating divisions that were previously autonomous being restructured to be interdependent with and answerable to centralised corporate functions. This situation, coupled with the growing diversity and sophistication of Analog's product range stimulated business managers to leverage IT to support its sales and marketing activities and to improve internal and external communications with colleagues and customers. The way in which this happened at Analog was in keeping with the organizations idiosyncratic character and social context. End-user IT competencies in the design and development of the sales and marketing IS proved pivotal in certain areas, particularly with Intranet-based applications for sales and marketing. Here, end-users employed client databases such as Excel and Access to help them 'work smarter.' Over time, this facilitated the development of standard technical and technical trade IT competencies among social actors in the business community. When married with their industry and intraorganizational business competencies, this facilitated the creation of the unique or core IT competencies and development of firm specific IT resources.

Exceptionally low staff turnover (by US standards) and relatively long periods of employment for senior engineers meant that Analog was able to build an *imperfectly immobile asset* in its human resource—at both managerial and professional levels. The people-centric philosophy of the company's founder, Ray Stata, which lay at the core of Analog's success, was evidenced across his management team and this made for high levels of intrinsically motivated commitment throughout the organization. Generous remuneration and stock options, competitive healthcare and retirement plans, ensured high levels of extrinsically motivated commitment. Consequently, Fortune magazine nominated Analog as being one of the top 10 US companies to work for. As a result, many engineers refused lucrative offers from competitors to remain at Analog and realize the benefits of employment in the company over the long term. Other major influences were the degree to which decentralised decision-making was facilitated, individual employees empowered, and creativity rewarded. Accordingly, Analog's employees had a strong sense of identity with, and loyalty to, the company. This permitted the organization to leverage one of its core

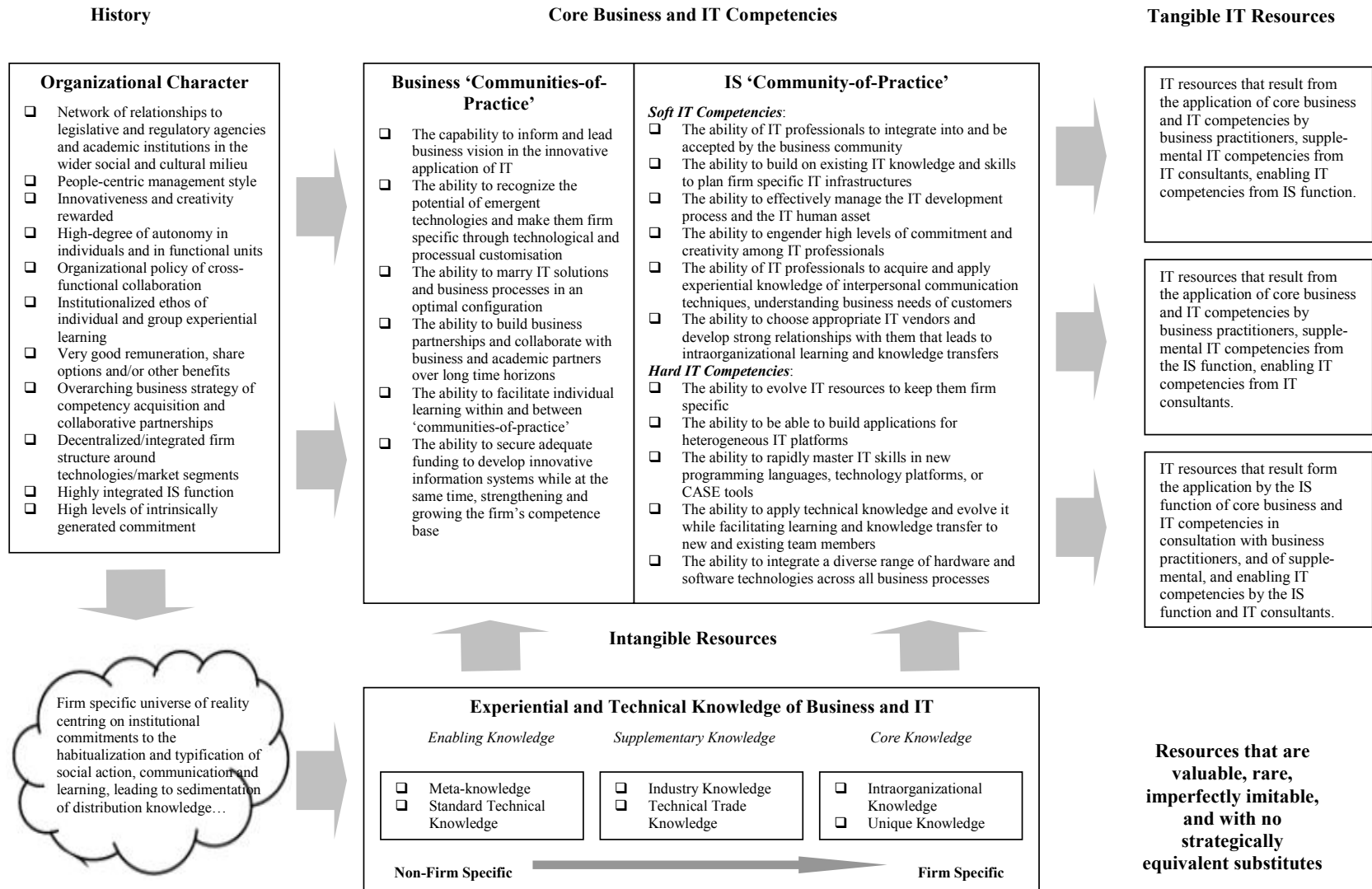


Figure 7 A Refined Theoretical Model of IT Competence and Resource Development

assets—the experiential knowledge of its engineers—to help design, develop market and support an ever increasingly sophisticated range of products.

This benign organizational environment provided fertile ground for the growth of end-users' experiential and technical knowledge, which, in turn, informed their industry, intraorganizational, technical trade, and unique business and IT competencies—and the explicit and tacit knowledge and skills that underpinned them. However, while the application end-user IT competencies worked well when business users sponsored and developed applications for their own functional needs, or when they developed systems that also met the needs of related functional groups, cross-functional applications that were jointly developed with the help of the IS function (e.g. OST-Lite and the Manufacturing and Marketing Forecasting System), or which were sponsored by corporate functions (e.g. the Internet), ran into significant turbulence in their development. The major problem in these IS development projects centred on poor communications between the 'communities of practice' involved. For example, product-line marketing engineers experienced difficulties with the Web-development team when publishing new product data on the Internet site, while no such difficulties were experienced with the Central Applications unit to whom they had traditionally provided this data on new product status. The close relationship and understanding between product-line marketing engineers and Central Applications' engineers contributed to the success of Central Applications' Sales and Marketing Information Central Intranet Website. Hence, the chief problem that engineers had with the Web-team in the development of the Internet was that their respective 'horizons of understanding' or 'worldviews' were radically different. This underlines the importance of aligning 'communities of practice' so that they share a common 'language' or 'worldview' so that close ties are facilitated across functional boundaries. Expressed differently, 'communities of practice' need to share common industry, interorganizational, technical trade and unique knowledge if communication is to be successful and understanding attained—this then is the key to aligning or integrating business and IS 'worldviews' and the successful application of business and IT competencies.

5. Conclusions

Analog Devices Inc. is regarded as a model company by industry observers and employees alike. This is due in part to the organization's culture and employee-centric managerial ethos. However, it is noteworthy that Analog was and still is a company run for, and primarily by, engineers. It was Analog's engineers, be they managers or functional specialists, and not the IT professionals, who had control over the development and implementation of IT resources to support their business processes. Thus, an opportunity was provided for engineers at all levels in the organization to develop 'hard' standard technical and technical trade IT competencies through experimentation with end-user applications. This, coupled with their experience and understanding of industry and organizational issues and processes, provided engineers with the 'soft' business and IT competencies that translated into the 'unique' or 'core' competencies required to build firm specific IT resources. Nevertheless, they had to draw on the supplemental and enabling 'hard' IT competencies of external consultants and the internal IS function.

The Analog Devices case study is an exemplar of sorts, as it provides rich and valuable insights into the antecedents and outcomes to the development and application of business and IT competencies. In summary, the empirical evidence presented in the case:

- (a) Challenges extant notions within the IS field on the origin and locus of the core IT competencies required to develop strategic IT resources.
- (b) Illustrates that the difficult task of fostering high levels of commitment to organizational imperatives at all levels within an organization is vital for the successful application of the ‘core’ intangible assets of individual experiential and technical knowledge in building and applying IT competencies.
- (c) Demonstrates that development of core competencies takes a considerable length of time.
- (d) And, finally, indicates that, while the importation of knowledge and expertise is beneficial to an organization, the retention and development of experienced staff—particularly experienced managers and professional knowledge workers—is critical to the development of firm-specific knowledge assets.

In relation to the last observation, Leonard-Barton (1995) indicates that the existence of long-serving employees might lead to the creation of ‘core rigidities’ in a firm: this, however, can be prevented through a culture of learning and experimentation.

In conclusion, the findings of this study complement and extend observations in the literature viz. ‘soft’ competencies constitute the ‘core’ element of IT competencies and are a source of rent. They are socially constructed and are shaped by a company’s culture where informal social processes predominate, and where individuals have a high degree of autonomy and ‘locus of control’ over their activities. In addition, ‘soft’ competencies are fostered by high levels of intrinsically motivated commitment and result from an ill-defined mixture business and IT knowledge—that is, practitioners’ understanding of how best to meet business needs through IT. This study also found that core IT competencies cannot be divorced from core business competencies. Furthermore, they grow best in organizational cultures that facilitate learning through communication and internal cross-functional and external collaborations. On the other hand, ‘hard’ competencies, while no less important, are non-core, tradable, and are not a source of rent. Firm specific IT resources consist of the ‘soft’ intangible knowledge of social actors and the ‘hard’ systems developed through the application of core competencies. Competencies, the tacit and explicit knowledge and skills that underpins them, and the resources that result from their application, are meshed together in a social web that renders them inseparable. More importantly, the valuable, rare, and imperfectly imitable IT human assets who possess the critical ‘soft’ knowledge and skills, and who embody ‘core’ IT competencies, are not necessarily IT professionals. While the creation of strategic IT resources is a team effort, *ceteris paribus*, it is business end-users with experiential and technical knowledge of IT, and not IT professionals with a knowledge of the business, that influence the strategic potential of the IT resource. Building on these observations, Figure 6 presents a refined theoretical model of the institutional and organizational web of conditions and factors that shape the creation, development and application of IT competencies and resources in firms. The model therefore provides important insights into the creation of core business and IT competencies for researchers and practitioners alike. This answers the call made by Bharadwaj (2000) for such a model to guide future research in the area.

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