Overcoming Barriers to Knowledge Aggregation: R&D Services Providers in Brazil

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Abstract
Intermediaries serve an important role in innovation systems, leveraging their internal capabilities and external relationships to support firms’ innovation efforts. These organizations are effective insofar as they are able to aggregate knowledge and then use it to solve problems on behalf of their clients. But knowledge aggregation is by no means a trivial task, especially for innovation intermediaries in developing and emerging economies, where weak legal regimes of appropriability lead clients to restrict the internal mobility of people and ideas.

Forced to erect barriers to intra-organizational knowledge sharing, these organizations become balkanized spaces unable to aggregate knowledge generated through projects. This paper examines barriers to knowledge aggregation in three R&D services providers in Brazil through the use of semi-structured interviews, extended periods of unobtrusive observation and longitudinal data of human resource allocation. It discusses how these organization became balkanized spaces in response to their multinational clients’ imperatives around data security, and then how they were able to overcome these barriers to knowledge aggregation by diversifying into industrial sectors unrelated to those in which their principal clients operate.
1. INTRODUCTION

Internal communication has long been seen as an important means of aggregating knowledge within the firm (Allen, 1970; Arrow, 1974). But creating information channels is by no means a trivial task. It requires that employees share a common language and common cognitive schema (Grant, 1996) and that the organization employ gatekeepers with the boundary spanning capabilities necessary to bring knowledge from where it is to where it is not (Allen and Cohen, 1969; Tushman and Scanlan, 1981). The absence of these features can make it difficult for an organization to integrate and amplify its employees’ specialist knowledge, on the basis of which it can create and sustain competitive advantage (Barney 1991; Nonaka, 1994; Grant, 1996).

The problem of knowledge aggregation is particularly complex for shared services providers. As Sydow and colleagues (2004, p. 1476) remark, these types of organizations encounter a perpetual tension between the “immediate task and performance demands of the project at hand versus the opportunities for learning and disseminating project practices that can be employed in subsequent projects.” The broad and heterogeneous bodies of literature on project-based organizations (Hobday, 2000; Gann and Salter, 2000), knowledge-intensive business services (KIBS) providers (Muller and Zenker, 2001; Strambach, 2001) and knowledge brokers (Hargadon and Sutton, 1997; Hargadon, 2002; Obstfeld, 2005) suggest that this tension can be resolved by moving people from one project to another.

But because much of the literature focuses on services providers in industrialized economies, where legal regimes of appropriability are often codified and clear, it does not examine how firms overcome barriers to knowledge aggregation when their clients forbid the internal mobility of people and ideas out of fear that they will find their way into the wrong hands (Teece, 1986). Few have discussed the difficulties faced by services providers in developing and emerging economies who seek to share information between teams working on behalf of competing clients (for an example, see Kawakami, 2011). In these cases, knowledge aggregation can be impeded not because employees lack a shared language, or because the organization lacks boundary spanning individuals, but because of clients’ imperatives around information security.
This paper examines barriers to knowledge aggregation in R&D services firms in Brazil. Specifically, it examines organizations created as a result of the country’s Informatics Law, an industrial policy that, among other things, encourages firms in the information and communication technology (ICT) sector to spend a fixed percentage of revenues on R&D, both internally and through third parties. Because of the sector’s constitution, these third parties often work on behalf of multinational firms, which tend to be reticent about conducting R&D in Brazil in the first place, not to mention having to outsource some of their R&D spending as well. Therefore, in these organizations, traditional barriers to knowledge aggregation are compounded by discrete physical, digital and legal barriers separating client-specific teams; what scholars studying other types of firms have called ‘Chinese walls’ (Brewer and Nash, 1989).

As services providers in an emerging market serving primarily foreign clients, these organizations offer lessons for how others might overcome obdurate barriers to knowledge aggregation. Insights from the literature on Chinese walls (Mendez-Peñaate, 1976; Brewer and Nash, 1989; Sandhu, 1992) are brought to bear on the empirical material examined in this paper. By examining how organizations facing the highest barriers to intra-organizational communication might overcome them, this paper offers insights that might be applied to project-based organizations (PBOs), KIBS providers and knowledge brokers along with other project-based firms offering knowledge-intensive services, especially those operating in developing and emerging economies. This paper also serves a broader purpose, which is to highlight and explore the increasingly important role that private innovation intermediaries play in emerging markets, an empirical phenomenon often overlooked in the academic literature (Tether and Tajar, 2008).

This paper proceeds with a review of the relevant literature, principally work on shared services providers and on Chinese walls. It draws from work on PBOs, KIBS providers and knowledge brokers in order to shed light on how R&D services firms, organizations that share certain characteristics with each of these ideal types, might overcome barriers to knowledge aggregation. It continues with an overview of the empirical context, as well as the research design and research
methods. It then provides an overview of the empirical results and concludes by discussing the significance of the findings beyond the study’s immediate context.

2. LITERATURE REVIEW

It has long been recognized that internal R&D capabilities are important but alone insufficient means of developing new technologies (Mowery, 1983; Mowery and Rosenberg, 1993). The threat of technological obsolescence drives large, established firms to look beyond their boundaries for new products (Balakrishnan and Wernerfelt, 1986; Pisano, 1990). Firms in ‘high-tech’ industries rarely innovate in isolation. They must be able to access, acquire, assimilate and exploit external knowledge to develop and sustain competitive advantage (Cohen and Levinthal, 1990; Zahra and George, 2002). “Many firms are no longer structured like medieval kingdoms, walled off and protected from hostile outside forces. Instead, we find companies involved in an intricate latticework of collaborative ventures with other firms, most of whom are ostensibly competitors” (Powell, 1990, p. 301). The literature on open innovation has highlighted the importance of reaching beyond firm boundaries to develop new products (Chesborough, 2003).

While firms access externally produced knowledge in a number of ways, this paper focuses on contractual relationships with R&D services providers. The type of research and development work that firms have traditionally outsourced is fairly peripheral to its technology roadmap (Mowery, 1983). This is because firms tend to internalize tasks when arms-length transactions are too risky or costly, as is often the case with core R&D (Coase, 1937; Williamson, 1979). As Pisano (1990) explains, uncertainty cloaks the process of scientific discovery. At the onset of a contractual relationship, neither the supplier nor the buyer has a precise understanding of the quality and value of knowledge that will be produced. Moreover, accurate forecasting of a project’s cost, duration and outcome is all but impossible. If we assume that firms invest in R&D to gain competitive advantage through proprietary access to new technologies, then it becomes clear that issues of appropriability are at the center of externally purchased R&D services (Pisano, 1990).
While there isn’t a discrete literature on R&D services providers, there are several bodies of work on organizations that share many characteristics with these sorts of firms. Several streams of research have sought to examine third-party organizations involved in innovation, both in terms of their structural roles in innovation systems and in terms of their business models. Work at the network level does not directly address the issue of knowledge aggregation, as it focuses primarily on how these organizations fill gaps in innovation systems (Howells, 2006; Tether and Tajar, 2008). These organizations drive upgrading by leveraging and distributing the resources made available to them through their network ties (McEvily and Zaheer, 1999; McDermott et al., 2009; Corredoira and McDermott, 2014). In these cases, effectiveness as an innovation intermediary is seen to be a function of its position in a network of actors rather than its organizational capabilities. Work at the organizational level offers a better vantage point for examining the issue on which this paper focuses. However, much of the literature of PBOs, KIBS providers and knowledge brokers takes knowledge aggregation as a given, or as an issue easily addressed through employee rotation.

Rather than being organized around divisional or functional lines, the pure PBO is organized in such a way that all key business functions are present in the team allocated to a specific project (Galbraith, 1977; Hobday, 2000; Gann and Salter, 2000). Here, the project is the key organizing principle; the needs of the project dictate the resources – both internal and external – allocated to it. But while the PBO has been seen as a remarkably effective means of organizing for project-based work, its structure raises a number of dilemmas as well. Principal among them is the issue of knowledge aggregation, how to induce organizational learning. In examining various PBOs, Hobday (2000) finds that “lessons learned from particular projects were not shared formally because there were no structures or incentives for cross-project learning or communications” (p. 885). If an organization lacks the boundary spanning capabilities necessary to share ideas across project teams, knowledge will collect in pockets without spreading evenly (Aldrich and Herker 1977; Tushman and Scanlan, 1981).
KIBS providers are defined as firms that furnish services that carry a high degree of embedded knowledge. They actively produce and diffuse knowledge in innovation systems, often on a contractual basis with a single actor, or with a discrete set of actors (Muller and Zenker, 2001; Miozzo and Grimshaw, 2005). The literature on KIBS providers delves into issues of intellectual property protection as they relate to their position vis-à-vis competitors. Amara and colleagues (2008) study the various synergistic ways in which KIBS providers protect their ideas from competitors, including patents, design patterns, trademarks, secrecy and first-mover advantage. But scholars have rarely explored the nature of these firms’ intra-organizational communication channels, or lack thereof. This could be because KIBS providers do not actually face imperatives around the separation of teams, or because existing studies of KIBS providers focuses on these firms in industrialized economies, where strict team segmentation may be unnecessary.

Many organizations identified by Hargadon and Sutton (1997) to be knowledge brokers tend to organize themselves around projects. Hargadon (2002) defines knowledge brokers as organizations that exploit “fragmented social structure by bridging multiple domains and moving ideas from where they are known to where they are not” (p. 44). He describes the process of knowledge brokerage as one that requires an actor to: have access to multiple knowledge domains, gain access to multiple domains, learn about the problems and the existing resources in each of these domains, link old knowledge with new problems and new knowledge with old problems and finally, build by introducing innovations into disparate domains. Emblematic examples of knowledge brokers include engineering design consulting firms like IDEO and management consulting firms like McKinsey & Company. But the process of brokerage is often described as a fluid movement of ideas in a friction-less space. Explicit barriers to knowledge aggregation go unmentioned.

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1 The process of brokerage requires one to make two assumptions, one about the nature of innovation and another about the structure of the social world. For knowledge brokerage to yield new, commercially viable ideas, one must assume that innovation is recombinant in nature (Schumpeter, 1934). Furthermore, for knowledge brokerage to be possible, one must assume that the social world is divided into numerous isolated domains, or small worlds (Burt, 1992).
As has been argued, work on PBOs, KIBS providers and knowledge brokers rarely delves into the barriers to knowledge aggregation. These organizations’ existence in countries with clear legal regimes of appropriability grants them the latitude to rotate and recombine teams, people and ideas relatively freely. Through flexibly staffed projects, these firms develop organizational memories, repositories for ideas that might be employed to solve as of yet undefined problems (Hargadon and Sutton, 1997). However, knowledge aggregation is a non-trivial task among services providers in developing countries and emerging markets, especially those working with clients crossing vast institutional distances (Kostova, 1997). These organizations face physical, digital and legal barriers to knowledge sharing. This paper seeks to address the issue of knowledge aggregation in shared services providers by examining firms for which organizational learning should be most difficult, R&D services providers in developing and emerging economies whose clients are primarily multinational firms hailing from industrialized economies.

As Arrow (1962) makes clear, “...no amount of legal protection can make a thoroughly appropriable commodity of something so intangible as information” (p. 615). This creates a potential hazard of expropriation by the R&D service provider, which may turn around and sell its newly acquired know-how to one of the sponsor’s competitors. In fact, the tacit nature of knowledge generated may preclude the sponsor from knowing for certain if the R&D service provider has shared its knowledge with a competitor (Howells et al., 2008). But what if internalization is impossible? The cases examined here are R&D services providers with whom firms are forced to work with if they wish to receive a range of fiscal incentives critical to their competitiveness in the Brazilian market. The uncertain degree of protection for intellectual property rights, coupled with the inability to internalize R&D, makes it necessary for outsourcing firms to take additional measures to protect their ideas.

Organizations erect barriers to intra-organizational knowledge transfer when client-specific data needs to be protected. Financial services firms eliminate the flow of client-specific knowledge throughout the organization where conflicts of interest could arise. This involves a digital and physical separation of a bank’s commercial lending and trust departments through what some
have called Chinese walls (Mendez-Peña, 1976). Further, financial services firms must separate one client’s dataset from another, so long as the two are situated in the same conflict of interest class, or industry. Data can only be shared between employees working on behalf of different companies if they are in different conflict of interest classes, or if the data has been sanitized to eliminate the possibility of backward inference to uncover the source (Brewer and Nash, 1989; Sandhu, 1992). These barriers have been studied in the context of law firms as well, as client-specific information is sensitive and sharing it with lawyers working on behalf of clients in the same industry could lead to breaches in confidentiality (Moser, 1989).

Work on innovation intermediaries, PBOs, KIBS providers and knowledge brokers is highly heterogeneous, as the sorts of firms that comprise each set vary in important ways. Latent in each of these strands of research is the understanding that firms must be able to aggregate the knowledge they collect through project-based work in order to compete. This is often achieved through employee rotation. Engineers, designers and consultants are moved from one project to another, bringing ideas developed on behalf of one client to bear on projects conducted on behalf of others. But in the cases examined here, the free movement of people is limited by client imperatives around intellectual property protection. Under normal circumstances, firms outsourcing R&D might internalize their work if the threat of expropriation is sufficiently high. However, internalization would make firms ineligible for incentives, so Chinese walls become the only means of ensuring security.

My primary contribution to work on intermediated innovation is an empirically derived understanding of how Chinese walls limit the possibility of knowledge aggregation, and further, how organizations might overcome these walls by diversifying into new and unrelated industries to those that their clients operate within. The issue of knowledge aggregation is not treated explicitly in studies on PBOs, KIBS providers or knowledge brokers. This may be because the literature has focused primarily on firms in industrialized countries. As such, scholars conducting empirical research may have not come across, and therefore have not addressed these obdurate barriers to knowledge aggregation. Because there is little work on intermediated innovation in
developing and emerging economies, these barriers have been seldom observed. This paper employs ideas developed in early work on Chinese walls to explain how knowledge aggregation is impeded within emerging market R&D services providers, and to identify ways in which these barriers might be overcome.

3. DATA & METHODOLOGY

3.1. Empirical context and case selection

Brazil’s ambitions of developing a domestic computer industry date back to the 1960s (Adler, 1986; Evans, 1995). The country’s Informatics Law was passed in 1991 and remains on the books in relatively unaltered form to this day. Its primary purpose was to ensure that the market liberalization of the 1990s wouldn’t hollow out what was still an uncompetitive industry.² Since its passage, it has sought to keep the electronics industry in place by encouraging the localization of final assembly and component manufacturing as well as R&D. The government requires that firms spend four percent of annual revenues on R&D, and that they outsource a significant percentage as well in order to be eligible for certain fiscal incentives, which include reductions in industrial production taxes (IPI).

The R&D outsourcing imperative embedded law was motivated by a desire, on the part of policymakers, to ensure that the benefits associated with increased spending would find their way out of some firms and into others, via universities or the emerging cadre of private institutes. Twenty percent of the total can be outsourced to a third party, whether it be a public university, a private university, a public R&D institute or a private R&D institute. To serve as sanctioned R&D partners, these organizations must be certified by the Ministry of Science and Technology

² The worry was not necessarily that the industry would leave the country altogether, but that it would migrate to the Manaus Free Trade Zone (ZFM), which has long been a hub for manufacturing given the generous incentives offered by the Superintendency of the Manaus Free Trade Zone (SUFRAMA).
Innovation and Communication’s (MCTIC)³ Committee for the Area of Information Technology (CATI). Ten percent must be deposited in the government’s science and technology fund. Finally, as of the law’s 2001 renewal, 16 percent must be outsourced to a certified third party located in the North, Northeast or Center West of the country (See Table 1 for a full breakdown).

| Table 1: Informatics Law R&D Obligation |
|----------------------------------------|----------------|
| **Internal Expenditures** (Can also be spent via third parties) | 2.16% |
| Agreement with CATI-certified science and technology institutes anywhere in Brazil | 0.80% |
| Agreement with CATI-certified science and technology institutes in the North (except the ZFM), Northeast and Center West | 4.00% |
| Public or private entities | 0.45% |
| Public entities only | 0.19% |
| Science and Technology Fund (FNDCT) | 0.40% |

*Source: MCTIC*

But rather than working with universities and existing laboratories, various large multinational firms responded to the law by creating legally independent yet operationally captive institutes of their own. The R&D director of one multinational subsidiary interviewed for this study claimed that when his firm began conducting R&D in Brazil in the mid-1990s, he could only work with universities, which produced “next to nothing” in terms of commercially viable outputs. The firm went on to establish one of the first multinational spinoff R&D institutes. Of the 170 organizations – which include university departments, public laboratories and private research institutes – certified by CATI, institutes created by multinational firms are by far the largest.

Private institutes have captured an increasingly large share of total funding earmarked for R&D. According to the MCTIC, while spending on projects at universities and at private institutes was fairly equal in the late 1990s, spending at private institutes has grown dramatically while

³ Previously the Ministry of Science Technology and Innovation (MCTI), and prior to that, the Ministry for Science and Technology (MCT)
spending at universities has remained relatively flat. Today, private institutes account for 74 percent of total funds earmarked for R&D via the Informatics Law. The largest of these institutes are those that were once spun off from multinational firms. Because the focus of this paper is the role of private innovation intermediaries in developing and emerging economies, the three cases selected for this study are all private institutes. They were selected because they are among the largest institutes in the country, and because they have diversified considerably since their days as captives to their principal benefactors. See Table 2 for summary statistics on the three institutes, which have been given pseudonyms to ensure the protection of sensitive information.

**Table 2: Three Selected Institutes, Data for 2013**

<table>
<thead>
<tr>
<th>Institute</th>
<th>Revenue (BRL Mil)</th>
<th>Employees</th>
<th>Clients</th>
<th>Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institute A</td>
<td>147.5</td>
<td>590</td>
<td>52</td>
<td>113</td>
</tr>
<tr>
<td>Institute B</td>
<td>46.3</td>
<td>226</td>
<td>10</td>
<td>49</td>
</tr>
<tr>
<td>Institute C</td>
<td>35.4</td>
<td>158</td>
<td>7</td>
<td>27</td>
</tr>
</tbody>
</table>

*Source: MCTIC, Institutional Presentations*

Multiple cases provide better fodder for robust theoretical insights than do single cases (Yin, 1994; Creswell, 2003; Eisenhardt and Graebner, 2007). This multiple case study is constructed according to a “most similar systems” design, as the three cases are similar across a range of important criteria (Przeworski and Teune, 1970). The cases include three institutes that are similar in that they are large relative to other R&D institutes, they were all spun off from multinational firms and they have all diversified considerably, both in terms of their client base and in terms of the industries they serve. Rather than seeking similar organizations to isolate the causes of the differences between them, similar organizations were sought in order to shed light on the similar ways in which they have evolved over time, and the similar issues they face in dealing with their balkanization.
3.2.  *Data collection and analysis*

While the use of one method of data collection may yield flawed data, the use of various sources of data, collected in various ways, increases the validity of constructs that eventually emerge in the process of theory construction (Yin, 1994). The primary means of data collection in this paper is the semi-structured interview, of which 36 were conducted (Bernard, 1988). Given that institute superintendents, directors, managers and engineers were interviewed, it was important to vary the interview format to suit each respondent’s perspective and vocabulary (Barriball and While, 1994). The researcher engaged in purposeful sampling within each institute, selecting respondents with disparate backgrounds in order to learn as much about each institute as possible (Lincoln and Guba, 1985). The interview protocol was adjusted for each interview, which lasted between 45 minutes and two hours, and was conducted in the language with which the participant was most comfortable, English or Portuguese.

The second means of data collection employed was observation. Eugene Webb and colleagues (1966) first discussed using unobtrusive measures to collect data in the social sciences. Many observational studies suggest that reactivity – how the presence of an observer affects the behavior of the observed – is common. However, Weick (1968) and Croll (1986) claim that people preoccupied with their everyday lives often assimilate an observer’s presence into their routines. The researcher spent between three and four weeks in each of the organizations that constitute the sample, which allowed for the collection of unobtrusive data to corroborate interview data. This element of the data collection process shares certain affinities with ethnography, as it involves studying inter-personal interaction in-situ, exploring locally produced phenomena, focusing on practices and artifacts and producing ‘thick description’ (Geertz, 1973).

Being present on a day-to-day basis allowed for a better understanding of the complexities associated with serving multiple competing clients concurrently. Turnstiles and keycard access doors were the most visible manifestations of the inertia managers operated under. The researcher was not allowed entry to most clients’ workspaces, interviewing managers and
engineers in public meeting rooms instead. The researcher was sometimes permitted to observe informal meetings with clients. On one occasion, a large client came to visit an institute. The researcher was invited to lunch, where client representatives, institute representatives and university representatives interacted on an informal basis. Also present was a representative of the client’s internal R&D operation in Brazil. As one manager made clear, this had caused some tension, as there was fear at the institute that the client wanted to take one of its core projects in-house. These sorts of observations strengthened the researcher’s understanding of the ways in which these institutes operated.

Finally, secondary materials were collected to support, enhance and sometimes contradict the findings generated through interviews and observations. Institutional presentations, annual reports to the MCTIC and other documents provided a more complete picture of how these institutes operated, how they liaised with clients and how they ensured that their work fit within the boundaries set by the Informatics Law. One institute shared human resource allocation data, which validated one of the core themes that emerged in many interviews, that internal balkanization exists, and that it is indeed a barrier to knowledge aggregation.

Interview data were analyzed along both descriptive and interpretive lines. After completing short periods of residency at each of the three institutes, interviews were transcribed, and the text was read alongside field notes. Data analysis began with each individual case. On the basis of recollections, field notes, secondary materials collected and interview transcripts, largely descriptive write-ups were produced on each institute. Each interview transcript was coded along descriptive lines before beginning what Strauss and Corbin (1990) call axial coding, selecting and connecting emergent categories to highlight specific themes and draw links between them. This recursive process of data collection and analysis was taken to the point of theoretical saturation (Glaser and Strauss, 1967).
4. KNOWLEDGE AGGREGATION IN R&D SERVICES FIRMS

4.1. Client diversification

Each of these three institutes began as captives to their primary multinational clients, but over time, broadened their base of clients in response to external pressure, which included demands for diversification emanating from the Brazilian government and financial difficulties on the part of their principal clients. For Institute A, 2008-09 was a watershed period. It was the year that its principal client temporarily stopped sending new R&D projects as a result of the company’s poor financial performance. In 2009, the institute brought in just one-third of the revenue it had generated during the previous fiscal year, according to one director interviewed. While the institute received an emergency loan from its board to stave off collapse, it soon became incumbent upon management to seek out new sources of funding in order to avoid massive layoffs. As the institute’s superintendent at the time put it:

We had been all Client A; the board was Client A; the director was Client A…everything was Client A. It was very difficult to approach other companies because they would say, ‘How are you going to protect my IP?’ So we decided to go into what I used to call a spiral model, in which we tried to find other niches with apparently no conflict, or less conflict with the Client A name.

The company approached an electronics contract manufacturer and various consumer electronics firms concentrated in the personal computer and printer product segments to gauge interest in allocating them their R&D earmarks. But in order to begin securing work from new clients, it became clear that the institute would need to dilute its principal client’s role on the institute’s board. Eventually, the institute’s spiral approach to diversification, coupled with the dilution of Client A’s role on the board, allowed it to approach competitors in search of projects; the institute began serving other mobile handset manufacturers in the ensuing years.

The government audited Institute B in 2004 because it was concerned that the institute was operating entirely captive to its founder. At that point in time, the institute was physically located within its principal client’s internal R&D department in the state of São Paulo. Nearly all of its R&D was conducted on behalf of its principal benefactor, a few small spot contracts with local
firms notwithstanding. As a result of the audit, Institute B was forced to move out of the client’s R&D facility and was strongly encouraged to find new clients. It set up a business development unit in 2007 and began serving other clients in the ensuing years. Diversification efforts focused on clients operating outside of its principal client’s main line of business, mobile handsets. For example, a Taiwan-based original design manufacturer (ODM), began manufacturing in Brazil in 2009 using incentives associated with the Informatics Law. It chose to allocate a significant portion of its R&D quota to Institute B, creating an embedded software lab to support its local tablet assembly operations.

As a spinoff of an electronics contract manufacturer, Institute C was better placed to diversify than either of the other two were. The principal client was able to leverage its institute as a value-added service on top of the contract manufacturing services it was already providing. As a result of the role its principal client occupies in the electronics value chain, Institute C is one of the most diversified institutes in the country. It conducts R&D on behalf of many of its benefactor’s clients, as well as its competitors; the institute works on behalf of various other global contract manufacturers without institutes of their own. But just like Institute B and Institute A, Institute C had to find ways to ensure that its broadening base of clients could rest assured that their intellectual property would be secure.

4.2. _Organizational balkanization_

As these institutes diversified, they built client-specific teams in order to make sure that the clients were working with engineers familiar with their needs, and perhaps more importantly, that said engineers were not allocated to teams working on behalf of their competitors. It is common for engineers to sign non-disclosure agreements (NDA) with the institutes that employ them, and often, with the clients that they work for as well. Most large clients require that their dedicated teams work in segregated areas, both physically and digitally. In this way, these institutes are conceived of as organizations comprised of balkanized spaces. The creation of segregated spaces allows these institutes to comply with their clients’ demands that their ideas be kept safe.
Infrastructure requirements can range from simple logical security – software controls that determine who is and who isn’t allowed to enter certain digital spaces – to complete segregation. This might entail dedicating a specific room, with its own air conditioning unit and generator, to a certain client’s servers. In some cases, institute superintendents don’t even have access to their clients’ servers. Some of Institute A’s largest clients insist on having separate server rooms with hard lines running directly to the rooms in which their engineers work. These spaces are often segregated from the rest of the organization through door-access control systems that are programmed to allow some engineers and high-level managers in, while keeping others out. In some extreme cases, cleaning staff have been barred from entering certain rooms if they have access to others. Compartmentalizing knowledge within a contained space can be seen as a means of tightening the regime of appropriability that governs who actually profits from the innovations that might emerge from work conducted by these teams (Teece, 1986).

Institute A made available a dataset that outlined where the organization’s engineers had been allocated, on a monthly basis, between January and August of 2016. Figure 1 lays out how engineers are allocated within the institute. Along the X-axis are each of the clients with which it worked during these eight months, 25 in all. Each client has been coded with a letter to differentiate it from the others, going from the largest in terms of engineer allocation (A) to the smallest (Y). The Y-axis refers to the number of engineers allocated to each client’s projects during the course of these eight months. The columns are segmented on the basis of much of the engineers’ time spent working for that specific client. For example, 225 of the 242 engineers (93 percent) that worked for Client A between January and August of 2016 spent 90-100 percent of their time working for that client. Further, 97 percent of engineers that worked for Client B during the same period of time spent 90-100 percent of their time allocated to this client.
Generally speaking, the smaller the client, in terms of engineers allocated, the more likely that the engineers working for it are not fully, or even mostly, dedicated to it. Conversely, the larger the client, the more likely it is that the engineers allocated to it are fully, or almost fully, dedicated. These data reinforce the broad idea that employee mobility across client teams is an exception rather than a rule. Beyond this, if we look at specific clients more closely, we see that engineer mobility across projects is also an exception rather than a rule. For example, if we examine this institute’s largest client, the issue of cross-project mobility comes into starker relief. Forty-seven percent of the institute’s engineers working on projects associated with the Informatics Law between January and August of 2016 worked on behalf of this client. During these months, Client A worked on 28 projects in collaboration with Institute A. In all but one of these projects, the
majority of engineers spent 90-100 percent of their time of the particular project to which they were allocated. In the largest projects, engineers tend to be wholly, or almost wholly allocated.

These institutes began as captive services providers for their respective benefactors. But over time, they constructed business development departments and diversified to serve other clients with R&D earmarks linked to the Informatics Law. To assure clients old and new that their intellectual property would remain secure, they erected internal barriers to knowledge sharing. Clients worked with program and project managers to build teams with the capabilities required to execute their projects. They cordoned these teams off from the rest of the organization. Legal instruments, segregated IT systems and separated physical spaces served to reassure clients wary of collaborating on R&D projects with shared services providers in a relatively unfamiliar institutional context. The data presented above serves as evidence of organizational balkanization, although it cannot capture its multidimensional nature. Interviews and observational data complement these human resource data to create a rich picture of intra-organizational fragmentation. The multidimensional separation outlined here eventually came to drive, and to be reinforced by, changes in employees’ identities.

4.3. **Identity as informal barrier**

As time goes on, the separation of space comes to shape workers’ identities, further ossifying existing intra-organizational divisions. Having a team work closely with a client has benefits, including the ability to understand the client’s organizational culture, to know what sorts of projects are likely to dovetail with its technology roadmap and to create a clear division of labor between teams that allows for a relatively seamless handoff of work. This level of integration makes it difficult to see the boundary separating clients from the institutes they work with (see Figure 2). In some instances, engineers working at an institute have access cards for their client’s facilities, client e-mail addresses or client business cards. Many engineers often co-locate, spending time based within their clients’ local subsidiaries. In some cases, they even spend considerable time at their clients’ headquarters abroad.
Stryker and Serpe (1982) define identity as “internalized positional designations that represent the person’s participation in structured role relationships” (p. 206). A particular identity’s salience depends on a person’s commitment to it, which depends on how important the people that require they occupy that identity are (Stryker, 1968). Engineers in these institutes operate in institutionally pluralistic environments that require they juggle between various identities. The process of organizational balkanization bolsters their identities as employees of their principal clients, rather than employees of the institutes on which they rely for their paychecks. Eventually, the physical, digital and legal boundaries that clients insist upon early in their relationships with Brazilian research institutes become little more than relics, their value supplanted by the reordering of employee identities and emergence of trust between clients and their teams.

Initially, boundaries are erected to safeguard against the possibility of opportunistic behavior on the part of a yet unknown R&D institute. Furthermore, they serve a symbolic purpose, as their existence allows multinational subsidiary managers employing these centers to telegraph to their paymasters back at headquarters that they understand the risks that outsourcing R&D in Brazil
presents, and that they are doing everything in their power to ensure that intellectual property created there remains secure. But over the course of various agreements and the multitude of projects nested therein, trust emerges between the institute and its client, as well as the client’s parent. Not only do clients come to trust that the institutes have the competences needed to complete projects, and that they will fulfill their contractual obligations to them; they come to build goodwill trust as well (Sako, 1992). Within the institutes, teams come to identify with their principal clients, creating a bond that in many ways obviates the need for more visible barriers.

Many institute managers often argue against their implementation in the first place. One institute’s ex-superintendent argued quite bluntly that all these physical barriers do is raise the cost of their operations substantially in exchange for a veneer of security. “Many clients of ours still ask for locked doors, and I say, ‘What is the point in that?’ You put ‘Restricted’ on the door, but the guys go and have lunch together...It is not the lock that is going to promote anything.” He continued by saying that “companies say, ‘I want a data center that is completely isolated.’ What is the difference? You can put everything in the same room!” A business development manager at Institute C stated that at the end of the day, engineers “have access, it’s only that they don’t use it.” But the barriers are useful in that they create the possibility of identity reordering on the part of engineers, and that they create the veneer of safety that multinational firms and their subsidiaries need to outsource R&D under unknown legal regimes of appropriability. Over time, physical divisions become afterthoughts running in the background of day-to-day operations.

4.4. Overcoming barriers to knowledge aggregation

The forces causing Brazilian institutes to erect barriers to internal movement, and by extension, causing engineers to reorder their identities in the workplace, are often met by opposing, but not quite countervailing forces. Institute superintendents, directors and program managers all exert centripetal forces on their teams to try to bring them back from the institute’s permeable membranes. This might include organizing institute-wide workshops, troubleshooting sessions, training modules and leisure activities. But the centripetal forces exerted through managerial
efforts are infrequent and weak relative to the centrifugal forces exerted by clients keen to ensure that the knowledge produced through collaborative R&D projects is contained in a clearly defined space, among a clearly defined group of engineers. Given the friction associated with sharing knowledge across client teams, institutes have enacted alternative strategies for leveraging technical capabilities across client teams.

Although these institutes were borne of the Informatics Law, many of them found that remaining entirely dependent on a single policy left them in a precarious state. Furthermore, dependence on the Informatics Law meant serving a group of largely electronics firms that would always see one another as competitors, restricting their ability to leverage knowledge gained working for one client in the service of another. Through years of working with the Brazilian government, many of these institutes have developed robust, transversal regulatory teams in order to ensure that their projects are admissible under the Informatics Law. Because the Brazilian government has modeled many of its policies aimed at boosting R&D spending and outsourcing on the Informatics Law, these institutes have been well-placed to tap sources of revenue tied to these new policies, which apply to the oil & gas sector, to the automotive sector and to the electric utilities, among others.

The proliferation of laws with R&D spending and outsourcing requirements have provided ample opportunity for these institutes to diversify into new industries. Institute A and Institute C have both engaged in significant industrial diversification, while Institute B has ventured little beyond the Informatics Law. Institute A has engaged with the Companhia Paulista de Força e Luz (CPFL), part of CPFL Energia, the third-largest electric utility in the country, on a number of projects linked to the R&D quota for energy distributors. For example, it developed a smart energy meter that, through non-invasive measures, isolates a home’s electricity consumption to test whether or not it is being served effectively by the grid. Institute C has targeted alternate funding schemes even more aggressively than has Institute A.
While a number of private R&D institutes count on experts in radio frequency identification (RFID), Institute C is perhaps the cognitive referent for clients seeking to complete R&D projects involving this technology. The institute developed its expertise in RFID in collaboration with a multinational electronics firm. The institute has sought to employ its technological capabilities to access new pools of earmarked R&D funds. For example, it has worked with the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) to develop RFID tags for certain species of birds that are often captured and sold illegally. Agribusiness presents another opportunity for industrial diversification, as one of the institute’s consultants notes:

> Today, agribusiness is the biggest market in Brazil, valued at $12-15 billion a year. Should I keep looking for business in electronics, which is worth $1-2 billion? We’re going out to agribusiness. Now, agribusiness is something we don’t know much about. Almost nothing. However, to enter agribusiness, we need to have something that we know how to do well: software development. That’s what I’m trying to do.

In the case of agribusiness, they have engaged the Brazilian Agricultural Research Corporation (Embrapa), the Brazilian Development Bank (BNDES) as well as one of the largest orange juice suppliers in the world to develop an RFID system to monitor the productivity of its orange groves. The aim is to access funding through the agriculture R&D program (Inova Agro). Beyond agriculture, the institute is developing projects with a number of electric utilities with R&D earmarks created through National Agency for Electric Energy’s (ANEEL) R&D program. For example, it has engaged with an electricity distributor in the south to develop active RFID chips powered by photovoltaic cells. While these organizations were created as a result of the Informatics Law, they have found that only through industrial diversification via new R&D policies can they create the internal communication channels necessary to engage in knowledge brokerage.

5. Discussion

Scholars studying intermediated innovation have taken one of two approaches to the study of these organizations. Some scholars have taken a structural approach, focusing on the question of how intermediaries leverage their position in networks of firms to support their clients’ upgrading
efforts. Others have taken an organizational approach. Many of the organizations characterized as PBOs, KIBs providers or knowledge brokers furnish high value-added services that support their clients’ innovation processes. Projects lead to organizational learning, which builds the firm’s stock of knowledge, and beyond that, forms the foundation of its competitive advantage. But the link between project-specific knowledge and organization-wide knowledge is rarely problematized in the literature on intermediated innovation. Of course, the literature does acknowledge the difficulty associated with aggregating and amplifying knowledge. But in these cases, barriers to knowledge aggregation result from the absence of certain catalytic features like boundary spanning individuals or units, not from imposition of barriers to knowledge sharing.

This paper takes a very particular set of organizations as its principal subject. The Brazilian R&D services providers examined here were created by foreign multinational firms in response to an industrial policy which required R&D spending, as well as outsourcing. While they were initially captive to the companies that spun them off, they eventually diversified for a variety of reasons. The three organizations examined here began to serve various clients, many of them competitors. Because the law required that a certain percentage of funds be outsourced, projects could not be internalized. As a result of the outsourcing imperative, as well as the unclear legal regimes of appropriability in Brazil, clients began to demand that the teams working for them be physically, digitally and legally separated from teams working on behalf of competitors. Because of these barriers, as well as the shifts in employee identity that they drove, all three institutes became balkanized organizations with few cross-team communication channels. This made meaningful knowledge aggregation complicated, if not impossible.

The process described here has an analogue in the field of landscape ecology: habitat fragmentation. This refers to the creation, whether by natural or artificial means, of discontinuities in a population’s environment. Habitat fragmentation often begets population fragmentation, which comes with its own set of pathologies including the attenuation of biodiversity, and eventually, ecosystem decay. These islands cannot support the same level of biodiversity that a contiguous space of the same size can (Forman, 1995). The same principle
applies to balkanized organizations. The separation of an erstwhile contiguous organization creates perpetual divides. Client imperatives create divisions, but it is the ensuing reordering of identities on the part of engineers that make them relatively enduring. For this reason, managers concerned with the long-term survival of their institutes spend a great deal of time pushing their employees back to center. But despite their best efforts, managers cannot match the centrifugal forces to which their employees are subjected. It is only through the pursuit of new opportunities in unrelated industries that managers are able to create communication channels within their organizations, as well as opportunities for knowledge brokerage.

These institutes have only recently begun to find ways to ease the blockages separating client teams. One of the primary means of creating internal mobility has been industrial diversification – seeking out clients in industries unrelated to the industries that their core base of clients inhabit. Organizations outsourcing their R&D earmarks to entities like Institutes A, B and C are most concerned with slippage between clients in a single industry. For example, Samsung does not want Apple getting a hold of its ideas, and vice versa. But the pressure to maintain barriers to intra-organizational knowledge transfer becomes less intense when institutes reach into other, unrelated industries for work. Clients might be more open to sharing an engineer with another client if they operate in an entirely different industry. Thus, the walls separating teams within these R&D institutes become softer and more permeable when a strategy of industrial diversification is enacted (see Figure 3).

Figure 3: R&D Institute Operating Across Industries
As the literature on Chinese walls instructs, working with clients in the same industry makes it problematic to share knowledge between teams (Brewer and Nash, 1989). But data security becomes much less critical when moving across conflict of interest classes. In the end, these institutes, some more successfully than others, have been able to diversify into new industrial sectors, easing restrictions on the internal movement of their personnel. Working across conflict of interest classes allows for the possibility that ideas developed on behalf of one client might be used in the service of another. Gaining access to new small worlds that existing clients are none too concerned about allows these institutes to create internal channels for knowledge sharing, and beyond that, allows for the enactment of brokerage strategies. The ability to broker depends on the ability to bring ideas from where they are within the organization to where they are not, through the cultivation of a cohesive organizational memory.

The idiosyncrasies of the empirical context render the institutes examined here quite unlike the third-party services providers traditionally examined in the academic literature. But an examination of how these institutes have evolved over time, from captive R&D labs to knowledge brokers, yields broader insights into the process knowledge aggregation, and how to overcome explicit barriers to it. As has been argued in this paper, the literature on intermediated innovation tends to see the process of generating organizational knowledge on the basis of specific projects as being relatively trivial. Of course, knowledge aggregation can be impeded for a number of reasons, many of which have been discussed. But generally speaking, the types of firms examined in the literature do not face explicit barriers to knowledge sharing. This is at least partially due to the fact that most studies on intermediated innovation focus on organizations in industrialized economies (Tether and Tajar, 2008). Examining these institutes allows for a better understanding of the challenges associated with intermediated innovation in developing and emerging economies.

As Hargadon (2002) notes, brokerage requires access to multiple small worlds, as well as the ability to collect ideas in a central repository. This paper suggests that in developing and
emerging economies, would be brokers cannot create repositories of ideas deployable across projects unless they first gain access to various disconnected small worlds. Chinese walls prevent knowledge aggregation when operating in a single conflict of interest class. These barriers only become permeable if the organization accesses clients in new, unrelated industries. Otherwise, shared services providers remain limited by their balkanized spaces. This study examines a relatively small sample of firms in a single country. Future studies might examine innovation intermediaries in other developing and emerging economies to test whether the problems associated with knowledge aggregation, as identified in this paper, are readily apparent in other countries as well. Furthermore, future studies might examine the implications of barriers to knowledge aggregation in innovation intermediaries for a country’s development prospects.

6. References


