Internal Governance of Design and Engineering: The Case of the Multinational Firm

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Abstract: This paper examines the process of design and engineering in large-scale construction projects delivered by multinational organizations. The analysis is on the basis of using transaction cost economics to represent design and engineering as a stream of intra-firm transactions between the local contracting office and the network of subsidiary offices. The paper then applies the concept of asset specificity to process-level design and engineering knowledge and induces a theoretical framework on the basis of local and expertise specificity of assets. The framework posits that different levels of local and expertise specificity lead to different modes for intra-firm governance of work packages in design and engineering. The paper validates the theoretical framework with interview data from six major international design and engineering organizations and derives a set of management recommendations for practitioners. The framework takes the transaction cost theory into the realm of intra-firm governance represented as a stream of asset-specific transactions. The framework extends construction engineering and management literature with a transaction-based elaboration of the design and engineering process.
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Introduction

In spite of the recent economic downturn, the global construction industry continues to face a significant demand for large-scale projects that will improve the urban quality of life for millions of people worldwide. Because of their scope, the delivery of these projects overrides organizational, national, and institutional boundaries. Because of their effect on local budgets, communities, and environments, large-scale projects need to account for an ever-growing set of economic, social, and environmental criteria (Levitt 2007). As a consequence, the process of development, design, and engineering of large-scale projects is increasingly complex, uncertain, and fraught with changes. On a global scale, this development strengthens the sector of interdisciplinary design services in construction, more commonly referred to as design and engineering (hereafter referred to as D&E). This strengthening results in internationalization and integration processes that give birth to the multinational D&E firm. Its aim is to engage in projects internationally by combining local area presence with various fields of expertise residing distributed within the various firm offices. Although the central office is held responsible for making strategic business decisions, local offices have the autonomy to make project-level decisions. In spite of the increasing number of multinational D&E firms that take part in the delivery of large-scale projects worldwide, little explicit knowledge exists about practices that employ geographically distributed organizational capacity in the context of local project execution.

The main goal of this paper is to analyze the design and engineering process in large-scale construction projects within the context of a multinational organization. This analysis specifically focuses on how the process is coordinated and controlled, or in other words governed within the firm. In doing so, the analysis presented in this paper uses a microeconomic lens of transaction costs (Williamson 1985, 1996) to represent the allocation of resources to projects as an intra-firm market setting.

The paper is structured as follows: in the next section, the context of the study is provided by introducing several key distinctions between organizing the D&E process and construction operations. Then, the concept of transaction costs as a lens for analysis of distribution of D&E work packages for a project is elaborated on. The paper continues with a literature review on the application of the transaction cost theory in the construction sector. By using this theoretical lens, a framework for internal governance of D&E work packages is derived. The paper continues by presenting the research design and method used to validate the framework and the results are presented. Finally, the paper concludes with three project cases as illustrative examples for the derived framework. The paper closes by discussing the contributions to knowledge and practice and opportunities for further work.

Design and Engineering Features

The formal basis of D&E is to meet the client's requirements by developing various functional systems that form part of the delivered facility. To meet the scope and complexity requirements of the defined functions, specific D&E experts are assigned to each function. In traditional project management, this is the practice of resource allocation that decomposes the overall scope of work into

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individually manageable work packages, which are subsequently assigned to specific teams for execution. The traditional practice of resource allocation in D&E has been the disciplinary breakdown on the basis of the type and level of technical expertise required to deliver the project. In the example of a building project, the disciplinary division of labor would sequentially follow the traditional pattern of architecture, structural engineering, mechanical engineering, and electrical engineering. Although a built facility is eventually defined by its technical features, the decision-making process that leads to the final solution includes not only technical aspects but also the local context that will eventually accommodate the project and the resulting facility.

Because every construction project is ultimately a locally delivered artifact, it needs to achieve alignment with its external context that consists of the environmental, economic, and social systems. The relationship between the project processes and the local environment will determine the extent to which a project needs to integrate with local institutions, such as regulations and norms of professional practice. In a recent study, Javernick-Will and Scott (2010) contend that for D&E in an international context, the most important types of knowledge are in the domain of social norms, expectations, practices, and knowledge of the local work practices. Although knowledge about work practices may be relatively simple to acquire, the social-level alignment with the local project expectations may be very difficult to achieve. Results of the study by Javernick-Will and Scott, therefore, imply that the success of international projects is, to a significant extent, determined by connections with the locals, either internal or external to the organization.

Because of the need to fulfill both the technical and local requirements, interdisciplinary D&E is a tremendously complex undertaking. Complexity in D&E is a consequence of the reciprocal interdependence among the work packages. Because of this, a change in one task will incur changes in all interdependent tasks. In a context of interdependent relationships, communication among the tasks is an essential means of integration and, if absent, the D&E process becomes fragmented, leading to suboptimal solutions (Magent et al. 2009). If D&E teams perform well individually, communication and collaboration among the disciplines is a key factor of process-level integration among the teams. Because even slight variances in decisions can have an enormous effect on the delivered functionality, D&E of projects should use the best professional expertise to address this issue.

In conclusion, the resource allocation and management in D&E can be defined as the internal governance of interdependency among work packages. This internal governance of the D&E process is chosen to be represented as a stream of transactions among diverse firm divisions and subsidiary offices that constitute the intra-firm market of services. The transaction-based view is well acknowledged by Williamson's transaction cost theory, which is utilized for this purpose (see, for example, Williamson 1985, 1996).

Transaction Cost Economics in Construction

Transaction cost economics (hereafter referred to as TCE) states that the main rule of structuring an organization is to minimize the sum of transaction costs of its operation, whereby a transaction cost occurs each time an economic exchange among separate entities takes place. Following this path of reasoning, Williamson's theory (1985) acknowledges two basic ways to coordinate the transactions: the market, in which mutually independent buyers and sellers negotiate the price of a transaction, and the hierarchy, in which a transaction is internally governed by organizational means. The most important contingency variable for solving the so-called make-or-buy question is the specificity of assets to the transaction made (Williamson 1985, 1996).

> "[An asset-specific investment is] a specialized investment that cannot be redeployed to alternative uses or by alternative users except at a loss of productive value."

Williamson's explication distinguishes several types of asset specificity, one of which is human asset specificity that occurs when the firm's employees acquire firm-specific knowledge and skills over the course of working for the firm. This creates an idiosyncratic relationship between the firm and the employee in a sense that neither of the two will be inclined toward replacing the other.

Transaction cost economics has been used to answer the question of why the construction industry favors subcontracting over bureaucratic hierarchies much more than the manufacturing sector (Stinchcombe 1959). Eccles (1981a, b) appears to have initiated the discussion of viewing the construction process as a stream of transactions in his seminal work on the quasi-firm in the construction industry. In essence, Eccles argued that project complexity, size, and the market extent result in extensive and recurring subcontracting in construction. Reve and Levitt (1984) continued the discussion by using transaction cost analysis to discuss contracts as a mechanism to govern the client-consultant-contractor relationships in a construction project. Winch (1989) subsequently included the project-firm dichotomy of the industry, whereby firms, not projects, make decisions about resource allocation transactions. Subsequent to these articles, the TCE discussion in construction has been differentiated into two streams of theory: governance of the boundary between the client and the principal contractor (Eriksson 2008; Puddicombe 2009) and the boundary between the principal contractor and its subcontractors (Costantino et al. 2001). An example of the subcontracting discussion is a comprehensive study including a panel of 278 construction firms in Spain, in which Díaz et al. (2000) argue that as asset specificity grows, firms subcontract less, and as process output diversity increases with intangible assets, firms subcontract more. Walker and Kwong Wing (1999), on the other hand, present project management activities as transaction costs in construction projects. They argue that the role of project management is minimizing the sum of production and transaction costs on behalf of the client. Drawing on these contributions, Winch (2001) proposes a TCE-based conceptual framework for governing the construction process across both the participants in the project chain and the resources that each of the participant uses to deliver the work.

Few studies concerning the governance of interdisciplinary D&E within the construction industry by using the lens of transactions exist. Two studies use TCE in the D&E context; in the first, Pietroforte (1997) argues for the adoption of new types of organizational structures to handle the information-intensive task of D&E. In the second study, Winch (2001) identifies construction design as a task with both high uncertainty and low frequency, and proposes that organizations handle D&E either internally or through professional associations. Following Winch's (2001) advice, the analysis of the intra-firm governance of D&E work packages was chosen.

This process can be defined plausibly in the context of the asset-bounded intra-firm market of design transactions. The next sections further elaborate this perspective by using the example of the multinational D&E organization. To the best of the writers' knowledge, no such studies exist.

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Developing a Framework for Internal Governance of D&E

A typical multinational D&E firm consists of a network of subsidiary offices that engage in a number of local projects. In this organizational setting, a subsidiary office is expected to provide the organization with projects in the region that the office covers, while simultaneously relying on the capacity and references of the internationally distributed organization. The intended advantage of this approach for the firm is to possess a diversified portfolio of projects in different regions. The intended advantage for the subsidiary office is the opportunity to become involved in other projects of the firm if the local demand temporarily should decrease.

The transaction-based representation of intra-firm D&E requires defining the supply and demand side of the transaction and the transaction itself. The transaction consists of applying D&E knowledge to a project-specific situation. This transaction occurs in an internal firm market setting in which the main contracting office creates the demand and the network of distributed firm offices creates the market for sourcing the technical expertise from within the organization. When put into formal TCE terms, the main question is whether the local office decides to employ its internal capacity to execute the design tasks or to source expertise from the distributed intra-firm market of offices. The concept of the multinational D&E organization as a stream of intra-firm transactions is shown in Fig. 1 subsequently. This arrangement calls for a matrix organizational structure addressed by two lines of management: one for the expertise-specific part and one for the local tasks.

Design Knowledge as Asset Specificity

The described intra-firm governance arrangements of D&E are a consequence of transaction-specific assets. The condition of asset specificity is here embodied in the firm's employees' knowledge that is required to produce D&E in an interdisciplinary context. Such knowledge can be either based in local work practices or global professional expertise in a field. On the basis of the need for either type of knowledge, organizations choose among a range of structural options in the make-or-buy context of D&E work packages. Design and engineering is, therefore, an asset-specific set of transactions between the contracting office and the company-wide network of offices. Therefore, asset specificity is defined in process-level D&E knowledge instead of merely in asset ownership as in a number of existing TCE studies.

- Local specificity is a condition in which a firm-specific pool of experts resides at the location of the project. In the condition of local specificity, local execution of the project is considered value adding as the most important knowledge required for the project is bounded by local institutions. Following this reasoning, local specificity can also be defined as institutional knowledge regarding the project location (Javernick-Will and Scott 2010). An example of locally specific organization is the traditional D&E firm that engages in local projects by offering knowledge gained through local experience. Local specificity is, therefore, a theoretical argument for a strong local D&E firm. In other words, it is an argument for a locally centralized and hierarchical process.
- Expertise specificity is a consequence of firm-specific knowledge and skills that the firm's employees have acquired over the course of time and that are not replaceable by means of third-party contracting. More specifically, expertise specificity is the possession of the scarce technical knowledge that is necessary for D&E of projects, regardless of their location. In the condition of expertise specificity, firm's leading experts add value to the project by providing technical expertise that might not be available locally. An example of expertise-specific organization is the specialist D&E firm that is acknowledged as a global leader in its field. Expertise specificity is, therefore, a theoretical argument for a global center of excellence in a D&E field. In other words, it is an argument for using the internal firm market of technical expertise.

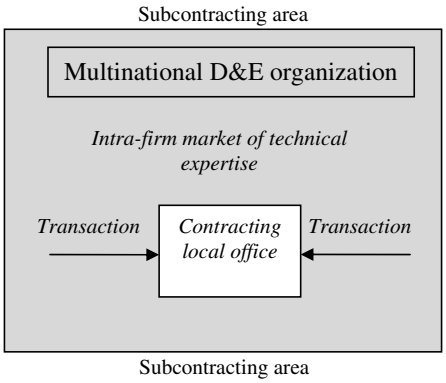

Fig. 1. The concept of multinational D&E as an intra-firm stream of transactions

The introduced conditions of asset specificity will cause different approaches in organizing the D&E work across offices of an international firm. The traditional way of governing the process has been through strong local specificity; therefore, through a local firm. However, as the size and uncertainty of the project increase, expertise specificity will play a more important role in the intra-firm governance arrangement. This calls for a setting that integrates both technical and institutional knowledge embodied in the firm's employees. This setting achieves superior capacity by integrating the technical expertise and local knowledge of the firm's assets. Local expertise means a strong lead from the local office with in-house staff consisting of best local experts. Expertise specificity means supplementing the local office with best specialist expertise available through the company network. When translated into TCE language, the hierarchical process by the local office is upgraded by technical expertise supplied from the organizational network. The condition of combined local and expertise specificity is referred to as knowledge-specific D&E because both conditions refer to knowledge as a transaction-specific asset.

Knowledge-Specific D&E

To manage the D&E process, managers decompose the overall scope of work into work packages to be executed relatively independently of one other. This decomposition process has traditionally been on the basis of disciplinary division and scope of each of the work packages. This reasoning is, however, not efficient in the complex setting of knowledge-specific D&E that needs to take into account both the centralized local specificity and expertise specificity distributed across the firm. The findings of this theoretical discussion are summarized in a framework (Fig. 2) that defines local and expertise specificity of assets as the two contingency factors for choosing different approaches to internal governance of D&E work packages.

On the basis of the two identified specificity variables, the framework decomposes the theoretically derived paradigm of knowledge-specific D&E into two basic governance dimensions. They constitute sourcing the project either by locally available experts or by using the best experts available regardless of their location. The former is a hierarchical choice, whereas the latter has features of a market transaction, thus the hierarchy and market

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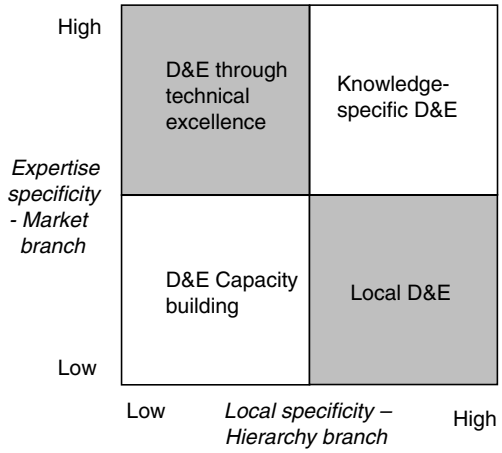

Fig. 2. Internal governance modes for design and engineering in a multinational D&E firm

branches in the theoretical framework. It summarizes the process of choosing the appropriate intra-firm governance mode for D&E work packages.

This process begins with an assessment of local specificity of the project. The project contracts are typically undertaken in the local firm office; therefore, the local specificity branch of the framework represents the hierarchical dimension of governance. A high-level of local specificity combined with a low level of expertise specificity is a situation in which using the best local experts is considered value adding for the project, whereas remote contributions by technical excellence centers are considered non–value adding. In this case, the organization will staff the project only from the local office. The resulting internal governance mode is "local D&E", in which the local offices are independent of one other. The local offices offer integrated services of interdisciplinary D&E for different types of buildings to local clients. Experts are hired locally on the basis of project demand and very little interaction among the offices within the firm occurs. An example of this would be a scenario in which all the local projects are assigned to a local firm. However, this mode is only possible for low-complexity small and medium scale projects that do not exceed the capacity of the local firm.

When the need for expertise exceeds the capacity of the local office, it is the threshold when the value of using the best technical experts is greater than the value of local staffing. In this case, the organization buys the expertise from the internal firm market to staff the project without the need to use the local expertise. The resulting internal governance mode is "D&E through technical excellence". An example of this would be a scenario in which all the structural engineering work packages are allocated to a hypothetical office that employs the world's best structural engineers. This mode calls for independent centers of technical excellence offering specialized services to clients worldwide.

The reasoning of this paper is on the basis of elaborating D&E in an international setting as a stream of transactions on the basis of local and expertise specificity. The part of the framework in which neither of the identified two variables is pronounced suggests the organizational development area. In other words, because the variables for intra-firm governance of work packages in D&E are local and expertise specificity, this is a transitional phase of "D&E capacity building" in which organizational knowledge is built before it can be employed as an asset for intra-firm governance decisions.

Research Method

To show the explanatory potential of the theory derived, the framework was qualitatively validated with a case study of six multinational D&E firms. The goal of this validation was to investigate how closely the theoretically derived paradigm of knowledge-specific D&E matches the practice in existing multinational D&E firms. More specifically, through this validation, the aim was to find evidence of work packages that can be categorized in the governance modes identified by the theoretical framework. Therefore, the unit of analysis was defined as a D&E work package within a single firm, and achieving theoretical and literal replication of findings across the cases was attempted (Yin 2003).

References to work packages with different governance modes at the firm and project levels were sought. The case sampling strategy was chosen by approaching different categories of firms to encompass a wide range of different internal governance mechanisms that would enable the replication of theoretical findings. The logic of the sampling strategy was to reduce variation attributed to size of the firms, thereby setting the domain of the findings to internal governance within large multinational D&E firms. Six firms from different core markets were selected to achieve theoretical replication, and engineering design of buildings and public infrastructure were focused on specifically to achieve literal replication. The case sample included the following:

1. Three firms specializing in engineering design of buildings and public infrastructure;
2. One firm specializing in integrated real estate development, design, engineering, and project management services;
3. One firm specializing in engineering, procurement, and construction of oil, gas, and petrochemical facilities; and
4. One firm specializing in interior design and architecture.

Suitable informants from each firm were identified on the basis of their management experience and involvement in complex D&E projects across the organization. All interview respondents held either executive management or senior project management positions. Table 1 describes additional details of the case sampling strategy. Firms' names are disguised with alphabetic letters. The respondents were located in Germany, the Netherlands, United Kingdom, United States, and Canada.

Following ethnographic interviewing techniques (Spradley 1979), the first writer collected the data in a semistructured and open-ended manner. The informants were interviewed either through telephone calls or meetings in person. The interviews included open-ended questions about management practices in D&E projects along with justifications and shortcomings of these practices. The structure of the open-ended interview included questions across the categories of motivators, organizational strategies, challenges, and success factors. Each interview lasted approximately 60 min.

Table 1. Case Sample Information

Company (coded)	Employees	Countries with offices	Number of informants	Location of informants
A	15,000	12	6	DE, NL
B	10,000	33	3	US
C	15,600	28	2	UK
D	13,000	26	3	US, UK
E	40,000	28	2	US, CA
F	2,000	7	3	US, UK

Note: CA = Canada; DE = Germany; NL = The Netherlands; UK = United Kingdom; US = United States.

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The case study method proposed by Yin (2003) was used to analyze the data. After transcribing the interviews, NVivo software was used to store and code the data. Because validation of the derived theoretical framework was intended, not building a new grounded theory, axial coding was used, in which properties from the interview data were related to existing theoretical categories (Strauss and Corbin 1998). The data were coded by using a structure of dependent and independent variables. The dependent variables included examples of the governance modes for work packages, whereas the independent variables included categories of local and expertise specificity of assets.

Results and Discussion

The results from the research data provide initial validation of the framework. By describing the categories of local and expertise specificity, general findings on the firm executive level are first presented, followed by the project-level findings. The results section concludes with three case projects to illustrate how the governance modes from the theoretical framework are used in practice.

Local and Expertise Specificity

The data show that conditions of expertise and local specificity are in constant interplay. Practically, local specificity takes precedence as a condition to staff D&E work packages. A good example of this occurs in public-funded projects in which clients require local specificity.

> "Since the funding for the projects is often locally based, there is a lot of pressure to make sure that local residents and tax payers and businesses are the beneficiaries of that local funding."—Company D, President of Infrastructure

Especially in major urban centers, in which markets of D&E services are abundant, the condition of expertise specificity is difficult to justify because it leads to costs associated with expatriate managers. An experienced design manager with expatriate experience summarized this tendency.

> "If we send an expat to a foreign assignment, we have to provide them with housing and cars and other things, and also their salaries are very high comparing to many other countries around the world. We find more and more resistance to the willingness to pay those high salaries and also more and more engineering capability within those countries. So 25 years ago you'd probably see a lot of expats on assignments on projects in countries around the world, now you'll see less of that because there is more capability in those countries and also the cost of our services is somewhat prohibitive in that as well."—Company D, President of Infrastructure

This quote also demonstrates a case of the capacity building process, resulting in the development of significant expertise capacity in the local office. As a result, the option of hiring an experienced manager from abroad on their project will incur substantially more transaction costs for the project when compared with the local D&E model.

> "Just saying: we have civil engineers here but they're too busy so we would like to bring some civil engineers from outside to help out, that becomes a bit more problematic."—Company D, President of Infrastructure

A way of mitigating the expatriate problem is to accentuate the local D&E model in the firm's strategy. In contrast with the previously described practices in organization D, organization A does not use expatriate managers in its projects. This translates into the condition of strong local specificity for this firm's projects.

> "When a project occurs in a certain country, the local office principal will execute this project in close contact with the Account Manager of that client. If we don't have an office in a certain country, then we use a partner to deliver the requested service."—Company A, Worldwide Consulting Operations Manager

Therefore, the company uses a network system to achieve local delivery without the need to share specialty expertise across the organization. This is, however, possible in situations in which the scale of the project does not require additional buying of expertise. In other cases, the advantages of using the best technical expertise are translated into the condition of expertise specificity that requires additional expertise to be bought from the organizational internal market. The following quote demonstrates how an office principal justifies expertise specificity as a competitive advantage in the bidding process for new projects.

> "There are definitely so many different aspects of our business that you can't have expertise in every area in every office. If, for instance, this office is very, very strong in healthcare, but other offices might not have that skill; if they work on a hospital—they can use us."—Company B, Principal

When the two conditions are combined together, it leads to the combined D&E mode of governance that uses both local and expertise specificity to meet the project demand. A senior project manager with an engineering design background portrayed the need to use both local and expertise organizational capacity in large-scale projects.

> "It is mainly the size of the project or the pace of the project or both, that dictate distributed project execution. A particular office will win a project, but they lack the expertise and size of the staff to execute the work."—Company D, Senior Engineering Manager

This person continued with explaining a number of issues with regard to justifying the transaction of using expertise specificity. In this person's opinion, these issues should be addressed already during resource allocation.

> "If you are going to consider a particular office for an assignment on your project, the first thing you want to know is if they have the necessary expertise. If the necessary expertise is not there, it doesn't matter if they are not busy and you are busy, you can't let them help you because it is not going to work. The second question is if there is enough manpower in the other office to perform the work in the time I have available. The third question I look at is if the required individuals are readily available and are they likely to stay committed for the time I need them. My experience has been that good people are normally busy and if someone is sitting there doing nothing, there is quite often a reason for that."—Company D, Senior Engineering Manager

Issues in knowledge-specific D&E are therefore a combination of expertise, capacity, and trust. The conditions of local and expertise specificity, however, evolve interdependently during the execution of D&E. One interviewee, for example, described how the conceptual design work packages required more expertise

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specificity, whereas the detailing design work packages required local-specific governance.

> "So in the initial phase, we would mostly resource projects [remotely] but we would wish to have one or two people from the [local] office to become intimately involved in the design decisions, and to make sure that what they are going to receive is according to the local expectations. However, as we go further into detailed design, the effort will translate to [the local office], because at the end of the detailed design phase they will be procuring a contractor and the permits and finally the construction works will take place."—Company B, Director

The organization for knowledge-specific D&E is a matrix combining technical expertise and local presence. As the writers learned, it is a common organizational structure for many of the multinational D&E firms that engage in D&E. The following quote matches the dimensions in the organizational matrix with the two basic governance modes from the theoretical framework: technical excellence as opposed to local execution.

> "It is pretty much a geographic organization that folds down from the company level across the regional level to the local area level. But there are some areas of expertise that don't reside within each of those offices so we have those organized more around business lines or disciplines. So we have, for example, tunneling and underground group, then we have a transit systems group, and these are what we call technical excellence centers and they are based more on their particular technical area or business line. And in these technical excellence centers, they are probably housed in a few locations, these experts like tunneling underground or transit systems and other specialty areas, they reside in several places around the country, around the world and they are there to support project wherever they exist."—Company D, President of Infrastructure

This paper continues with examples from projects that link the independent variables of local and expertise specificity with internal governance modes in a coherent project context.

Example #1: Knowledge-Specific D&E

For an example of knowledge-specific D&E, a large-scale infrastructure project delivered in a fast-track arrangement is presented. The project consisted in reconfiguring 1.4 km of a highway through a system of streets, ramps, bridges, retaining walls, drainage structures, landscaping, and urban improvements in the central district of a major city in the United States. Because of the fast-track schedule and the scope of work, the project used 42 different design teams distributed around various places in the United States. Because the project was funded by a public agency and it was delivered in a densely urbanized area in which the local market of D&E services is abundant, the local specificity requirement was strong. The main reason to use the remote capacity of the organization was to address the additional changes in requirements and project scope. The client introduced the changes in the scope of approximately the size of the original contract, which greatly exceeded the capacity of the local organization. This translated into the condition of high expertise specificity that allowed the project manager to staff the project with teams from 26 company offices and 16 subconsultants.

> "Another case is a street that was going to be on fill in the original part of the project. And someone raised an idea of can you put it on a structure and put a transit center under it. And we did…The client was okay with us using all that additional capacity because incorporating the new requirements into the original contract made so much sense for them. We've torn up the heart of the city, so why would you compact it and tear up it again to do something that you could do now cheaper and less disruptive."—Company D, Senior Engineering Manager

In this arrangement, the project manager subdivided the entire scope of work into work packages on the basis of disciplinary expertise and the physical scope. An example of the former was that the geotechnical engineering for the whole project was done in one remote office, and an example of the latter was that one office would be responsible for one or several entire buildings. In conclusion, although the knowledge-specific D&E case project was contracted locally, significant expertise had to be procured from the internal company market because of a number of changes in project scope that were introduced by the client.

Example #2: Local D&E

As an example of strong local D&E governance mode, a large-scale design-bid-build project consisting of an 80,000 m^2 building complex of offices, accommodation, and research facilities in a major European urban center is presented. The project owner is a multinational client. The interviewed project managers argued that although the project included substantial parts of complex design and engineering, it did not require expertise specificity outside the project office.

> "We didn't require the type of expertise that wasn't available in [this area]."—Company A, Design Manager #1

Again, the local market of D&E services was abundant, which translates into a strong condition of local specificity. This is not surprising even at the firm level because the company that was awarded the job is organized as a multinational conglomerate of locally specific D&E with very limited interaction across the network of offices. The entire interdisciplinary design was executed by using several locally based offices.

> "About 40 people were involved during the design process. We had three of our design offices across the country participating and project leaders coming from different design disciplines were sitting in the design board."—Company A, Design Manager #2

Because the project included a substantial amount of architectural master planning and design, the subdivision of scope was carried out to different offices on the basis of stand-alone units. In such an arrangement, buildings were the basic units of scope and subdivision.

Example #3: D&E through Technical Excellence

The third project presented is D&E for a cable stayed bridge in a small city in the United States. Because of the remote location of the project and the technically demanding D&E process, it was carried out remotely by 12 different company offices with the assistance of 14 subconsultants. The most obvious feature of the project that required this governance mode is high expertise specificity taking precedence over local specificity because of the remote location of the project. More specifically, the local market was scarce with organizations able to provide the service with the needed level of expertise, as the following quote by the project manager demonstrates:

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"Normally we would have a dedicated project office, but on that occasion the local office was so small, that there was not enough engineering capacity to deliver the work. So we used people from other offices because it was a fast-track project and we needed resources. For that case we didn't have the pressure from the contractor that we would normally get when working for a public works client who would say, 'No I want the work done locally.'"—Company D, President of Infrastructure

The project was, therefore, able to justify the condition of high expertise specificity, which enabled its internal governance in a "technical excellence" mode through a distributed organizational setting with very limited local sourcing. Although only a small number of organizations were simultaneously involved in the design process, the overall design sourcing was risky because of the transaction costs of this distributed design. The project manager indicated

"You can save money, probably, in the long run, by using the right people to do the task but there is always some additional cost that I had to budget into my project for worksharing. Those extra costs can be small but they always exist."—Company D, Senior Engineering Manager

Another example of expertise specificity taking precedence over local specificity is in D&E of projects for global clients. In such cases, projects are delivered across a number of worldwide locations, which weakens the condition of local specificity.

D&E Capacity Building

No specific evidence for this type of governance mode could be found in the data because all the projects investigated were delivered within stable organization networks. The capacity building governance mode is anticipated to be found in the context of multinational D&E network expansion.

Discussion

The conducted interviews provide evidence for the theoretically derived framework of internal governance. Although this evidence can be considered anecdotal, it supports the theoretical reasoning behind the framework. On the one hand, local specificity of assets results in utilizing the local office to its fullest extent and, on the other hand, expertise specificity of assets results in utilizing the internal expertise-based market of services in the firm.

Multinational D&E firms strive to establish local offices that not only provide local specificity, but also contribute expertise specificity within the internal company market. Instead of staffing every region's office with every type of expertise, the knowledge-specific D&E organization is able to economize by supplementing local knowledge with design expertise to deliver its projects. When needed, expertise from remote offices can supply the local project with high-level expertise and international reputation. The advantage of using a local office hierarchy is the opportunity to mobilize resources on short notice without incurring significant transaction costs. The advantage of using the internal firm market of technical expertise is providing the project with high-level design expertise not available at the location of the project without the need for third-party subcontracting.

The internal market setting that this paper presents in the context of TCE depends on comparing the variables of local and expertise specificity for a project. The local office that is typically responsible for the project decides to either hire local experts independently of the rest of the organization or to supplement the needed capacity with the existing intra-firm expertise. Hiring experts locally will incur more transaction costs than using the intra-firm network of expertise for one-off projects. Therefore, the work packages can be distributed opportunistically outside the centralized hierarchy of the local office.

Theoretical Contributions

The main contribution of the study is the application of transaction cost theory to explain the intra-firm governance of D&E in large-scale construction projects. The theoretical framework in this paper is unique because is treats D&E operations separately from construction operations, which have been primarily the focus of TCE-based analysis to date. In contrast with the field of construction operations that has been long acknowledged to use extensive subcontracting with low levels of vertical integration (Stinchcombe 1959; Eccles 1981a), this study represents the network of multinational D&E organization as an intra-firm market characterized by transactions between the contracting office and the rest of the D&E organization. This analysis yields a strong argument for the intra-firm governance of D&E in large-scale projects.

Furthermore, this study not only contributes to existing TCE analyses in the construction sector (Eccles 1981b; Walker and Weber 1984; Díaz et al. 2000; Winch 2001; Eriksson 2008; Puddicombe 2009), but also extends knowledge management theories in multinational design and construction organizations (Javernick-Will and Levitt 2010; Javernick-Will and Scott 2010) by further developing the concept of institutional and technical knowledge as assets that help to enable the expansion of multinational organizations through engagement in large-scale D&E projects. Finally, this analysis extends arguments of TCE beyond discussions on market, hierarchy, and hybrid arrangements among firms and into the realm of internal firm governance. In doing so, the analysis also extends the scope of asset specificity to local and expertise specificity of human assets in the D&E process.

Practical Recommendations

Internal project governance is an emerging area of study that can have significant implications on management divisions. In essence, this research should help managers govern the D&E process on the basis of work package process-level characteristics rather than merely matching man-hour requirements with the available capacity within the organization. To accomplish this, managers should assess relative levels of local and expertise specificity and opt for creating work packages accordingly. In this assessment, considering the following project characteristics may be helpful:

- Is the project located in a dense urban area with a high concentration of D&E service providers or in a remote area with scarce availability of such services? The condition of local specificity will prevail in the former case, whereas the condition of expertise specificity will prevail in the latter.
- Does the project consist of unique requirements for technical systems and are significant changes in scope likely during the project execution? This might be a reason to consider additional expertise specificity through the knowledge-specific D&E governance mode.
- Is the project publicly funded and do a large number of primarily local stakeholders have an effect on project decisions? Public involvement usually calls for the local D&E governance mode.
- What is the estimated ratio of conceptual design development versus detailed engineering design in the project? Expertise specificity may be stronger in the former case, and local specificity may be stronger in the latter case.

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- Is there a substantial scope of D&E that requires neither strong local knowledge nor strong technical expertise? This situation acknowledges a wide range of possible choices, from economizing on production costs by using low cost centers to opportunistic decisions by empowered members of the project coalition.

On the basis of the work package characteristics, project managers can run a trade-off analysis by comparing the possible governance modes for each work package. After determining the work packages to be executed by teams of distributed experts and the local office, managers need to determine a management strategy that addresses the interface among the work packages.

- In the technical excellence D&E model, integration occurs among different teams of experts and between the specialist contributors and the local office. Most of the work will be managed by the manager of the center of excellence office. Therefore, attention must be paid at the interface between the technical expertise office and the local office.
- In the local D&E model, the integration mostly occurs within the local office. Most of the work will therefore be managed by the local office manager. This strategy poses a risk of communication breakdown between the local office and the organization. As a result, particular attention might be paid to the reporting system. Management costs will only be significant if the local office is not aligned with the organization's processes and requires management to assist with the alignment.
- In the knowledge-specific D&E model, both management lines are needed within a matrix organizational setup. As a result, the project manager will need to interact with managers of both the local office and the technical centers of excellence. In some cases, the project managers even decide to keep the entire D&E team collocated at the location of project delivery, which is the most costly option, but by some measures, also the least uncertain.

Limitations and Suggestions for Future Research

The preceding discussion captures the knowledge level of asset specificity that is needed to execute the D&E in a multinational context. Therefore, instead of asset-specific transactions in ownership, the focus is on asset-specific transactions in knowledge. This assumes that the only economic factors governing the process-level D&E are on the basis of knowledge and not on risk minimization, political empowerment conditions in the project, and other factors. Further research is needed to investigate how these factors motivate other internal governance modes that are not captured by the analysis in this paper.

Moreover, several issues in the internal governance framework might need further clarification. First, the induced framework is interpretive, and the unit of project scope it addresses is the intra-firm work package. Indeed, in a decentralized decision-making environment, such as in multinational D&E, each of the identified governance modes occurs simultaneously; therefore, the main intention of the framework is to help managers in the decomposition of D&E scope. Because of the interpretive nature of the framework, only the managers' perception on the individual work packages will determine their corresponding mode of governance.

Secondly, although the research was designed to capture a wide range of governance modes within D&E, transitional forms because of the evolution of project tasks throughout the project lifecycle exist. Therefore, the evolution of work packages should be addressed by future research. Finally, the data collection method was focused on ex–post interpretations given by project managers. For that reason, the data do not reveal how the governance modes were actually implemented during the project. Thus, the data remain on an anecdotal level without significant support by secondary and tertiary data sources.

In conclusion, the continuation of this research should include more in-depth project-level longitudinal studies, possibly through participant observation, to reveal mechanisms that determine the governance in ongoing decision-making processes on projects. Future work should also complement this study by attending to a multilevel organizational analysis showing how the governance processes vary at different organizational levels to induce a richer theory than what is possible with a single level analysis. With respect to its focus, this study identified an intra-firm governance framework within the D&E process from the perspective of the contracting office. Future work should include a wider scope of perspectives, for instance, project stakeholders beyond the D&E core team. Finally, the development of further quantitative research is needed to provide additional evidence for the governance framework presented in this paper and to create a predictive model of the presented theory.

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References

Costantino, N., Pietroforte, R., and Hamill, P. (2001). "Subcontracting in commercial and residential construction: An empirical investigation." *Constr. Manage. Econ.*, 19(4), 439–447.

Díaz, M., Arruñada, B., and Fernández, A. (2000). "Causes of subcontracting: Evidence from panel data on construction firms." *J. Econ. Behav. Organ.*, 42(2), 167–187.

Eccles, R. (1981a). "Bureaucratic versus craft administration: The relationship of market structure to the construction firm." *Adm. Sci. Q.*, 26(3), 449–469.

Eccles, R. (1981b). "The quasifirm in the construction industry." *J. Econ. Behav. Organ.*, 2(4), 335–357.

Eriksson, P. (2008). "Procurement effects on coopetition in client-contractor relationships." *J. Constr. Eng. Manage.*, 134(2), 103–111.

Javernick-Will, A. N., and Scott, W. R. (2010). "Who needs to know what? Institutional knowledge and global projects." *J. Constr. Eng. Manage.*, 136(5), 546–557.

Javernick-Will, A. N., and Levitt, R. E. (2010). "Mobilizing institutional knowledge for international projects." *J. Constr. Eng. Manage.*, 136(4), 430–441.

Levitt, R. (2007). "CEM research for the next 50 years: Maximizing economic, environmental, and societal value of the built environment." *J. Constr. Eng. Manage.*, 133(9), 619–628.

Magent, C. S., Korkmaz, S., Klotz, L. E., and Riley, D. R. (2009). "A design process evaluation method for sustainable buildings." *Archit. Eng. Des. Manage.*, 5(1–2), 62–74.

Pietroforte, R. (1997). "Communication and governance in the building process." *Constr. Manage. Econ.*, 15(1), 71–82.

Puddicombe, M. S. (2009). "Why contracts: Evidence." *J. Constr. Eng. Manage.*, 135(8), 675–682.

Reve, T., and Levitt, R. E. (1984). "Organization and governance in construction." *Int. J. Proj. Manage.*, 2(1), 17–25.

Spradley, J. P. (1979). *The ethnographic interview*, Holt, Rinehart and Winston, New York.

Stinchcombe, A. (1959). "Bureaucratic and craft administration of production: A comparative study." *Adm. Sci. Q.*, 4(2), 168–187.

Strauss, A. L., and Corbin, J. M. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*, Sage Publications, Thousand Oaks, CA.

J. Constr. Eng. Manage. 2012.138:135-143.

Walker, A., and Kwong Wing, C. (1999). "The relationship between construction project management theory and transaction cost economics." *Eng. Constr. Archit. Manage.*, 6(2), 166–176.
Walker, G., and Weber, D. (1984). "A transaction cost approach to make-or-buy decisions." *Adm. Sci. Q.*, 29(3), 373–391.
Williamson, O. E. (1985). *The economic institutions of capitalism: Firms, markets, relational contracting*, Free, New York.
Williamson, O. E. (1996). *The mechanisms of governance*, Oxford Univ., New York.
Winch, G. (1989). "The construction firm and the construction project: A transaction cost approach." *Constr. Manage. Econ.*, 7(4), 331–345.
Winch, G. (2001). "Governing the project process: A conceptual framework." *Constr. Manage. Econ.*, 19(8), 799–808.
Yin, R. K. (2003). *Applications of case study research*, Sage Publications, Thousand Oaks, CA.

J. Constr. Eng. Manage. 2012.138:135-143.