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Firm Context and Patterns of IT Infrastructure Capability (Best Paper Award)

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FIRM CONTEXT AND PATTERNS OF IT INFRASTRUCTURE CAPABILITY

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Abstract

The importance of a firm's information technology (IT) infrastructure capability is increasingly recognised as critical to firm competitiveness. This is particularly the case for firms in industries going through dynamic change, for firms reengineering their business processes, and for those with extensive international or geographically dispersed operations. However, the notion of IT infrastructure is still evolving and there has been very little empirically based research on the patterns of IT infrastructure capability across firms.

We develop the concept of IT infrastructure capability through identification of IT infrastructure services and measurement of reach and range in large, multi-business unit firms. Using empirical case research, we examine the patterns of IT infrastructure capability in twenty-six firms with diverse strategic contexts, including different industry bases, level of marketplace volatility, extent of business unit synergies and the nature of firm strategy formation processes. Data collection was based on a combination of quantitative and qualitative methods with multiple participants.

More extensive IT infrastructure capability required both more IT infrastructure services as well as more reach and range. More extensive levels of IT infrastructure capability were found in firms where (i) products changed quickly; (ii) attempts were made to identify and capture synergies across business units; (iii) there was greater integration of information and IT needs as part of planning processes; and (iv) there was greater emphasis on tracking the implementation of long term strategy. These findings have implications for both business and technology managers particularly in regard to how firms link strategy and IT infrastructure formation processes.

1. THE IMPORTANCE OF INFORMATION TECHNOLOGY INFRASTRUCTURE

Information technology (IT) infrastructure is increasingly seen as a fundamental differentiator in the competitive performance of firms (McKenney 1995). New competitive strategies (Boynton, Victor and Pine 1993) and progression through higher levels of organizational transformation (Davidson and Movizzo 1996) each require major IT infrastructure investments. IT infrastructure capabilities underpin the emergence of new organizational forms (Davidow and Malone 1992), such as global virtual corporations (Miller, Clemons and Row 1993), and facilitate the development of virtual value chains (Rayport and Sviokla 1995). IT infrastructure capability is critical to globally competing firms (IS Analyzer 1991; Clemons, Row and Venkateswaran 1989; Neo 1991).

IT infrastructure can be a significant barrier or enabler in the practical options available to planning and changing business processes (Grover, Teng and Fiedler 1993; Wastell, White and Kawalek 1994). The support of enabling technologies and platforms is an important contributor to successful business process change (Furey and Diorio 1994; Ramcharamdas 1994; Caron, Jarvenpaa and Stoddard 1994). Cross functional process changes require a shift in the role of the IT function from being

guardians of information systems to providing infrastructure support, particularly in the form of data management expertise (Dixon et al.; 1994, Earl and Kuan 1994).

While the significance of IT infrastructure is now being recognized (Davenport and Linder 1994), this is often as a by-product or retrospective analysis of the success of strategic initiatives or process change implementations. Our knowledge of the value of IT infrastructure remains largely "in the realms of conjecture and anecdote" (Duncan 1995, p. 39).

In this paper, we develop the concept of IT infrastructure capability through identification of IT infrastructure services and measurement of reach and range (Keen 1991; Keen and Cummins 1994) in large multi-business unit firms. We examine the patterns of IT infrastructure capability in twenty-six firms with diverse strategic contexts, such as firms from different industries, and with different strategic intent focus and synergies among its business units. We compare the number and nature of services and the level of reach and range to understand patterns of IT infrastructure capability and discuss the implications for both business and IT management.

2. THE DIMENSIONS OF IT INFRASTRUCTURE

Over the past five years, issues associated with IT infrastructure have consistently been identified as a key concern of IS management (Niederman, Brancheau and Wetherbe 1991; CSC Index 1994; Pervan 1994; Koeller 1994; Broadbent, Butler and Hansell 1994). IT infrastructure is a major business resource and is now seen as a key source for attaining sustainable competitive advantage (Keen 1991; McKenney 1995). However, few works have had the notion of IT infrastructure as their central focus.

IT infrastructure is the enabling base of shared IT capabilities which provide the foundation for other business systems (McKay and Brockway 1989). This capability includes both the internal technical (equipment, software and cabling) and managerial expertise required to provide reliable services (McKay and Brockway 1989; Weill 1993). This complex set of technological resources is developed over time and its precise description and value are difficult to define (Duncan 1995).

IT infrastructure differs from applications in its purposes as a base for future applications rather than current business functionality, and in the way in which it must cope with the uncertainty of future needs (Grossman and Packer 1989). IT infrastructure is usually justified and financed differently from applications, its benefits are often hard to quantify (Parker and Benson 1988; CSC Index 1993) and such investments often require board level or executive management approval (Weill 1993; PE International 1995).

The major components of IT infrastructure are hardware platforms, base software platforms, communications technology, client-server technology and other software (or embedded) components that provide common services to a range of applications, common handling mechanisms for different data types and methods, standards and tools (Turnbull 1991; Darnton and Giacolette 1992). IT infrastructure capability is usually provided by the corporate information systems (IS) group (Weill and Broadbent 1994) but can also encompass public or outsourced facilities used by the firm (PE International 1995).

The purpose of building IT infrastructure is to support the commonality between different applications or uses (CSC Index 1992) facilitating information sharing across the enterprise and cross-functional integration (Darnton and Giacolette 1992) and to obtain economies of scale. IT infrastructure flexibility refers to the degree to which its resources are shareable and reusable (Duncan 1995). Building in flexibility adds cost and complexity but provides a business option that may be exercised in the future (Kambil, Henderson and Mohsenzadel 1993), widening the variety of clients a firm can handle without increased costs (Weill 1993). Firms take different approaches to IT infrastructure investments depending on strategic objectives for costs savings through economies of scale, current strategy needs or longer term requirements for flexibility (Venkatraman 1991; Weill 1993).

Greater IT infrastructure capability is required where firms need to respond more rapidly to changes in the market place (Quinn 1992) and where there is higher interdependence between business units. The increasing importance of relationship-based services and cross-selling raises the stakes for information sharing across the business in order to capitalize on opportunities for cross-selling and synergy. This business flexibility requires IT capability (Duncan 1995) to share information across

products, services, locations, companies and countries and thus a common IT infrastructure rather than separate IT platforms and services for separate business activities is required (Keen 1991).

The mortar which binds all the IT components into robust and functional services includes a specific body of knowledge, skill sets and experience embodied in the human infrastructure (McKay and Brockway 1989; Davenport and Linder 1994). This human component provides the policies, architectures (Keen 1995), planning, design, construction and operations capability necessary for a viable IT infrastructure and usually resides in the corporate IS group.

3. IT INFRASTRUCTURE CAPABILITIES

Drawing on conceptual and related empirical work, we define IT infrastructure as:

> *the base foundation of budgeted-for IT capability (both technical and human), shared throughout the firm in the form of reliable services, and usually managed by the IS group.*

We contend that such capability is a firm resource (Barney 1991) which is difficult to imitate as it is created through the fusion of technology and human infrastructure.

The various elements of IT infrastructure are presented in Figure 1 (drawing particularly on McKay and Brockway 1989 and Weill and Broadbent 1994). At the base of this model are the IT components, such as computers and communications technologies, which are commodities and readily available in the marketplace. The second layer comprises a set of shared services such as management of large scale data processing, provision of electronic data interchange (EDI) capability, or management of firm-wide databases. The base level IT components are converted into useful IT infrastructure services by the human IT infrastructure composed of knowledge, skills and experience. This human infrastructure binds the IT components into a reliable set of shared IT infrastructure services.

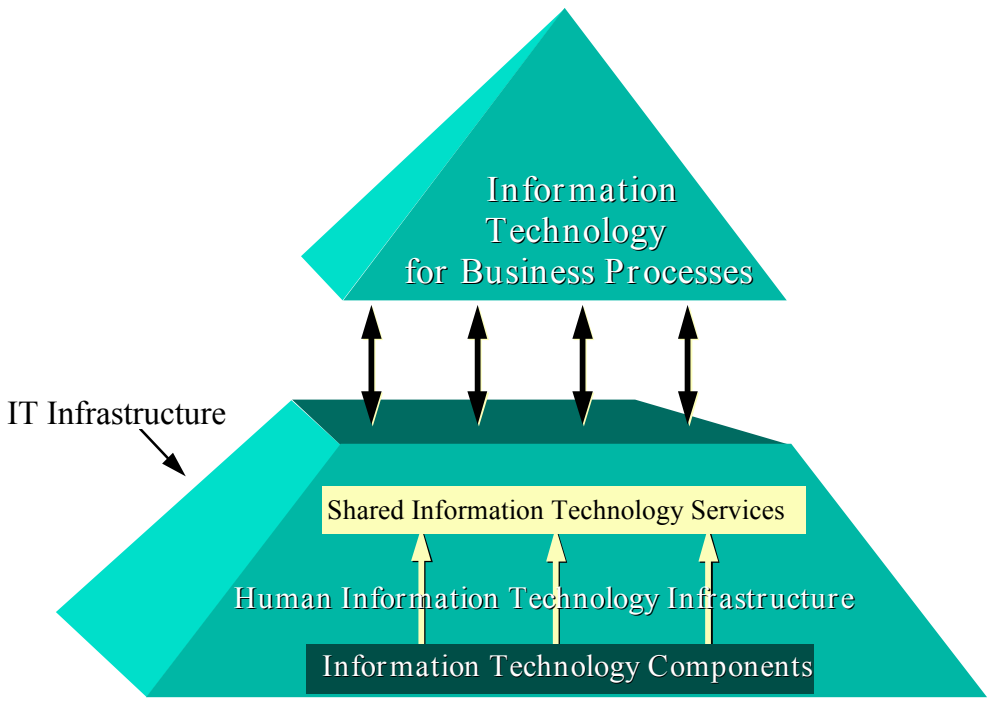

Figure 1. The Elements of IT Infrastructure

Evidence for IT infrastructure capability can be found in the nature of IT infrastructure services in a firm, together with their functionality. The notion of IT infrastructure and thus shared services leads to there being an identifiable set of services offered across firms by corporate Information System groups in multi-business unit firms. The set of IT infrastructure services is relatively stable over time (Weill et al. 1995) and focused on the long term strategic intent (Hamel and Prahalad 1989, 1994) of the firm. However, the systems required for business processes would be expected to change regularly to meet the needs of current strategies of specific businesses within the firm.[1]

The business functionality of IT infrastructure and its dimensions can be defined in terms of "reach and range" (Keen 1991; Keen and Cummins 1994). "Reach" refers to locations that can be connected via the infrastructure, while "range" determines the level of functionality that can be shared automatically and seamlessly across each level of "reach."

Key attributes of IT infrastructure capability are the extent to which it is shareable and reusable across the firm (Duncan 1995). Thus firms where business units share products, customers, or expertise would be expected to provide more extensive firm-wide IT infrastructure services and functionality to gain benefit from cross-business synergies. Industries generally differ in the extent of cross selling of products, cross ownership of customers and similarly, of processes. For example, in finance firms, customers might utilize several products from different parts of the firm. In retail firms, processes might be similar across different chains or brands. Similarly, firms which value flexibility because of marketplace volatility would be expected to have more extensive IT infrastructure capabilities. Capabilities in such firms would indicate alignment of business and information technology and systems strategies (Henderson and Venkatraman 1992) where strategy formation processes (Hax and Majluf 1988; Segev 1988) encompassed both long term business and technology developments (Broadbent and Weill 1993). Successful strategy formation processes in the complex environment of multi-business unit firms require a high level of planning sophistication to achieve their goals, particularly the goal of creating synergy between business units (Pearce, Robbins and Robinson 1987; Christodoulou 1988).

Drawing on this theoretical perspective when assessing patterns of IT infrastructure capability, we are particularly interested in four aspects of firm context: industry differences, the level of marketplace volatility, the extent of synergies among business units in firms, and characteristics of strategy formation processes in firms.

The model for the study which evolved from the literature analysis and initial concept formulation is presented in Figure 2.

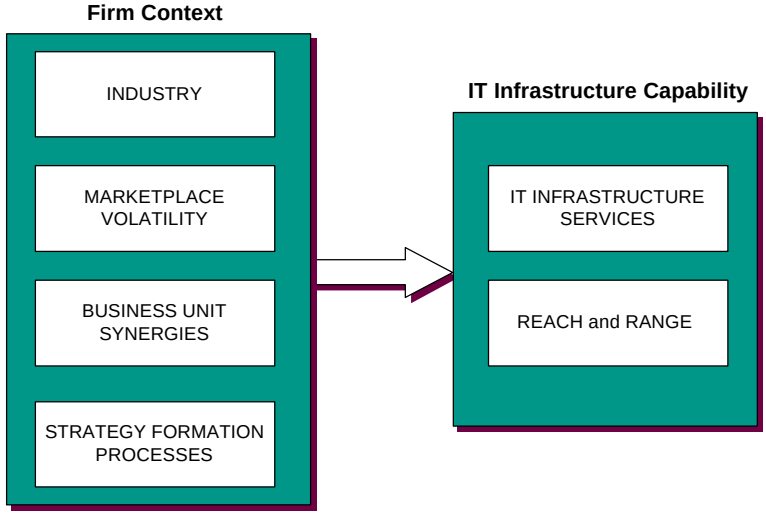

Figure 2. Preliminary Model: Firm Context and IT Infrastructure Capability

[1]While we are focusing on firm-wide IT infrastructure services, it is also possible to envisage business unit infrastructure services to meet the needs of several functions across a business unit.

4. RESEARCH APPROACH AND METHODOLOGY

4.1 Research Focus

We examined the patterns of firm-wide IT infrastructure capability in large multi-business unit firms using multiple case design (Eisenhardt 1989; Yin 1994). Our objective was to gain insights in a complex, under-researched and increasingly significant area of firm competitive capability. We adopted a multiple case design as it is an intense empirical approach suited to the study of emerging and complex phenomena (Yin 1994). Our research approach was to operationalize the concept of patterns of IT infrastructure capability in terms of the number and nature of IT infrastructure services offered on a firm-wide basis, together with an assessment of the firm's reach and range. We then examined the prevalence of these services and measured reach and range in a selection of twenty-six firms with different strategic contexts using a combination of qualitative (e.g., grouping and construct development) and quantitative (tabulations and correlations) data and analysis.

4.2 Propositions

The different patterns of IT infrastructure capability are posited as three types:

1. More extensive IT infrastructure consisting of a larger number of distinct infrastructure services.

2. More extensive reach and range.

3. The preponderance of particular types of infrastructure services.

We also posit that firms with a more extensive reach and range will require a larger number of services to deliver a more extensive IT platform (Keen 1991).

Seven propositions explore the linkage of patterns of IT infrastructure capability and firm strategic context.

4.2.1 IT Infrastructure Capability and Industry Differences

1. *Firms from different industries and thus having different requirements for information, will have different patterns of IT infrastructure capabilities.*

   The demand for IT infrastructure capability should vary among industries due to different levels of information intensity (Porter and Millar 1985) and the different nature and pace among industry structures (Bradley, Housman and Nolan 1993).

4.2.2 IT Infrastructure Capability and Marketplace Volatility

2. *Firms with greater emphasis on the need to change products more quickly will have different patterns of IT infrastructure capabilities from those with less emphasis on this need.*

3. *Firms that tend to make resource decisions based on current needs will have different patterns of IT infrastructure capabilities.*

4. *Firms with greater emphasis on flexibility to meet changing needs of their marketplace will have different patterns of IT infrastructure capabilities from those with less emphasis on flexibility.*

   IT infrastructure capability is a major business resource and differentiator among firms which lead their industry in changes in the dominant basis of competitiveness (McKenney 1995). Firms needing to respond more rapidly to changes in the

marketplace (Quinn 1992) would benefit from a more extensive IT infrastructure base on which applications can be quickly built. Marketplace changes increasingly emphasize higher interdependence between business units, thus leading to a stronger impetus for shared firm-wide services.

4.2.3 IT Infrastructure Capability and Business Unit Synergies

5. *Firms with greater emphasis on identifying synergies between business units will have different patterns of IT infrastructure capabilities from those with less emphasis on identifying synergies.*

   The increasing importance of relationship-based services and cross-selling raises the stakes for information sharing and common transaction processing across the business to capitalize on opportunities for cross-selling and synergy. The business flexibility requires IT capability (Duncan 1995) to share information across products, service, locations, companies and countries. It requires a common infrastructure and an end to separate IT platforms for business activities (Keen 1991).

4.2.4 IT Infrastructure Capability and Strategy Formation Processes

6. *Firms with greater integration of information and IT needs as part of the firm's overall planning processes will have different patterns of IT infrastructure capabilities.*

7. *Firms with greater emphasis on tracking the success of implementation of strategic intent will have different patterns of IT infrastructure capabilities from those with less emphasis on tracking strategic intent implementation. The indicators of the extent of a firm's emphasis are (i) the level of reporting progress against strategic intent; (ii) whether achievements are actively measured; and (iii) whether those responsible are named.*

   The inclusion of information and IT needs in strategic planning processes is evidence of higher levels of planning sophistication (Pearce, Robbins and Robinson 1987; Christodoulou 1988) and acknowledgment of the role of IT in a firm (Broadbent and Weill 1993; Venkatraman, Henderson and Oldach 1993). Such acknowledgment is more likely to lead to greater consideration of the requirements for firm-wide IT infrastructure capability.

4.3 Methodology

Extensive field investigation was considered the most appropriate methodology to investigate the under-researched and ill-defined area of firm context and IT infrastructure capability. Intensive on-site work was required to understand the strategic context and specific situation of each firm and the nature of its IT infrastructure capability.

We selected twenty-six leading firms (in seven countries) in the finance, retail and manufacturing industries for investigation. These three industries are at the forefront of change in industry structure due to the combination of technological innovation and the accelerating pace of globalization (Bradley, Housman and Nolan 1993). However, they provide a contrast in their strategic use of information and information technology (Porter and Millar 1985; Cash et al. 1992).

In order to focus on firm-wide IT infrastructure services in complex settings, the firms selected met the following criteria:

1. Comprised at least two autonomously managed business units with a distinct set of products or customers.

2. Were in the top five in their industry by market share in their region.

3. Had historical IT investment data and IT infrastructure services information which could be made available to the researchers.

4. As a group of firms, provided an international perspective.

The participating firms are listed in Appendix 1 by region.

To reflect the international nature of the study, data was collected by a research team of seventeen people from universities located in or near the country of the firm headquarters base. The researchers met to refine the concepts and methods for the study and then used the same data collection procedures. The lead researchers also visited each of the research groups on a number of occasions and, in some cases, also visited some of the firms in those locations. The team members are listed in Appendix 2.

4.4 Data Collection

The study design involved a combination of quantitative and qualitative data collection (Kaplan and Duchon 1988; Benbasat and Nault 1990) and analysis methods. There were multiple respondents in each firm to achieve triangulation of data and insights. Data were collected by means of interviews, the completion of extensive response forms by participants, analysis of organizational documentation (e.g., memos, internal reports) and notes of presentations made by executive managers about recent strategy and technology developments.

In each firm there was a minimum of four participants, some of whom were interviewed on multiple occasions. The four participants were the Chief Information Officer (CIO), IS executives from at least two different business units, and a corporate executive who was able to provide a strategic perspective across the firm as a whole. This person was one of the CEO, the Chief Finance Officer or the Director of Strategy. (This person is referred to hereafter as the Corporate Executive or CE). In each firm the CIO was interviewed about the IS arrangements in the firm and the decision-making process relating to both business and IT strategy. Four different response forms to be completed by the participants were then distributed. When these were completed and returned, interviews were held with each manager to explore the issues in more depth.

Data and documentary material gathered at the time of site visits were combined with public information sources to generate a vignette on each firm. This included information about the firm's strategy and strategy formation processes, structure, business units, organizational arrangements for the IS functions and the extent and nature of the firm's IT infrastructure capabilities. These vignettes were checked for accuracy by each firm and approved.

4.5 Constructs

4.5.1 Strategic Context

Data came from nine questions (with five-point Likert scales) answered by both the CIO and CE. There was generally high correlation between CIO and CE responses, with two exceptions (see Appendix 3 for questions used and for coefficients of correlation between CIO and CE responses). The CE responses were used for analysis purposes as they provide an independent data source (i.e., independent of the CIO responses concerning patterns of IT infrastructure capabilities) and are considered more likely to offer a broader perspective than the CIO responses.

Three questions related to marketplace volatility, two to the synergies between business units, one to the role of information and IT needs in planning processes, and three to the tracking of long term strategy implementation. These questions drew on concepts of strategic intent (Hamel and Prahalad 1989, 1994) strategy formation processes elaborated by Hax (1990) and Hax and Majluf (1988) and the iterative nature of IT considerations in planning processes (Venkatraman 1991; Broadbent and Weill 1993).

4.5.2 Pattern of IT Infrastructure Capabilities

Number of IT Infrastructure Services: During interviews with the first eleven firms, we identified the firm-wide IT infrastructure services managed by the corporate IS group in each firm. We reviewed these to develop a list of twenty-one

generically expressed IT infrastructure services, eight of which were common to all firms. We used this content analysis as the basis for assessing IT infrastructure services in the subsequent thirteen firms, while concurrently checking for further services. Two further IT infrastructure services were identified and we reviewed the data on the initial eleven firms, and in some cases revisited the firms, to check for the existence of these subsequent services. A final list of twenty-three services was identified and this is included as Table 1. Five of these services were prevalent in all firms that had firm-wide IT infrastructure services. One of the twenty-six firms did not have any firm-wide IT infrastructure services. A high number of services indicates a high level of IT infrastructure capability.

Table 1. Firm-Wide IT Infrastructure Services

		% of Firms*
Five Core IT Infrastructure Services		
1.	Management of corporate communication network services	100
2.	Management of group-wide or firm-wide messaging services	100
3.	Recommend standards for at least one component of IT architecture (e.g., hardware, operating systems, data communications)	100
4.	Security, disaster planning and business recovery services for firm-wide installations and applications	100
5.	Technology advice and support services	100
Eighteen Additional IT Infrastructure Services		
6.	Management, maintenance, support of large scale data processing facilities (e.g., mainframe operations)	96
7.	Management of group-wide or firm-wide applications and databases	96
8.	Performing IS project management	88
9.	Data management advice and consultancy services	84
10.	Providing IS planning for business units	80
11.	Enforcement of IT architecture and standards	76
12.	Management of business-unit specific networks (e.g., LANs)	76
13.	Managing and negotiating with suppliers and outsourcers	76
14.	Identification and testing of new technologies for business purposes	72
15.	Development of business-unit specific applications (usually on a chargeback or contractual basis)	68
16.	Implementation of security, disaster planning and recovery for business units	60
17.	Electronic provision of management information (e.g., EIS)	56
18.	Management of business-unit specific applications	56
19.	Group-wide or firm-wide data management, including standards	52
20.	Development and management of on-line and/or EDI linkages to suppliers or customers	52
21.	Development of a common systems development environment	
22.	Technology education services (e.g., training)	52
23.	Multi-media operations and development (e.g., video-conferencing)	36
		16

*Of the twenty-five firms that offered at least one IT infrastructure service

Nature of Services: We allocated each of the services into one of eight service areas by functionality and this appears as Table 2. This grouping enabled us to review the nature of services provided and link this to aspects of firm context.

Table 2. Firm-Wide IT Infrastructure Services Grouped by Functionality

	% of Firms*
Communications Management	
1. *Management of corporate communication network services*	100
2. *Management of group-wide or firm-wide messaging services*	100
12. Management of business-unit specific networks (e.g., LANs)	76
Applications Management	
7. Management of group-wide or firm-wide applications and databases	96
15. Development of business-unit specific applications (usually on a chargeback or contractual basis)	68
17. Electronic provision of management information (e.g., EIS)	56
18. Management of business-unit specific applications	56
20. Development and management of on-line and/or EDI linkages to suppliers or customers	52
21. Development of a common systems development environment	
23. Multi-media operations and development (e.g., video-conferencing)	52 16
Data Management	
9. Data management advice and consultancy services	84
19. Group-wide or firm-wide data management, including standards	52
Standards Management	
3. *Recommend standards for at least one component of IT architecture (e.g., hardware, operating system, data communications)*	100
11. Enforcement of IT architecture and standards	76
IT Education Management	
5. *Technology advice and support services*	100
22. Technology education services (e.g., training)	36
Services Management	
6. Management, maintenance, support of large scale data processing facilities (e.g., mainframe operations)	96
8. Performing IS project management	88
10. Providing IS planning for business units	80
13. Managing and negotiating with suppliers and outsourcers	76
Security	
4. *Security, disaster planning and business recovery services for firm-wide installations and applications*	100
16. Implementation of security, disaster planning and recovery for business units	60
IT R&D	
14. Identification and testing of new technologies for business purposes	72

*Of the twenty-five firms that offered at least one IT infrastructure service

Reach and Range: During interviews, we worked with each firm to identify its reach and range, using the example presented in Figure 3 below. Each firm's reach and range was plotted using the grid shown. An algorithm was developed to convert the plot into a score ranging from 0 to 1000. This involved drawing a diagonal from the point of no reach and range to the point of maximum reach and range and then used a standard cubic function to calculate the distance from the leading diagonal to a given point on the grid. This distance was then multiplied by a coefficient of 1, 2, 3 or 4, weighting range more highly than reach as it is generally more difficult to achieve. A high score indicated a high level of IT infrastructure capability. Reach and range scores for the firms in the study varied from 176 to 605, with a mean of 371. The shaded area in Figure 3 shows an actual reach and range plot for one of the firms in the study, with that plot equating to a score of 377.

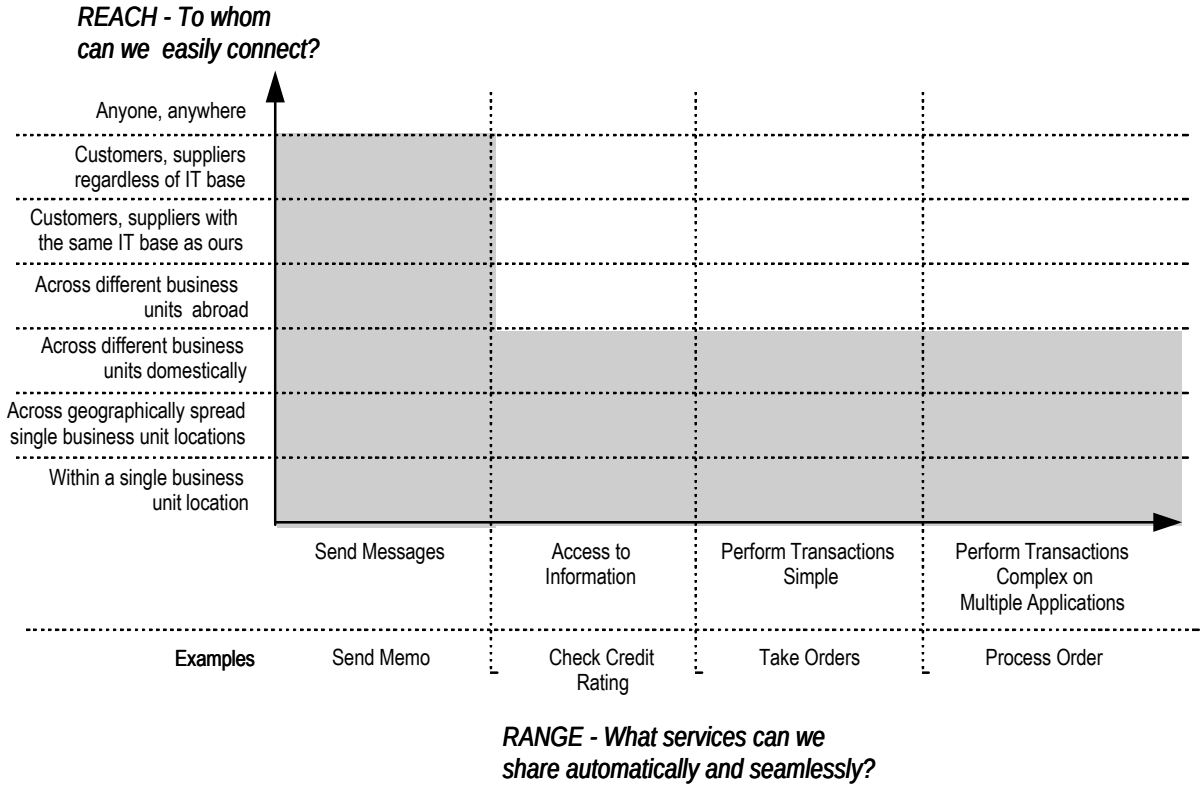

Figure 3. Reach and Range

5. FINDINGS

We found evidence for six of the seven propositions among the twenty-six firms. In addition, the reach and range was significantly correlated with the number of IT infrastructure services (r=0.36, p=0.04). Propositions were analysed using Pearson Correlation Coefficients and a summary matrix is presented in Appendix 4.

5.1 IT Infrastructure Capability and Industry Differences

1. *Firms from different industries will have different patterns of IT infrastructure capabilities.*

   Evidence supporting this proposition was found in relation to the number and nature of IT infrastructure services. Manufacturing firms tended to provide fewer services (r=-0.38, p=0.03) than retail or finance firms. The specific areas where those differences occur to a significant degree are in the areas of communications (r=-0.34, p=0.04), applications

(r=-0.33, p=0.05), IT management (r=-0.27, p=0.09), security services (r=-0.26, p=0.09) and research and development (r=-0.39, p=0.02). Retail firms had more IT infrastructure services in research and development (r=0.32, p=0.05). Reach and range was not correlated significantly with any of the industries.

5.2 IT Infrastructure Capability and Marketplace Volatility

2. *Firms with greater emphasis on the need to change products more quickly will have different patterns of IT infrastructure capabilities from those with less emphasis on this need.*

   Support for this proposition was found in relation to the number of IT infrastructure services and in two IT infrastructure service areas. Firms which needed to change products more quickly provided more IT infrastructure services (r=0.29, p=0.08) and provided a higher number of services in the areas of applications (r=0.27, p=0.09) and data management (r=0.45, p=0.01).

3. *Firms that tend to make resource decisions based on current needs will have different patterns of IT infrastructure capabilities from those that do not base resource decisions on current needs.*

   Limited support for this proposition was evident in one IT infrastructure service area. Firms which tended to base resource decisions on current needs provided fewer IT education infrastructure services (r=-0.41, p=0.02).

3. *Firms with greater emphasis on flexibility to meet changing needs of their marketplace will have different patterns of IT infrastructure capabilities from those with less emphasis on flexibility.*

   No support was found for this proposition. Greater emphasis on flexibility to meet changing needs was not correlated significantly with IT infrastructure capability in terms of either the number of services or reach and range, nor was such an emphasis correlated significantly with any of the IT infrastructure service areas.

5.3 IT infrastructure Capability and Business Unit Synergies

4. *Firms with greater emphasis on identifying synergies between business units will have different patterns of IT infrastructure capabilities from those with less emphasis on identifying synergies.*

   Firms which identify the cooperation required between business units to achieve strategic intent have more extensive IT infrastructure capability in both the number of services provided (r=0.52, p<0.01) and reach and range (r=0.40, p=0.02). Six of the eight service groups correlate significantly with the identification of cooperation between business units. The six groups are standards (r=0.61, p<0.01), IT management (r=0.55, p<0.01), applications (r=0.41, p=0.02), communications (r=0.40, p=0.02), data management (r=0.34, p=0.04) and security (r=0.29, p=0.08). Firms which document how business units contribute to the achievement of firm strategic intent have a greater number of services in communications (r=0.39, p=0.03) and IT management (r=0.32, p=0.06). Hence, the identification and achievement of business unit synergies seems to be a primary driver for the development of IT infrastructure capability.

5.4 IT Infrastructure Capability and Strategy Formation Processes

5. *Firms with greater integration of information and IT needs as part of overall planning processes will have different patterns of IT infrastructure capabilities from those with less integration of such needs as part of planning processes.*

   There was a very strong positive association between the integration of information and IT in overall planning processes and the pattern of IT infrastructure capabilities. The number of IT infrastructure services had a correlation coefficient of 0.64 (p<0.01) and reach and range a coefficient of 0.43 (p=0.01). A higher level of integration affected every

infrastructure service group with the most positive associations being IT management ($r=0.70$, $p<0.01$), applications ($r=0.58$, $p<0.01$), communications ($r=0.57$, $p<0.01$) and standards ($r=0.40$, $p=0.02$). Thus, among this group of firms, a high level of IT infrastructure capability was associated with a high level of integration of information and IT needs in planning processes. This could be because such a capability is important in order for the firms to compete or because deeper consideration of information and IT needs results in a different pattern of investment based on higher expectations.

7. *Firms with greater emphasis on tracking the success of the implementation of strategic intent will have different patterns of IT infrastructure capabilities from those with less emphasis on tracking long term strategy implementation.*

   More extensive IT infrastructure capability is evident in terms of both number of services and reach and range where there is a higher level of reporting progress in achieving the strategic intent of the firm (services: $r=0.42$, $p=0.02$; reach and range: $r=0.43$, $p=0.01$), where such achievements are measured (services: $r=0.45$, $p=0.01$; reach and range: $r=0.28$, $p=0.08$), and where those responsible are named (services: $r=0.44$, $p=0.01$; reach and range: $r=0.42$, $p=0.02$). Thus firms with a higher level of tracking the success of strategy implementation have more extensive IT infrastructure capabilities. Service areas which correlated most positively with these strategy formation process variables were communications, applications, and IT management.

6. DISCUSSION

The links between firm context and the pattern of IT infrastructure capability in the firms in this study indicated a strong association between higher levels of IT infrastructure capability and firms which value business unit synergies, integrate information and technology needs into overall firm-wide planning processes and had specific practices in place aimed at achieving firm-wide strategic intent. These links are summarized in Table 3.

The link between firm context and IT infrastructure capability is clearly more complex than that in the preliminary model (Figure 2). The revised model, drawing on our research, is presented in Figure 4 showing the thin base of the five core services and the extensive capability provided by all twenty-three services. This depicts the increasing importance of IT infrastructure capability to firms which have higher levels of information intensity, greater emphasis on garnering business synergies and the nature of the strategy formation process. There were industry differences with extensive infrastructure capability of less importance to the less information intense manufacturing firms. Concurrently, firms with a focus on identifying synergies between business units, integrating information and IT needs as part of planning processes and tracking the implementation of strategy have more extensive IT infrastructure capability in the form of both more shared services and greater reach and range.

While all firms had the five core services, the pattern of the further eighteen services varied considerably. IT infrastructure services in the areas of communications, applications, IT management, and standards management were consistently associated with a focus on identifying business unit synergies, the integration of IT planning and well developed planning processes. While communications provide a basic technical capacity, the other three focus more on the application of human expertise and intellect in light of the firm's long term investments. This is consistent with recent findings as to the significance of IT managerial skills and knowledge in achieving sustained competitive advantage (Mata, Fuerst and Barney 1995) and appropriate business and technology strategy integration (Boynton and Zmud 1987).

7. LIMITATIONS

This empirical case research study was limited to twenty-six firms in three industries. The firms were carefully selected to meet certain criteria: namely, as a group they had to provide an international perspective and each firm had to be an industry leader by market share within its region. However, the firms in this study do not constitute a random sample, nor are they representative of the total population of firms in any of the three industries.

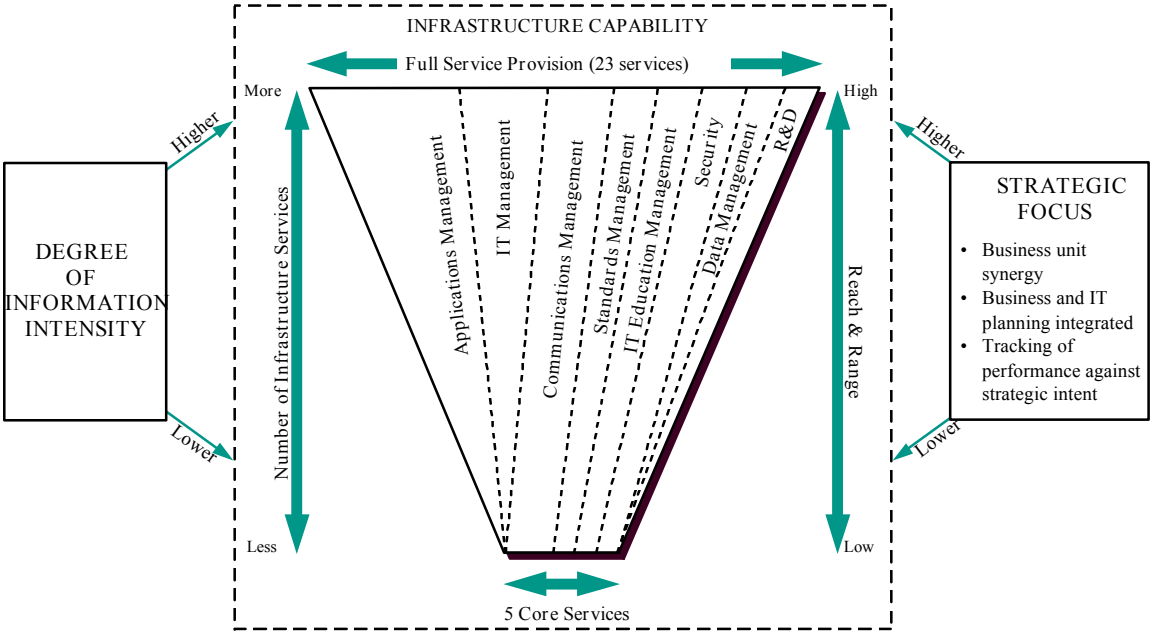

Figure 4. Revised Model: Firm Context and IT Infrastructure Capability

8. CONCLUSIONS

We have provided an empirically based starting point to describe features of IT infrastructure capability, highlighting the role of human expertise in the development and management of infrastructure services.

The patterns of infrastructure capability among the firms in this study indicate an iterative link between the efforts to garner synergy from business units and the consideration given to investment in IT infrastructure services and extending reach and range. The identification and achievement of business unit synergies seem to be primary drivers for firm-wide IT infrastructure capability. This can be seen as an attempt to generate "system value" (Viscio and Pasternack 1996, p. 13) which is more than the sum of each of the separate business units.

Higher levels of IT infrastructure capability were associated with greater integration of information and IT needs in strategy formation processes. This could indicate that a deeper consideration of the IT implications for strategic choices leads to more extensive investment in IT infrastructure services. A question for further investigation is whether different strategic intents lead to deeper consideration of IT implications and thus more extensive IT infrastructure. Alternatively it may be that firms who better integrate IT needs with business strategy tend to have more extensive IT infrastructure regardless of strategy.

Firms which tracked long term strategy implementation had greater IT infrastructure capability. The implication here could be that more careful post implementation assessment focuses on how strategic choices can be implemented, and thus greater realization of the role of IT infrastructure capability in their achievement.

Future work can focus on at least four areas: further analysis of each IT infrastructure service through the development of depth indicators to measure the level at which each service is offered; application of the notion of IT infrastructure services to other levels in the firm, such as within business units; analysis of other industries to provide a rich source of comparison; and deeper examination of the management processes by which firms link strategy and IT infrastructure formation processes.

Table 3. Firm Context and IT Infrastructure Services and Reach and Range

			EIGHT IT INFRASTRUCTURE SERVICE AREAS							
	Number of Services	Reach & Range	Communi-cations	Appli-cations	Data Mgmt	Standards	IT Educat'n	IT Mgmt	Security	R&D
Industry										
Finance firms	–	–	–	–	–	–	–	–	–	–
Retail firms	–	–	–	–	–	–	–	–	–	More
Manufacturing firms	Fewer	–	Fewer	Fewer	–	–	–	Fewer	Fewer	Fewer
Marketplace Volatility										
Firms that value organizational flexibility	–	–	–	–	–	–	–	–	–	–
Firms that base resource decisions on current needs	–	–	–	–	–	–	Fewer	–	–	–
Firms that need to change products quickly	More	–	–	More	More	–	–	–	–	–
BU Synergy										
Firms that document how a BU contributes to achievement of FIRM strategic intent	–	–	More	–	–	–	–	More	–	–
Firms that identify cooperation between BU's	More	Higher	More	More	More	More	–	More	More	–
Strategy Formation Processes										
Firms that integrate information and IT needs into the overall planning process	More	Higher	More	More	More	More	More	More	More	More
Firms that report progress toward the achievement of Firm strategic intent	More	Higher	More	More	–	More	More	More	–	–
Firms that name those responsible for tracking achievements toward Firm strategic intent	More	Higher	More	More	–	More	–	More	–	–
Firms that describe how to measure achievement towards Firm strategic intent	More	Higher	More	More	More	–	–	More	More	–

nb: all table entries represent statistically significant relationships.

From a management perspective, the results provide an indication of the importance of IT infrastructure for different strategic intents. If a firm's strategic intent is focused on synergies between business units (rather than on autonomous business units or on lowest-cost production), then IT infrastructure must be actively managed. To actively manage IT infrastructure requires having a senior person or firm-wide committee to take responsibility for IT infrastructure. A firm desiring greater IT infrastructure capability will need to provide more IT infrastructure services as well as more extensive reach and range.

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APPENDIX 1: PARTICIPATING FIRMS BY REGION

AUSTRALIA (15 Firms)

- ANZ Banking Group
- BP Australia
- Brash Holdings
- Caltex
- Carlton and United Breweries
- Coles Myer
- Commonwealth Bank
- ICI Australia
- Johnson & Johnson (Asia Pacific)
- Metway Bank
- Monier/PGH
- National Australia Bank
- RACV
- Southcorp Holdings
- Woolworths

NORTH AMERICA (4 Firms)

- Johnson & Johnson
- Ralston Purina
- Sunlife of Canada
- Unum

EUROPE (1 Firm)

- S.G. Warburg

ASIA (6 Firms)

- BP Singapore
- Citibank Singapore
- Development Bank of Singapore
- Development and Commercial Bank
- MayBank
- Times Publishing

APPENDIX 2: RESEARCH TEAM

Research team members include:

- Professor Peter Weill, Associate Professor Marianne Broadbent, Carey Butler and Tim O'Brien, Melbourne Business School, University of Melbourne
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- Professor Bob Tricker, John Whitman and Dr. Ali Farhoomand Hong Kong University
- Professor Peter Keen, International Centre for Information Technology
- Professor Jack Rockart, Research Associate Jeanne Ross and Associate Director Judith Quillard, Massachusetts Institute of Technology
- Associate Professor Boon Siong Neo and Dr. Christina Soh, Nanyang Technological University Singapore

APPENDIX 3: FIRM CONTEXT QUESTIONS

To what extent do you agree or disagree with each of the following statements in relation to the FIRM as a whole? Please circle the number that best describes your view ranging from: 1 (Strongly Disagree), 3 (Neither Agree nor Disagree) to 5 (Strongly Agree).

		Strongly Disagree		Neither Agree or Disagree		Strongly Agree	Pearson Correlation Coefficient (CIO & CE Responses)
A.	MARKETPLACE VOLATILITY						
a)	We value organizational flexibility to meet changing needs of the marketplace	1	2	3	4	5	0.05
b)	We make resource decisions based on current needs	1	2	3	4	5	0.17
c)	We need to be able to change products and services quickly in response to changes in the marketplace	1	2	3	4	5	0.68**
B.	BUSINESS UNIT SYNERGIES						
	Approaches are in place that:						
d)	Document how BUSINESS UNITS contribute to the achievement of Strategic Intent of the FIRM	1	2	3	4	5	0.57**
e)	Identify cooperation between BUSINESS UNITS to achieve the Strategic Intent of the FIRM	1	2	3	4	5	0.49**
C.	STRATEGY FORMATION PROCESSES						
f)	The Information & Information Technology needs of the FIRM are an integral part of our panning process (Information Technology (IT) is an umbrella term that includes all computers, systems, communications, software, fax, phones, ATMs, point of sale terminal, and personnel dedicated to providing IT services)	1	2	3	4	5	0.79**
	Approaches are in place that:						
g)	Report progress toward achieving the Strategic Intent of the FIRM	1	2	3	4	5	0.37*
h)	Name those responsible for tracking achievement of the Strategic Intent of the FIRM	1	2	3	4	5	0.52**
i)	Describe how achievement towards the Strategic Intent of the FIRM is measured	1	2	3	4	5	0.41*

^ Significance level $p < 0.01$ * Significance level $p < 0.05$ ** Significance level $p < 0.01$

APPENDIX 4: PEARSON CORRELATION COEFFICIENTS

			Eight IT Infrastructure Service Areas							
	No. of Services	Reach Range	Com-muni-cations	Appli-cations	Data Mgmt	Stan-dards	IT Educ'n	IT Mgmt	Security	IT R&D
Number of Services		0.36*								
Industry										
Finance (dummy)	0.20	0.23	0.25	0.19	0.14	0.10	0.04	0.06	0.07	0.12
Retail (dummy)	0.21	-0.07	0.11	0.16	0.06	0.10	-0.10	0.25	0.22	0.33^
Manufacturing (dummy)	-0.38*	-0.19	-0.34*	-0.33*	-0.20	-0.18	0.03	-0.27^	-0.26^	-0.39*
Marketplace Volatility										
Value organization flexibility	0.10	-0.10	-0.18	0.23	0.20	-0.11	0.02	-0.01	0.04	0.07
Base resource decisions on current needs	-0.14	-0.01	-0.06	-0.13	-0.02	-0.10	-0.41*	-0.10	-0.06	0.25
Need to change products quickly	0.29^	-0.12	0.15	0.27^	0.45*	0.06	-0.12	0.13	0.14	0.21
BU Synnergy										
Document how BU's contribute to achievement of strategic intent	0.23	0.23	0.39*	0.17	-0.09	0.20	0.24	0.32^	0.17	0.06
Identify cooperation between BU's to achieve strategic intent	0.52**	0.40*	0.40*	0.41*	0.34*	0.61**	0.23	0.55**	0.29^	0.00
Strategy Formation Processes										
IT needs are an integral part of the firm's planning process	0.64**	0.43*	0.57**	0.58**	0.31^	0.40*	0.36*	0.70**	0.36*	0.34*
Report progress toward achieving strategic intent	0.42*	0.43*	0.57**	0.33*	0.20	0.27^	0.35*	0.46**	0.20	-0.05
Name those responsible for tracking strategic intent	0.44*	0.42*	0.44*	0.39*	0.22	0.32^	0.18	0.44*	0.19	0.08
Measurement of achievement toward strategic intent	0.45*	0.28^	0.36*	0.39*	0.35*	0.22	0.15	0.37*	0.32^	0.04

^ Significance level ≤ 0.10 * Significance level ≤ 0.05 ** Significance level ≤ 0.01