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Technological Learning and Capability-Building: How Do African Telecommunication Firms Learn?

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Abstract

This paper presents the results of a larger study that focusses on technological learning in developing country firms, using empirical data from 26 telecommunication firms in Uganda, Ghana, Tanzania and South Africa. The paper adds to knowledge by providing a cross-disciplinary study of how African firms undertake technological learning and capability-building. The conceptual framework used in the paper, the TCB system approach, suggests that the underdevelopment of the strategic and systematic management of technological learning capability development is a major constraint for developing country firms and cannot be explained by country-level factors only. It therefore suggests that a simultaneous focus on internal factors that contribute to effectiveness, and on boundary conditions, is necessary. This paper focuses on the internal, intra-firm dimension and provides insights on how features such as ability to manage cultural change, leadership and organisational integration influence and explain variation in the ability of telecom firms to build capabilities. These insights have implications for firm strategy and policy and offer avenues for future research.

Introduction

Technological learning and capability-building involve intra-firm processes as well as the relationship between firms and their environments. When focussing on the intra-firm level, an understanding of human behaviour, motivations, facilitating conditions and barriers to change is important. However, despite strides in the development of this field of scholarship, interested readers wishing to understand how developing country firms, and particularly those in Africa, undertake technological learning and capability-building would be hampered by a lack of empirical research at the intra-firm level and relatively limited integration of the insights across disciplines.

It is in this context that this paper presents some of the results from a study that focusses on technological learning in developing country firms, using empirical data from 26 telecommunication firms in Uganda, Ghana, Tanzania and South Africa. The firms included public telecommunication operators (PTOs); mobile communication network providers; data communications companies and Value-Added Network Services(VANS) providers; satellite signal distribution companies; and one pre-launch branch of a global satellite company. The sample ranged in firm size, measured in terms of number of employees, from seven to over 50-thousand employees. At the time of the interviews, the range of experience in technological capability-building (TCB), varied from a minimum of four months to a maximum of 15 years.

The research strategy employed involved developing an original conceptual framework, the "TCB system approach," and applying it to explore the following question: How do developing countries undertake technological capability-building, and what accounts for variation in effectiveness?[2] The

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2 For further details on the study, see Marcelle (2002).

TCB system approach draws on organisational development, strategic management, evolutionary economics and development studies theorists to craft an integrated conceptual framework that is then used to investigate technological capability development and technological learning in developing country firms.

One of the research topics included in the larger study is the role and contribution of internal processes in technological learning and capability development. It is the results and analysis relating to this issue that are presented in this paper. As will be shown, there are significant benefits to applying a cross-disciplinary perspective, such as the TCB system approach, to the study of technological learning and capability development in developing countries.

The TCB system approach differs from other approaches to understanding capability development in firms. First, it links the insights of organisational learning theory, most of which was developed for firms operating at technological frontiers, to the insights emerging from several decades of research on capability development in the development studies tradition. Second, in the TCB system approach, internal processes and boundary relationships are considered to be equally important for effective capability development. Finally, the approach emphasises the systematic aspect of capability development, building on concepts of organisational coherence and the strategic management of change. The TCB system approach suggests that the underdevelopment of the strategic and systematic management of technological learning capability development is a major constraint for developing country firms, and cannot be explained by country-level factors only. Therefore, a simultaneous focus on both the internal factors that contribute to effectiveness, and on the boundary conditions, is necessary. This paper focuses on the internal, intra-firm dimension.

The rest of this paper is organised in four sections. Section 2 presents an outline of the TCB system approach. Section 3 presents empirical evidence on technological capability processes among the sample of 26 firms. Section 4 analyses the implications of these results for understanding and improving the effectiveness of technological learning and capability-building; the final section, Section 5, provides concluding remarks and some recommendations.

Overview: The TCB System Approach

The TCB system approach argues that to be effective in technological learning and capability-building, developing country firms must organise their learning and capability accumulation efforts as a systematic, organised process involving five critical components, including both management of internal processes and management of boundary relationships. It is further argued that proportional and simultaneous investment in all these five elements is likely to increase the stock of technological capabilities and to improve effectiveness of technological capability-building. In investigating the TCB process at the firm level, it is assumed that variations in TCB activity cannot be fully explained by country- level factors, and are likely to be influenced by developments that occur endogenously within the firm.

Technological capability (TC) is defined, in this paper, as a collection of firm-specific assets, both material and non-material, including equipment, skills, knowledge, aptitudes and attitudes that confer the ability to operate, understand, change and create production processes and products. In this definition of technological capability, there are aspects that are located in people, referred to as embodied elements of a technological capability, e.g., skills, attitudes, tacit knowledge, and aptitude, and other aspects that are non-embodied elements, e.g., codified knowledge, equipment, and software. It is further specified that both of these broad types of capabilities are required for the optimal effect of a capability to be realised. The full specification of a TC also includes elements that

coordinate the embodied and non-embodied aspects of TCs – organisational integration elements. These aspects are required to make TCs operational and effective. The organisational integration element of a TC is similar to the concept of organisational coherence (Leonard-Barton, 1995; Pettigrew, 1991) and the Tushman (1996) concept of organisational congruence. At the detailed level, organisational integration is understood to include activities related to setting conditions for realising benefits from embodied and non-embodied capabilities, and management systems for decision-making, implementation and resource allocation, and establishment of a facilitating organisational culture. This framework builds on the resource-based approach to understanding capability development (Teece 1987, 1994, 2000), which suggests that a capability is only meaningful because of the services it delivers to the firm. The framework developed here extends that treatment by delineating some of the human attributes that are required to confer meaning.

The process of technological capability-building (TCB) is defined as a non-linear investment process in which technological capabilities are assembling and/or accumulating under conditions of uncertainty. Because of these characteristics, TCB effort requires sustained, purposive coordination. TCB is considered to be the process of organisational learning in which capability accumulation is not linear, sequential, orderly or guaranteed to succeed.

The TCB system approach is designed explicitly to investigate those aspects of firm performance that cannot be explained by exogenous factors. It argues that firms may go further in capability development than is suggested by the environments in which they are located. The TCB system permits investigation and explanations of why some firms are able to compensate for external conditions that are not conducive to technological learning.

The TCB system approach presents a hypothesised “ideal system” for developing country firms. It is suggested that for firms to be effective in their TCB efforts, they require a system consisting of five critical components: three internal processes, for (1) allocating financial resources to TCB effort, (2) management practices, systems and decision-making rules that implement and support the TCB effort, and (3) practices to establish and maintain an organisational culture in which the TCB effort is exercised with committed and skilled leadership; and two boundary processes, for (4) accessing external TC resources from suppliers, and (5) accessing external TC resources from the innovation system (local and global).

The three internal processes of the TCB system are:

1. **Financing:** allocating financial resources to technological capability-building effort. This involves mechanisms that identify and allocate financial resources to the TCB investment effort. This takes account of the investment characteristic of TCB.

2. **Management practices,** systems and decision-making rules that implement and support technological capability-building effort. This process includes a number of actions to manage the TCB process, to set rules and decision-making systems for undertaking TCB activities, and to provide coherence for the effort by linking the TCB activities to overall firm objectives. These actions provide organisational coherence for TCB activities, as well as make the intentions to invest in TCB operational. This element builds on the integrative approaches, particularly Leonard-Barton (1995), the functional approaches (Tidd et al.,1997) and the emphasis on process competence and coherence in Pettigrew and Whipp (1991).

3. **Culture and leadership** practices to establish and maintain an organisational culture in which technological capability-building effort is exercised with committed and skilled leadership.

This process includes actions to provide legitimacy, psychological encouragement and motivation for the TCB effort. The culture and leadership aspect is not the preserve of the senior management team, but represents the actions taken to create an environment and culture in which staff at all levels perceive that they are free to undertake the complex, risky, problem-solving activities associated with TCB. These are the facilitating actions that are crucial for TCB, and draw on the concepts of organisational culture change and strategic change management of Pettigrew and Whipp (1991), Schein (1992), Leonard-Barton (1995), Senge (1992), Vaill (1996), Starkey (1996) and Moingeon (1996).

The importance of boundary relationships draws on the resource-based approach to understanding competitive advantage, in which core capabilities are defined to include boundary assets (Teece 1987, 1994, 2000), combined with the propositions of the NIS and development studies perspective on capability development.

The boundary processes are as follows:

4. **Relationships with suppliers,** for accessing external TC resources. These are mechanisms for accessing technological knowledge and artefacts from suppliers. For the majority of developing country firms, importation of technological inputs from international firms is a major source of capability. The local innovation system in the majority of developing countries does not adequately provide sources of advanced technological knowledge, equipment, software and technical services. In this conceptual framework, this set of boundary relationships is defined as a technology acquisition process, in which developing country firms exercise constrained agency, but are not passive actors.

   This proposition is in line with Bell and Pavitt (1997) and Hoffman and Girvan (1990). In this framework, the limits and opportunities for making effective use of supplier relationships for TCB change over time and are intrinsically linked to the nature of the technological inputs being sought by developing country firms, since the nature of the input influences the willingness and ability of supplier firms to provide these inputs.

5. **Relationship to the innovation system,** used to access TC resources from the innovation system (national and global). This boundary relationship refers to relationships between firms and institutions in the innovation system. In this framework, the institutions within the domestic innovation system that are considered to be important sources of technological inputs include: knowledge-creating institutions such as universities, technical vocational colleges, training institutes and national research centres; policy-making bodies; and regulatory authorities. This is consistent with the NIS approach of Nelson (1982), Lundvall (1996), Bell and Pavitt (1997), Mytelka (1999) and Kim (2000). The types of technological inputs that firms can derive from relationships with these institutions include: codified knowledge; tacit knowledge; improved understanding of technological trends and patterns through regular interaction; information about sources of technological information and know-how; information on what TCB activities are permissible or feasible under existing legislative and regulatory rules; and information regarding changes in legislative and regulatory rules. These institutions can also be a source of embodied skills and know-how, to the extent that the local setting can provide skills and experience required by operating companies. The domestic innovation system institutions can also improve cost-efficiency in technological search activities, by providing common information services to all firms, and thus reducing the duplication of search costs.

The TCB system approach draws on insights into the behavioural, structural, environmental and functional enablers of learning, and specific development studies that analyse technological

capability development. In particular, the approach extends the work of Bell (1984), Bell and Pavitt (1997), Dutrenit (1998), Ernst et al. (1998), Hobday (1990), Hoffman and Girvan (1990), Kim (1999), Leonard-Barton (1995), Pettigrew (1991) and Tidd et al. (1997).

Learning Systems of African Telecommunication Firms

This section provides a detailed review how the African firms in the sample established and managed internal organisational processes for TCB. This paper reports on qualitative accounts of how firms in the sample implemented their internal TCB practices. In the larger study, this qualitative assessment was supplemented by statistical exploration that is outside the scope of this paper. Through a combination of qualitative analysis and statistical exploration, the study was able to explain variation in the nature and effectiveness of learning and capability-building processes, and to generate useful insights.

Mechanisms for Learning & Capability-building & Investment in TCB Activities

Primary data collection from the sample of 26 firms revealed that the firms used 61 different TCB mechanisms for learning and capability-building. For analytical convenience, and to permit statistical exploration of the patterns of learning, these 61 individual TCB mechanisms were organised into seven groups corresponding to the elements of the TCB system defined in the earlier section. Table 1 provides definitions of these seven functional groups and the constituent TCB mechanisms:

Table 1: Composition and characteristics of the seven groups of TCB mechanisms

Group number & function	TCB mechanisms	Type of orientation/ TCB system element	Functional characteristics of TCB mechanisms
I. Increasing people skill base	M1-M15	Internal/ management practices	Focus on attracting people with skills, providing in-house training and information, and making efforts to retain people with technical and commercial skills.
II. Organisational development	M16-M31	Internal/ management practices, culture & leadership	Establishing and implementing organisational systems for targeting skills development and supporting learning, and integrating TCB activities with organisational systems for productivity growth and quality improvement. Undertaking organisational development activity to create culture/environment that facilitates learning.
III. Technological search	M32-34	Internal/ management practices	Using search and evaluation systems to support technology choice and selection, to maintain a high level of awareness of technological trends and developments, and to match technologies to customer needs.
IV. Acquiring complementary knowledge from industry	M35-53	External/ supplier relationship	Acquiring technical information, knowledge and skills from a variety of sources, including telecommunication equipment suppliers, international organisations and other private sector training organisations, and transferring this information and skill to staff members.
V. Acquiring expatriate people skills	M54-57	Internal/ management practices	Bringing knowledgeable and highly-skilled people into the firm for limited duration, and transferring their information, knowledge and skills to permanent staff members.

VI. Interaction with innovation systems	M58-60	External/ relationship with innovation system	Accessing information and knowledge from institutions in the local and global innovation system, including universities and vocational colleges.
VII Funding TCB	M61	Internal/financing capability development	Allocating budgets to TCB activity.
Source: author			

Of the total, 39 mechanisms were internally-focussed, and 22 were externally-focussed. In this paper, the internally-oriented TCB mechanisms will be the primary focus. Table 2 provides a listing of the internally-oriented TCB practices and also provides data on the frequency with which these TCB mechanisms are used by the sample firms.

Table 2: Usage of internally-oriented TCB mechanisms

Management, culture & leadership, & funding TCB effort	Code	Description of TCB mechanism	No. of firms using
Recruitment & retention			
	M1	Recruitment of graduates from universities and technical colleges	20
	M8	Sponsorship of university undergraduate and postgraduate training through scholarships, bursaries and study loans	9
	M54	Recruiting expatriate staff on contracts of 2-5 years duration	8
	M56	Recruiting experts on short-term consultancies lasting less than 6 months	8
	M4	Targetted recruitment of overseas nationals	4
	M55	Recruiting experts on assignments of 6 months to 1 year	4
	M57	Implementing formal skill transfer from expatriate staff	4
	M7	Induction programmes for new recruits	4
	M5	Internships for university students	3
	M2	Implementing formalised graduate recruitment programmes	1
	M3	Targetted recruitment of high-level specialists	1
	M6	Apprenticeship schemes	1
Training, motivation & reward systems			
	M9	Organising in-house training programmes	18
	M10	Providing on-the -ob training	14
	M19	Performance-related pay for learning activities	10
	M16	Mentoring programmes	9
	M12	Organising “training of trainers” programmes	7
	M15	Special training and staff development programmes to develop and maintain technical specialists	7
	M17	Formal, individual training plans	5
	M20	Leadership development programmes	5
	M18	Individual career development programmes	4
	M11	Distance learning	3
	M14	Improving administrative coordination of training programmes	2
	M13	Improving supervision of technical recruits	1
Organisational design			
	M26	Assigning responsibility for TCB to a particular function	11
	M23	Creation of open learning facilities, e.g., libraries, resource centres, Internet access points	9
	M27	Decentralising responsibility for TCB objectives to line managers	5
	M21	“Change management” programmes	5
	M28	Formal quality management systems, e.g., ISO-9000 and ISO-1400	4
	M29	Establishing TCB expenditure targets and monitoring spend on TCB activities	2
Organisational integration			
	M30	Staff rotation programmes	3
	M31	Programmes to integrate TCB into strategic planning	2
Evaluation & assessment			
	M33	Carrying out staff training needs assessments, technology needs assessments and customer technology requirement assessments	8
Scan & search			
	M34	Formal active technology search and evaluation processes	7
	M32	Active involvement with industry associations	4
Knowledge management & codification			
	M24	Providing access to technical journals, periodicals and handbooks	7
	M25	Codification of technical knowledge in standard operating procedures	4
	M22	Implementation of knowledge management systems	2
Financing TCB effort	M61	Allocating budgets to TCB activity	19

No. of firms =26; No. of internally-oriented TCB mechanisms =39

The following sections provide further detail on these TCB mechanisms used for implementing management practices, stimulating a culture to support TCB, and funding TCB investment.

Recruitment and retention systems

Processes to identify, attract and keep people with technical skills -- including recruitment of overseas nationals and expatriates -- are important TCB activities. Recruitment of graduates from universities and technical colleges (M1) was, for the majority of firms in the sample, the basic mechanism for attracting people with relevant skills. This was the traditional approach to recruitment used by African telecommunication companies in the sample, and many well-established firms, particularly the publicly-owned national operating companies, continued to rely on this as a major focus of their TCB activities.

The new entrants often supplemented graduate recruitment with other methods for attracting skilled staff. For example, in Ghana many of the new entrants participated in the scheme sponsored by the UNDP and the Ghanaian government to recruit overseas resident nationals back to the country (M4),[3] and also implemented targeted recruitment of high-level specialists (M3) and formalised graduate recruitment programmes.

3 For example, the Government of Ghana has set up a Non-Resident Ghanaian Secretariat and actively seeks investment from the diaspora.

Some of the firms in the sample provided evidence that they made investments in increasing the pool of skilled personnel by sponsoring university training for existing staff and potential recruits (M8). Nine firms from three countries used this mechanism, but they were all well-established and well-resourced firms with developed TCB systems.

Fifteen firms in the sample used recruitment of expatriates as a source of technological capability, and acquired this people-based capability through employment contracts of limited duration. The expectation was that during the period of employment, expatriates would transfer skills, knowledge and information to permanently-employed staff. However, of the 15 firms that employed expatriates, only four had specific, formal knowledge-transfer programmes to ensure that permanent national staff genuinely acquired the skills, knowledge and information of the expatriates. For the remaining firms, transfer was left up to an unmonitored and informal process of exchange.

There were other aspects of considerable variation in the usage of expatriates as a source of technological skills. The majority of firms making use of expatriates were private sector companies, including those with non-African equity partners and cross-border African equity ownership. Conversely, the large publicly-owned firms in the sample, except for those where there was private participation through strategic investors, did not use expatriates as a source of technological skills.

The sample firms reported varying degrees of satisfaction with the role of expatriates as a source of technological knowledge and skills. One large public network operator in a competitive market expressed concern that its ability to select expatriates was compromised by the terms and conditions of technical assistance funding. In this instance, it was believed that the expatriates made available through these arrangements did not contribute to TCB, as their skills were often out-dated and the work practices of the individuals did not assist with knowledge-sharing and skills transfer. However, for the majority of the 15 firms using expatriates as a source of knowledge and capability, the mechanisms were considered effective, typically where there was direct control of selection of expatriates and careful management of the transfer process. For example, one national mobile operator that used expatriates as a core component of a network deployment team surpassed its own objectives and was able to build a network with national coverage on time, and within budget, in three months.

Seven firms in the sample had specific programmes to retain and develop staff with technical specialisations (M15). The implementation of these programmes included career paths for technical specialists, remuneration systems to reward and "incentivise" these staff, and payment of "loyalty bonuses" to retain specific individuals who were considered to be irreplaceable. One of the new entrants pegged the salaries and bonuses of technical specialists to the US dollar as an incentive. There were two firms that implemented formal career development paths for technical specialists where promotion and career progression possibilities were designed and mapped by human resource professionals in the firm and formally communicated to staff. Firms with underdeveloped TCB systems fared less well in meeting the challenge of recruiting and retaining skilled people.

These firms had also not been able to diversify away from existing sources of technical recruits, and were more likely to be affected by flagging performance in the quantity and quality of the graduates supplied by local universities and technical colleges. This TCB mechanism satisfies the objectives of recruitment and retention, as well as human resource development and motivation, since these retention mechanisms also served to keep motivation levels high among technically-skilled staff members.

Many of the firms in the sample identified problems with recruiting sufficiently high numbers of information technology and computer science graduates. These difficulties appeared to be more severe for well-established firms that used traditional mechanisms for recruitment of staff and had not diversified their sources of technical personnel.

Human resource development (HRD)

These processes involve design and management of HRD systems to train staff, carry out performance evaluations, design and implement reward and incentive systems, and implement promotion systems and staff development systems that increase individual motivation and performance. The approach to HRD is illustrated by the examples drawn from three firms that were able to establish extensive organisational development programmes aimed at achieving the above objectives. Although these firms varied considerably in size and number of years of operation, and were producers in different segments of the telecommunication services sector, they shared many similarities in their respective approaches to HRD.

The first example is a large public network-operating company, which operated several formal systems for staff development, including a leadership training programme for senior managers, a fast-track management programme for managers and staff at functional levels, and a change management programme for employees at all levels. This company also operated sophisticated reward and remuneration systems that tied training outcomes to individual remuneration packages, and further, included the training and skills development of team members as one of the evaluation criteria against which management performance was assessed. These systems were formally managed as part of the specialist HRD function, with senior managers and the executive level having designated responsibility for achievement against the objectives.

The second example is a much smaller public network operator that faces competition across all of its business lines and had been in operation for only two years at the time that the data were collected. The start-up operations of the public network operation placed emphasis on organisational development activities, as a result of the background and orientation of a key decision-maker in the organisation. This individual had had a previous career as a professor of entrepreneurship in a US business school, and as senior executive, had considerable sway and flexibility in the design of the corporate development systems in the company. This emphasis on organisational development and HRD is reflected in the importance given to the professional and specialised HRD function, at a relatively early stage in the life of the company, and the investment made in the implementation of remuneration systems that rewarded individual performance, denominated salaries in US dollars to hedge against foreign currency risk, and implemented remuneration surveys to set reward packages for staff.

The third example is a small specialist firm providing telecommunication services to business users. This company identified its technological leadership as its competitive advantage and used organisational development methods to maintain high levels of motivation among the technical staffers. In addition to the methods used by the other two example firms, this company set individually-defined learning objectives and paid bonuses against achievement of these objectives.

Firms with less well-developed TCB systems did not employ as wide a range of human resource development mechanisms, and focussed on traditional approaches, such as organising classroom-based training. The data from the sample suggest that firms with more developed TCB systems had a much more focussed and individually-targetted approach to HRD than their counterparts with less-developed TCB systems.

values that encourage TCB activities. Firms in the sample also supported culture change through introducing resources for informal learning and adopting non-traditional approaches to learning (M23). While some firms in the sample reported success in changing their culture and values through the use of the mechanisms identified here, many of the well-established firms reported that they continued to face serious challenges in shifting organisational cultures and leadership styles that were not adapted to TCB objectives. Issues regarding culture and leadership are particularly important because TCB is effected by people at various levels and with many different responsibilities. In this diffuse and amorphous process, it is vital that the overall set of values, norms and mental models in operation within the firm are supportive and facilitating.

Financing TCB effort

Data provided by the sample companies on levels of expenditure and effort on TCB activities often did not disclose disaggregated information on levels of spend on embodied TCs (people-related) or disembodied TCs (hardware and materials). Most companies expressed reluctance to disclose information on grounds of confidentiality, and in the vast majority of cases, the management and financial accounting systems of the sample firms did not capture information at a disaggregated level. Estimates of spend on network equipment ranged from US$20-25-million per annum to multi-billion-dollar budgets, and these estimates were substituted as a rough proxy for investment in disembodied TCs.

Expenditure levels on training and staff development activities, which ranged from a low of several thousand dollars per year to a high of a multi-million-dollar budget -- were used as a proxy measure for expenditure on embodied capabilities.

Implications for Increasing Effectiveness of Technological Learning

In the larger study, the descriptive data on TCB mechanisms in use, detailed qualitative accounts such as that presented in the previous section, and quantitative data on intensity of use of the seven types of TCB mechanisms, were used to construct indicators of TCB system development. In addition, there was a statistical exploration of patterns of use across these categories of TCB system development. The detailed qualitative analysis and intra-firm investigation shed light on why firms with more-developed TCB systems were able to increase the effectiveness of technological capability inputs and how they managed to diversify beyond the traditional approaches to capability development. From the detailed statistical exploration, the sample of 26 firms was found to consist of 10 firms with well-developed TCB systems, seven firms that had made very little progress in establishing functioning TCB systems, and the remaining nine firms that had made some progress in establishing TCB systems. Using statistical tests, it was confirmed that the 10 firms with more-developed TCB systems did display patterns of learning and capability development that differed significantly from the firms with less well-developed TCB systems, and also that these 10 sample firms displayed properties similar to the hypothetical “ideal system.” It is the combination of all of these areas of analysis that confirms the finding that effectiveness of TCB effort is positively associated with the development of TCB systems, and further provides insights into how African firms might improve effectiveness (Marcelle, 2002).

To explore the implications of these results more generally, this paper uses the device of painting a picture of the most commonly observed patterns or the prevailing “systems in use”[5] among the

5 The term “systems in use” (Senge, 1992) is a useful concept for describing the most commonly observed patterns that appeared to be typical of firms operating in the sample. It also appears to be more meaningful to describe a prevailing kind of organisational practice than to introduce terms such as “average,” which tend to suggest statistical representativeness. The characteristics of the sample firms described here as being illustrative of the systems in use were drawn from a qualitative assessment of the evidence and were not based on the results of a statistical calculation.

sample, and then provides an analysis of the firms that performed better or worse.

Prevailing ‘Systems In Use’ for African Firms

The prevailing ‘systems in use’ for the sample firms -- and this may be true of many developing country firms, particularly in Africa -- saw firms expend a great deal of effort on increasing the stock of TCB inputs, particularly the supply of people (embodied TC), and on ensuring that these people had the right skill set. Firms in Africa -- and in developing countries generally -- face challenging supply conditions, and are preoccupied with continuously ensuring that skills match the requirements for effective operation and change in technological systems.

Among the sample firms, this often led to the neglect of internal processes that aim to ensure that TCB inputs are used effectively. For the African telecommunication companies sampled, the prevailing “systems in use” for managing technological learning and capability-building had the following characteristics:

Management practices

- There was a great deal of reliance on recruitment of graduates from domestic technical colleges and universities as the main source of people-embodied technological capability. Public sector companies in the sample often organised this recruitment effort quite formally, and then required new recruits to undertake induction programmes where they were introduced to different technical disciplines over a period of up to three years.

- Formal in-house classroom-based training programmes were the main method for continuous updating of skills, information and knowledge. The large firms in the sample, both publicly-and privately-owned, organised this in-house training through specialised departments or separate training colleges that were attached to the operating company. The older and more established companies often carried out their training without reference to knowledge production institutions in the country, and were more likely to complain that the curricula in their internal training programmes were out of date.

- Experiential training was recognised and appreciated as an important component of training, skills development and knowledge acquisition. Smaller firms in the sample were better at organising and rewarding experiential training opportunities.

- The approach to managing the people-centred capability development process was to assign the responsibility for developing training and knowledge development to a single identified specialist department within the organisation, most often the human resource development (HRD) department. The interaction between HRD and the technical specialist departments, e.g., around network-planning and information technology, was relatively irregular and there was little joint ownership of objectives for organisational learning across disciplines.

- Performance-related pay and benefits systems were used extensively to encourage and motivate capability development for individuals. There appeared to be greater effectiveness in promoting individual capability development than at aggregating this effort to the team and organisation-wide level.

- There was extensive use of expatriate employees and consultants to expand the skills base available to the firm beyond the boundaries of the domestic economy. The effectiveness of

internal processes to ensure genuine knowledge-transfer from expatriates, even when these were the employees of shareholder companies, varied considerably across the firms. More often than not, African firms were relatively weak in managing the process of the flow of tacit information from expatriate staff and consultants to local employees.

- Use of open-learning facilities, including resource centres, on-line training facilities and provision of Internet-based resources and tools, was not very widely practiced by firms in the sample. Although there was widespread recognition that these facilities could provide extensive benefits, in practice, African firms had not moved much further beyond that recognition.

Culture and leadership

- There were diffused and amorphous approaches to managing capability development, as opposed to systematic and strategic approaches. A wide range of activities was aimed at increasing capabilities available to the firm.

- There was a good understanding of the importance of capability development for meeting both competitive and defensive objectives.

- The most commonly-observed patterns among these firms were those of a novice rather than an experienced and sophisticated developer of capabilities. However, there was an acute awareness of the importance of technological knowledge and expertise in providing the ability to produce telecommunication services cost efficiently.

- There was an awareness of the imperative of developing more "open learning styles," and shifting away from more traditional approaches to developing capability. In the publicly-owned firms, there was a sense of crisis, i.e., the impetus for this change was not experienced as being under the control of existing management. Rather, it was perceived as an involuntary process associated with privatisation and imminent changes in ownership. Even in the privately-owned companies, the most common experience was of the operating companies struggling to cope with the pace of technological change.

Allocation of financial resources

- There was much more emphasis on budgeting for the hardware and tangible material inputs to the technological capability process than for the human-related elements.Telecommunic ation operating companies, including those in this sample, have well-established network-planning routines that allow the firms to plan and allocate resources to network expansion and maintenance. These routines were typically engineering-led, and often took place with little integration with the rest of the organisation. In addition to expenditure on the hard elements of technological capabilities, the operating companies also established routines for allocating resources to training and human resource development. Budgets for hardware, equipment and human resource development were often separately managed, and a common problem identified was the lack of integration between training and the technological requirements.

The features just described were observed in 16 of the 26 firms, while 10 firms performed better than these characteristics, and it is the success factors of these "out-performers" that we turn to now, in this next section.

'Out-Performers' and Critical Success Factors (CSFs)

As discussed in the previous section, there were African firms in the study that displayed best practice and compared favourably with the "ideal system" for TCB[6]. These companies demonstrated the necessary breadth of routines, selectivity, and integration of routines across functional disciplines and made attempts to establish the cultural and leadership setting for organisational learning to take place. These firms out-performed the prevailing "systems in use," and were very effective in their technological capability-building efforts. In the rest of this section, five general critical success factors, and specific characteristics that contributed to these firms' "out-performance" and effectiveness in technological learning and capability-building are discussed.

Critical Success Factors for Learning

The first critical success factor (CSF) that can be identified for out-performers is that they exhibited awareness of the importance of technological capability for firm survival and competitiveness. This ability was observable in terms of specific internal processes associated with evaluation and assessment, as well as routines, which aimed to direct the TCB effort in the firm. This is an important finding since it may indicate that success in TCB effort requires the following kinds of effort, noticeably absent in firms with less well-developed TCB system involving:

- Sensing of TC gaps and selecting appropriate responses

- Implementing responses

- Refining responses and continuous change of TCB effort

The second CSF is the ability to continuously address and manage change, by deploying appropriate organisational culture and leadership practices. The most effective firms were those that had the ability to refine and adapt their TCB effort in response to change. This ability was not limited to large firms, since, as noted, traditional public telecommunication operators (PTOs), although they had well-developed TCB systems, seemed often to be stuck in old ways of mobilising TCB effort and were, therefore, not able to select appropriate responses and to change over time.

Out-performing firms in the sample displayed a third key strength in terms of their willingness to experiment with organisational design and to introduce mechanisms for facilitating more openness in learning. Eleven out of the 26 firms reported providing environments that were conducive to organisational learning, including through changes in organisational design. These firms provided open-learning facilities such as resource centres, Internet facilities, on-line tutorials and libraries. This high propensity to support open learning exceeds the expectation that was suggested by previous studies of capability development efforts by African firms. It suggests that the telecommunication sector is likely to be an outlier in terms of organisational learning and capability development in Africa.

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6 A statistical test was done to compare TCB systems in use with the "ideal system." A firm with an "ideal system" for TCB would be expected to balance its TCB effort across all of 5 elements of the TCB system, i.e. adequate and appropriate financing; facilitating management practices; supportive culture and leadership; and effective management of supplier relationships and relationships within the innovation system. A Wilcoxon Sign Test procedure was applied to compare the reported patterns of usage in each of the three categories of TCB system development to the "ideal system" suggested by the conceptual framework. This test examined the morphology of learning systems to investigate whether proportionate and balanced deployment was present. Interpretation of the results of the Wilcoxon Sign Test suggested that 10 firms with well- developed TCB systems (firms in the high category) adopted patterns of usage that were similar to the "ideal system" -- that is, they employed a diverse range of mechanisms and a balanced, systematic approach. Meanwhile, 16 firms with less well-developed TCB systems did not adopt the most effective patterns of deployment of TCB mechanisms. The differences or deviations from the "ideal system" were found to be statistically significant at the 5% level.

The fourth CSF exhibited by firms in the sample with well-developed TCB systems was the existence of a high absorptive capacity for bringing knowledge and expertise from external sources into the firm and making effective use of those inputs. The firms with a well-developed TCB system appeared to be particularly good at managing the flow of people and tacit knowledge across organisational boundaries. The capabilities and factors that assisted with this boundary-spanning activity included management practices, such as evaluation and monitoring of expatriate contracts, as well as attitudes. Firms with a well-developed TCB system reported that they cultivated a willingness to learn, were not closed and suspicious, and were more confident in their approaches to TCB management than firms with poorly-developed systems. The combination of culture and leadership, management practices, financial resources, and interaction with the innovation system and suppliers – the defining elements of the TCB system -- appeared to have reinforcing effects that were expressed in the values and attitudes of the people in the firms. These values and attitudes were not acquired instantaneously, or through a single event of TCB, but rather through a process that took place over an extended period of time, and required the processing of failures and mistakes and refining of the processes.

The fifth and final key distinction that emerges from the analysis of the experiences of these 26 firms is the central importance of disciplinary-based technological knowledge. In every instance of a firm that was successful in building a culture of openness and strong absorptive capacity, there was evidence that the internal capabilities of the firm were strong and resilient. The firms that had developed a strong foundation of in-depth technological knowledge[7] were much more confident in their boundary-spanning activities than the weaker firms, and were less likely to complain of dependence on external actors. The interviewees were more likely to believe that their firms could respond to external changes in technology or commercial conditions. This finding has implications for recommendations on how developing country firms can build technological capabilities, and lends support to the wealth of empirical evidence that suggests that indigenous capability is an absolutely essential requirement for capability development.

Specific Competencies for Effectiveness in Learning

In addition to these general features, there are some specific characteristics of the TCB effort within out-performing firms that contributed to their relative success. These are: the ability to blend traditional and non-traditional approaches; active and purposive engagement; and routines for rewarding and developing skills.

Blending of traditional and non-traditional approaches

Successful TCB firms appear to have combined traditional PTO-style approaches to developing capability with more specific and tailored approaches. This was particularly evident in the recruitment and retention routines used by firms in the sample. In particular, successful TCB firms in the sample recognised the weaknesses of the local labour market and education systems. They reported that they proactively engaged with the system, so that their access to trained highly-skilled staff would improve. This is confirmed by the reported attention given by firms with a well-developed TCB system to interaction with the local and global innovation systems. An example was the medium-sized Ghanaian firm that developed very specific routines for filling the gap in network management expertise by requiring local staff to follow an international, best-practice, industry-defined training programme over three years. In contrast, a large Tanzanian network operator had failed to expand its recruitment and training efforts beyond the traditional approaches,

7 In small firms in the sample, this was often a single individual – the founder.

and was reportedly experiencing the negative effects of outdated skills.

Active and purposive engagement

Successful firms with a well-developed TCB system did not leave matters to chance, but reported that they managed and monitored individual TCB mechanisms and the TCB system as a whole. For example, while many firms in the sample used expatriates as a source of capabilities, few firms had management mechanisms that would increase the probability of these mechanisms being effective. In firms where there was active engagement, expatriate programmes were managed at every step, from the selection of individual experts, to the coordination of skills transfer programmes, the design of accountability measures and the succession planning. The expatriate programmes in which there was active and purposive engagement generally demonstrated the following attributes:

- Shared responsibility between local staff and expatriates
- Mutual trust and respect
- Joint staffing of project teams
- Shared ownership of goals and objectives and accountability for outcomes
- Common vocabulary for defining project objectives and outcomes
- Similar depth of knowledge between local and foreign counterparts

This finding is illustrated by a close examination of the medium-sized mobile network operators in the sample. For all of these firms, there was very high reliance on expatriate individuals as a source of technological capability, but there were major distinctions between their approaches to the management of this TCB mechanism. Those firms that demonstrated the characteristics of active and purposive engagement also reported greater satisfaction with expatriates as a source of capability, while for other firms of similar size, there was the same level of reliance on expatriates but less satisfaction with the performance of this mechanism. These findings are in line with the experience of firms in other contexts (see Brewster, 1991).

Developing and rewarding learning skills

The evidence appears to confirm that, of the firms in the sample, those that were able to develop the boundary-spanning skills required to bridge disciplinary and organisational boundaries were more successful in their TCB efforts. This sample of telecommunication operating firms, therefore, provides support for a well-established theoretical proposition that firms must build boundary-spanning skills, or "*T* skills."[8] The specific routines that the sample firms used to develop the *T* skills required for boundary-spanning included: tailored recruitment programmes, continuous training of technical specialists, special incentive programmes to retain specialist skills, mentoring programmes, assignment of responsibility for motivating technical specialists, and team development.

For the more sophisticated companies in the sample, there were specific routines designed to achieve better integration between budgeting for non-embodied technological capabilities and person-embodied capabilities, and much more attention was placed on gaining value from that expenditure.

8 See Leonard- Barton's definition of "T skills".

Pervasive Weaknesses and Enduring Challenges

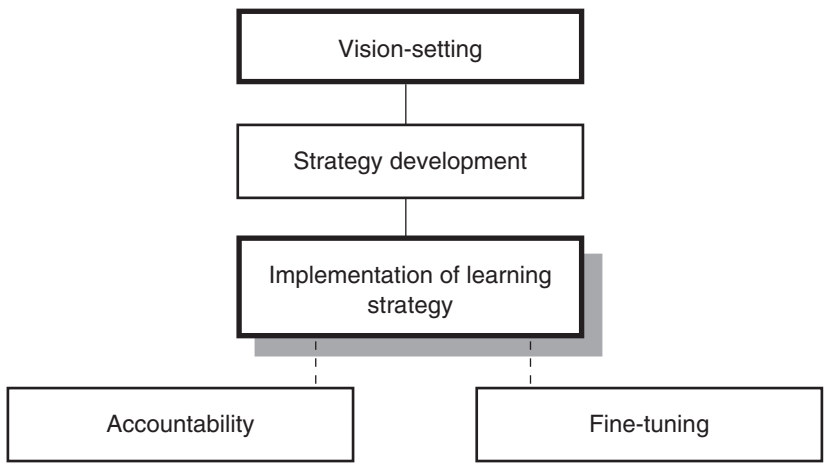
The study was also able to identify and to analyse persistent weaknesses and enduring challenges for technological learning and capability development for African firms. These weaknesses include: inadequate organisational integration of learning efforts; weak evaluation and assessment capabilities; limited range and inadequate stock capability inputs; imbalance among different sources of capabilities; and weaknesses in sustaining cultural and leadership support for TCB. These challenges are discussed in turn.

Inadequate organisational integration and limited innovation in organisational design

The degree of ability to ensure that there was effective organisational integration of TCB effort was found to be a major weakness among the firms in the sample, even for those with a well-developed TCB system. The TCB system approach suggests that a successful TCB effort requires assignment of responsibility for learning, (vision-setting and strategy development) and implementation of learning, on the basis of accountability and with appropriate evaluation systems that allow for refinement of learning effort, and that take account of past failures and changing external circumstances. Figure 1 below illustrates the relationships between these factors, where the thickness of the lines on each box is indicative of the relative strength across the sample firms. In the "ideal system," there would be symmetry across these types of effort.

The TCB system approach suggests that the vision-setting aspect of organisational integration is most effective when it is undertaken at the most senior level of management. The evidence suggests that this feature was reasonably effective in the sample firms. In many of these firms, either the chief executive or Board level management personnel were the champions of learning and the TCB effort. However, despite the relative strong performance on vision-setting, strategy development effort among the sample firms was a major weakness. There were few examples of well-designed strategies that translated senior-level vision and aspirations into consistent strategies applicable at multiple levels in the firm. As a result, although the implementation of TCB effort was active, it was often uncoordinated and undirected. Systems to ensure accountability and fine-tuning of TCB effort were also weak and underdeveloped. Although TCB activities took place at the line management level, there was insufficient decentralisation of responsibility to enable quick recovery from mistakes and shortcomings.

Figure 1: Key Processes in learning systems



Weak evaluation and assessment capability

The sample firms demonstrated significant expertise in their approaches to evaluating their needs and requirements for non-embodied technological capabilities, drawing upon the substantial internal engineering competencies. However, these assessments were isolated from the broader technological evaluation and did not emphasise embodied and tacit elements of technological capabilities. This seems to have led to a mismatch in the approaches to filling the gaps in technological capabilities identified in the assessment exercises. The qualitative and quantitative accounts suggest that there were significant gaps in codified knowledge, tacit knowledge, and in material and non-material technological capability inputs. This evidence suggests that evaluation exercises should be balanced and well-integrated, so that the TCB system can be applied to tackle problems associated with missing pieces of all the combinations of embodied and non-embodied technological capabilities and tacit and codified knowledge. Evaluation and assessment capabilities were elements of the learning strategy development process discussed under the theme of organisational design and organisational integration, in the preceding sub-section.

Scarcity of different types of capabilities

As noted in the sub-section on "blending of traditional and non-traditional approaches," telecommunication operators have tried and tested mechanisms for getting people into their organisations. The sample of firms reported that they used these mechanisms to solve their shortages of embodied technological inputs. However, because these firms operate in a fast-moving technology space, these mechanisms were failing in many cases to provide the necessary levels of codified knowledge, e.g., development of wireless access technologies. Put simply, firms were bringing people in without the required knowledge base. Successful firms reported that they complemented the tried and tested methods with other mechanisms to reduce this gap in codified knowledge, most frequently by relying on suppliers of equipment to provide additional knowledge inputs. Other mechanisms used were improving the performance of local knowledge-producing institutions, so that people skills were upgraded prior to recruitment. For improving access to tacit knowledge, improving management of expatriate programmes and management of relationships with suppliers were perceived to be the key requirements.

For firms in the sample, there was a major weakness in the development of internal reservoirs of codified knowledge. This was so even for firms with a well-developed TCB system. There were very few instances of firms that had successfully captured and encoded learning events and formal knowledge to make this available for wider dissemination across the firm. Even in the firms that reported that they had designed open-learning systems, the learning materials were developed externally and so did not include their own experiences of technological capability-building. There were some repositories of formal codified knowledge in the courseware of formal in-house training programmes delivered by suppliers or internal experts.

Weakness in diversifying sources of capabilities

For developing country firms, including those in this sample, suppliers of equipment and services are the main external source of technological capability. However, the TCB system approach also suggests that managing relationships with external suppliers should be balanced with managing relationships with other external sources of technological capability inputs. The empirical evidence suggests that firms with a well-developed TCB system were better able to manage the acquisition of technological capabilities from different sources, through widening their familiarity with sources other than suppliers of equipment and services, such as shareholders, other operators, regional and international organisations, industry associations and the innovation system. These firms used

all of these relationships to complement knowledge acquired from suppliers. However, the over-reliance on commercial suppliers of equipment and services remained a persistent weakness of the majority of firms in the sample, suggesting that this is a challenge.

Organisational culture for learning is not sustained

There is a theoretical argument that suggests that developing an organisational culture that facilitates learning requires activities that over time affect the attitudes and values of individuals in the firm, making them more disposed to learning as well as increasing the number and type of learning opportunities available. In the TCB system approach, this proposition is taken to mean that, while the presence of specific individual TCB mechanisms is important, for an organisational culture to take root, these mechanisms must be present in appropriate combinations, so that there is reinforcement. A truly facilitating organisational culture is considered to be one that is sensitive to the additive and cumulative effect of many different TCB mechanisms, rather than to the existence of these mechanisms in isolation.

To analyse this aspect of the TCB effort, the extent to which the sample firms demonstrated the ability to use internal TCB mechanisms in reinforcing combinations is examined using the three groups of TCB shown below.

Group 1
M23: open-learning facilities
M26: organisational culture re-design aimed at supporting experimentation and learning

Group 2
M19: performance-related pay
M27: assigning line responsibility for TCB
M29: TCB expenditure targets

Group 3
M20: leadership development
M21: formal change management programmes
M31: integration of TCB objectives into strategic planning

The conceptual framework suggests that for TCB to be effective, firms should deploy these TCB mechanisms together. The evidence from the sample of firms indicated that only five firms implemented the pair of mechanisms associated with developing open-learning systems and undertaking actions to re-design culture to support experimentation and learning (Group 1). It is also worth noting that three publicly owned firms with well-developed TCB systems did not deploy this pair of mechanisms. This finding provides further support for the proposition that the publicly-owned firms in the sample had not undergone the cultural change that is necessary to support effective TCB effort.

The TCB system approach suggests that the occurrence of the second group of internal processes is likely to improve a firm's ability to influence the extent to which individuals and the entire group assume accountability for TCB objectives. Only two firms in the sample had all three mechanisms in place, while four additional firms had a pair of the mechanisms (M19 and M27, but not M31). The only firms making an effort to improve accountability for their TCB efforts in the sample were from South Africa. This evidence confirms that only a few firms were taking action to move beyond

having strategic visions and top-level support for TCB, to implemented management practice that would be expected to have an impact over time.

Finally, there was only one firm in the sample that had implemented leadership development, change management programmes, and TCB integrated into strategic planning all at the same time (Group 3). There were four other firms that had two out of the three mechanisms. This group of mechanisms is indicative of the extent to which firms formalised their TCB development effort and integrated it with planning. This suggests that, among the sample firms, there was limited development of the sustainability of culture change and TCB effort. Firms had not been able to formalise their TCB efforts and closely align these with business goals and objectives. While there were informal programmes, these often lacked legitimacy and could not attract sufficient resources -- factors that negatively affected effectiveness.

The study provides evidence that firms with weak TCB systems -- while often aware of the importance of specific internal processes for supporting technological learning and capability-building and often experimenting with some interventions -- typically were not able to deploy TCB effort in a systematic manner.

For example, a small Tanzanian firm had implemented leadership development programmes and introduced facilities for informal learning, but the overall impact of these activities was not sustainable. In many of the other smaller firms, TCB was managed and led by an individual champion for learning.

There were five firms in the sample of 26 that demonstrated the "charismatic approach" to developing a learning culture. In these firms, the learning culture was associated and identified with the technical competence and knowledge of an individual or group of individuals in the firm who were frequently the founders of the organisation. For this sub-set of firms, the culture was dependent on the communication skills of these individuals and their ability to inspire and motivate others.

In summary, the TCB system approach suggests that the ability to effectively implement learning at the company level involves transcending individual effort through processes that support and develop changed ways of "being and doing." In this perspective, processes to aggregate effects of learning and ways of thinking are as important as the isolated learning events themselves. The evidence from this sample supports this proposition, in so far as the firms that were effective in TCB and undertook learning that responded to their business objectives also reported that they introduced processes to integrate isolated learning events and develop reinforcing culture change. In the firms that were less effective in TCB and those that were unable to align TCB with business objectives, learning experiments were in place, but the activities were present without corresponding benefits. The presence of reinforcing internal processes improves the probability of changing culture over time and producing a sustainable facilitation of learning. Together with organisational integration, these features exert very important influences on the effectiveness of TCB. Operational experience and firm size were found to be positively associated with development of effective TCB systems.

The evidence illustrates that only firms that had achieved a threshold level of development of their TCB system attempted to tackle the cultural change aspects required to achieve substantial support for learning and capability development. Even for the firms that had made the most progress in the sample, there were gaps in the effort to develop facilitating cultures for capability development. An important missing ingredient was the development of approaches that are more

likely to be sustainable because they incorporate reinforcement features of culture development. These styles were not as widely used as the "charisma approach," which was highly dependent on a single individual. Another shortcoming of the sample firms was the limited success in making learning widely accessible across the firm.

Insights from the TCB system approach

This analysis has highlighted the importance of sustainable cultural change to support capability development efforts, and processes to ensure that there is organisational integration of TCB effort. Neither of these factors has hitherto received much attention in the investigation of capability development in developing countries. By focussing on internal processes of technological learning, the TCB system approach has identified factors that have the potential to explain variation in effectiveness of TCB effort.

The analysis of the evidence confirmed that firms with well-developed effective TCB systems deployed internal processes in their capability-building efforts and managed these processes to improve firm-wide learning. The factors that appeared to facilitate effectiveness in capability-building among the sample firms included: providing leadership for learning; creating conditions that were supportive of firm-wide learning and raised awareness of the importance of technological capability for firm survival and competitiveness; introduction of open-learning facilities; implementing specific management routines such as rewarding development of boundary-spanning skills and managing the transfer of knowledge from expatriates; implementing evaluation and monitoring systems; and proactively engaging with the local labour market and education system to provide access to people with requisite education and skills, particularly those with disciplinary backgrounds in telecommunication engineering and information technology.

Major weaknesses among this sample were that none of the firms had made substantial progress in the organisational integration of TCB, and few deployed efforts to sustain the implementation of a supportive cultural environment for learning. As a result, their efforts did not achieve consistency, cohesiveness and consonance.

These results are important also because, first, they demonstrate the fruitfulness of integrating organisational development and strategic management insights into the analysis of capability accumulation by developing country firms. For example, the importance of having diverse routines for learning, coordinating mechanisms, and supporting culture and leadership, has not received much attention in the development studies tradition.

Second, the TCB system approach yields new knowledge by identifying specific internal processes (e.g., introduction of open-learning systems and proactive support of public education and training institutions to provide access to skilled people) that were found to be important for the sample firms, and which may be important for other developing country firms operating in similar contexts of rapid technological change.

Finally, it is worth noting that the analysis provides support for the view that it is necessary to have an appropriate balance between internal accumulation of capabilities and acquiring capabilities from external sources. This finding is in line with received views. However, the TCB system approach operationalises the concept of balance between external and internal accumulation, by defining an indicator of TCB system development that captures both types of effort. Making use of the TCB system development indicator permits the measurement and comparison of the extent to which firms undertake investment in either or both types of capability development activities.

Concluding Remarks

This study of the capability accumulation processes of 26 telecommunication operating companies in four African countries has shed new light on how developing country firms undertake learning processes that are considered to be important for fostering competitiveness, innovation and economic development. The study's strengths are that the conceptual framework developed for this research extends development studies work on capability development by emphasising intra-firm and endogenous factors that derive from the soft, human aspects of capability development processes. The TCB system approach also integrates the notions of organisational coherence and the strategic management of change and the transcendent aspects of learning into the analysis of capability accumulation by developing country firms. These areas of organisational development and strategic management theory have hitherto not been emphasised and treated in detail as explanations of success or failure in capability development. This paper has focussed on the internal processes that are required for technological learning and capability development.

The TCB system approach as applied to the empirical context of telecommunication operating companies in four African countries offers support for adopting a people-centred approach to understanding capability development in firms. The analysis undertaken offers support to the claim that individual effort and learning leadership can make a substantial difference in the ability of firms to develop technological capability. At a theoretical level, this study provides strong support for considering technological capability development to be an investment process, where an essential component is improving the ability of individuals to absorb technological knowledge and circulate that knowledge throughout the firm.

The study uses indicators of the level of TCB system development that are robust enough to be used in quantitative tests of the patterns of capability development. The resulting evidence provides useful insights into how specific routines that firms use for managing learning are deployed.

The TCB system approach can form the basis for investigating technological learning across a number of industries since the "ideal system" proposed contains generalisable features of the capability accumulation process in developing countries. To apply the approach in other contexts, the technology- and industry-specific features would have to be incorporated. Future research can build on and extend the approach taken here, and improve on its weaknesses and limitations. First, although there was a focus on the individual aspects of capability development, the psychological dimensions of learning and capability development were not explored. Integrating insights from the psychology discipline is likely to lead to further understanding of the barriers to capability accumulation in developing country firms. For example, this integration would permit further disaggregation and unpacking of the contribution of individual motivation and the development of confidence in increasing the learning and capability development potential of firms. Second, future research can extend beyond cross-sectional analysis of the process of technological capability-building and learning to include methods that permit exploration of how TCB effectiveness is linked to other variables over time. Finally, it may also be possible to refine the TCB system development indicators developed in the exploratory study on which this paper is based.

Several key policy implications emerge from this research that can be implemented by firms in developing countries. First, firms can improve their technological capability accumulation effort by paying attention to the individual aspects of absorptive capacity. This requires developing cultures in which employees are supported and encouraged to acquire technological knowledge, technological confidence and to develop boundary-spanning skills. Features of this learning culture include senior management leadership and involvement, clear assignment of responsibility, and careful design of learning programmes to ensure that opportunities are widely available and include

higher-order and “transcendent” aspects of learning. Second, firms can adopt a diverse range of learning mechanisms selected to be appropriate for the business objectives and the technological gaps that exist. Investment in learning should have breadth and be sustained over time. Third, given the unfavourable local contexts, developing country firms ought to be proactive in increasing the size of the pool of technically-skilled persons. Firms can jointly develop technological training courses with universities and technical colleges, maintain industry involvement in, and support for, curriculum development, and implement cross-industry formal and informal training programmes where costs are shared among beneficiaries.

These recommendations for African telecommunication country firms can contribute to the transformation of the capability development effort, moving the investment in learning closer to the theoretical “ideal” envisaged in the TCB system approach.

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