# *Entrepreneurial innovation in the construction sector: overcoming process discontinuities in projects*

# Entrepreneurial innovation in the construction sector: overcoming process discontinuities in projects – who's in charge?

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## Introduction

The design and construction processes create a complex supply chain in the construction sector. Because of the complex, inter-firm networks, the supply chain is fragmented. This results in process discontinuities horizontally, as the project passes through stages of work from one group of actors to another. In addition, it involves process discontinuities vertically, as work of all kinds is sub-contracted, often in multiple layers (Hughes, Gray and Murdoch, 1997). This complex network of contracts is significant. It occurs not only because of the way that the process is usually organized but also because of the high level of risk attached to much of the work. Regardless of the type of contract, horizontal process discontinuities, accentuated by contractual obligations, are an inherent part of this network. These discontinuities have an impact on communications between stakeholders; specifically, communications that enable or inhibit innovation. Our focus is primarily on how these process discontinuities help or hinder the development and use of technological innovations in building, both as a process and as a product. There are several simultaneous reasons for the occurrence of these significant discontinuities in the process, making it a seriously difficult problem to resolve.

With a focus on technological innovations in the building process and the building product, the key innovators are contractors and specialist sub-contractors. To bring an innovative product to market in the construction sector, the innovator must overcome these discontinuities, especially in the horizontal dimension where different organizations are only responsible for part of a project that create discontinuities. The discontinuities between demand for the building, specification of the building and installation of materials, components or equipment seem to be of specific importance as inhibitors to getting innovative technology to the market. The general contractor plays a pivotal role in coordinating the construction tasks and realizing a building. However, the practice of sub-contracting most of the work results in construction firms with little need of capital assets; this results in a "hollowed-out firm" that does not own the means of production for the construction process (Green, Newcombe, Fernie and Weller, 2004). They are paid for work in progress, and pay their sub-contractors for work in progress, resulting in a cash flow business with few assets of its own. Indeed, Chiang and Cheng (2010) show that this leads to low barriers to entry for highly competitive firms with little access to finance, posing a major barrier to innovation. They conclude that this holds back industry development. These conventional structures result in tasks that are typically split into different firms through a network of contracts. The institutional infrastructure of professional roles, standard-form contracts and traditional

business models creates a lot of inertia and conservatism in the sector. The logic of contractors as hollowed-out firms is that actors that operate only within a specific task or within a specific phase of the project. The business model depends on the suppliers of technology being sub-contractors to cash-flow businesses with little in the way of assets, especially by comparison to the projects they build. The route to getting materials and components into a project involves contracts being set up with specifications of what is required before a supplier of technology is identified. This is both a horizontal and vertical discontinuity. It is horizontal because the specification is drafted at one stage and the installer identified at a later stage. It is vertical because the installer is (frequently) a sub-contractor to a contractor who was not involved in writing the specification. It might be said that it is difficult to conceive of a more effective way of *preventing* entrepreneurs with technological innovations from introducing their ideas in to the buildings they are contracted to contribute to. This phenomenon of the hollowed-out firm is an unintended consequence of the contemporary approach to construction contracting. It is the first obstruction to innovation.

The major horizontal discontinuity between design decisions and construction decisions has long been recognized in reports on the UK construction industry (Emmerson, 1962; Banwell, 1964; Latham, 1984; Egan 1988), which all commented on the discontinuity between the design and construction process. What is less obvious and, perhaps, more impactful, are the discontinuities at all the other stages in the overall process. The process runs from the need for development through to the operation of the completed facility. There may be discontinuities at every stage in this process, which could account for many of the issues that plague the construction sector and make it distinctly different from other industry sectors. For example, Hughes (1989), in four detailed case studies of the organization of UK public sector building projects, found that it was quite normal for a project to be in the capital planning stage for years until it becomes approved for expenditure, at which point, the entire project becomes the responsibility of others, with no further involvement from the capital planning team (and little access to all of the associated information and history about the funding decisions). These organizational characteristics of how projects progress from one stage to another form the second obstruction to innovation.

Discontinuities in the process may be further understood through the theoretical framing of transaction cost economics (TCE) (Williamson, 1979); i.e. the “make-or-buy” decision. TCE holds that such decisions will tend to be influenced by the differential costs of making vs buying, all other things being equal. We argue that, while this may lead to a more economical decision for the buyer, when the result is to contract out, a supplier then takes on the responsibility for procuring the goods or services and they, too, face a similar decision. In the construction sector, this often leads to the establishment of series of contracting-out decisions, each of which is a rational and economic decision for the buyer of the sub-transaction. In combination, these result in vertical discontinuities through multiple layers of sub-contracting and horizontal discontinuities through handing responsibility from one organization to another at successive stages. This combination of vertical and horizontal discontinuities is sub-optimal for the end user, who is far removed from the initiators of innovative, and even speculative, technologies. The successive, contracting-out decisions make it almost impossible for innovation to take place, if innovative entrepreneurs with ideas for new technological solutions are at the end of a long chain of sub-contracts. The need for suppliers of construction goods and services to maintain continuity of use for their resources is a third obstruction to innovation.

One reason for the success and longevity of this discontinuous process is because construction often involves major decisions about capital development, where the price of land is the larger part of the equation, compared to the price of construction. Some developers of real estate lease their property and, in common with end-users, often engage with long-term revenue and operational issues. However, many developers seek to sell the asset on completion. Thus, in many cases, the major decisions in development are driven by the optimization of transactions around capital acquisition. This favours a market structure that prevents optimization of transactions around operational acquisition through revenue. These two aspects of capital and revenue are familiar to anyone who is familiar with construction. TCE, alone, does not account for the economic issues that prevent the construction industry from improving productivity and technological innovation. A business model focus provides specific questions that help to expose how the different business models required for success of companies at each stage and layer of the process are fundamentally incongruent. It is this incongruence of business models that explains a widespread lack of construction industry development (see for example Pan and Goodier, 2012, addressing off-site construction take-up in relation to business models), and offers potential agendas for modernizing the industry. The role of construction in the development of real estate is a fourth obstruction to innovation.

The aim is to investigate how an innovative technology gets to the market and to examine how the multiple obstructions to innovation may be overcome in practice. Two theoretical bases are adopted; transaction cost economics (TCE) explains make-or-buy decisions at multiple tiers and business development (BD) explains how different companies in the process respond to the way that demand is put to them and how markets for products are developed. TCE provides the basis for modelling the contractual relationships which can be observed in and between a variety of construction firms. BD provides the empirical basis for interviewing one actor in Sweden, whose business is developed around the emergence of innovations and productivity improvements. We explore some key questions such as how the construction firm positions itself in the market; how clients put demand to the market; how markets are altered by innovators; and what entry points into the market are used by the innovator. These two theoretical framings help to deal with all four obstructions to technological innovation in construction.

## Horizontal discontinuity in the process

While vertical discontinuity through sub-contracting is well-known and virtually indispensable in construction contracting (see, for example, Hughes, Hillebrandt, Greenwood and Kwawu, 2006), less is written about horizontal discontinuity. Essentially, horizontal discontinuity is about the specific stages through which all projects must progress, involving hand-offs from one organization (or one part of an organization) to another, sometimes with overlaps and not always in the same sequence. These main stages approximate to:

- Developing: someone has some real estate to develop or acquire
- Funding: needed to pay for the development, perhaps also for the land
- Designing: figure out, define and document what is needed
- Managing construction: the construction work must be co-ordinated
- Installing: specialists install equipment and carry out construction work
- Servicing: such as heating, lighting, ventilation, etc.
- Operating: facility operation is not usually the remit of construction sector

The idea of horizontal discontinuity is that a different organization may be responsible for a part of a project at each of these stages. Some stages may be done in-house by certain types of organization but, even then, there are sometimes different parts of the organization responsible for carrying out the work. And, within this sequence of stages, there will, inevitably, be contracting out, i.e. vertical discontinuity, as the mix of specialized resources required is different in each project and, as stated earlier, it is uneconomic to keep them all in-house as they cannot be kept continuously busy because the variety and variance in the building projects.

At each stage, work is sub-contracted, and suppliers are enrolled into a project through a variety of contracting techniques. It is common to sub-contract and values up to 70% of the contract sum are not uncommon in housebuilding (Johnsson 2013); moreover, it makes sense to do so because of continuity of work. However, this involves putting the demand to the market such that parties may negotiate the terms of their contract (usually via competitive tendering) on assumptions about the kind of technology that will be eventually installed. This dominant approach to construction procurement is based on economic, organizational and business practices that unintentionally conspire to prevent innovative technologies getting to the market. Of course, in the construction management literature, these issues have long been recognized as significant. Because of this recognition, a variety of techniques have been developed in many countries for overcoming various kinds of discontinuity:

- Direct relationships with suppliers as in construction management procurement (see Hughes, Champion and Murdoch, 2015: 69-79)
- Integrated project delivery (Fischer, Ashcraft, Read and Khanzode, 2017)
- Integrated supply chains (Cox and Ireland 2002)
- Early contractor involvement (Gil, Tommelein and Ballard, 2004; Song, Mohamed and AbouRizk, 2009))
- Nominated sub-contracting, (Hughes *et al.* 1997; Hughes *et al.*, 2015, p. 81-92)
- Partnering (extra-contractual) and strategic alliances (Black, Akintoye and Fitzgerald, 2000)

One message that comes out clearly from the research cited in the list is that the most effective means of overcoming discontinuity is in creating a direct relationship between the client and the producer. Alternatively, it is about overcoming the problem caused by the lack of such a direct relationship through one or more of the integrating techniques listed above, some of which require resource and effort to bring them about. Something that is often not emphasized in the literature is that the client is not always the employer of contractor and the contractor is not always the producer of the technology. Thus, there will often be horizontal discontinuity between the end user and the supplier of a specific technology.

In many cases, the specification of the work to be done is contracted out to a design team. Typically, they are not part of the same organization as the contractor or sub-contractor. The client of the process may be an end user, unknown at the time of designing and producing the building. Even if the end user is in direct contract with the contractor, the work tends to be mostly sub-contracted to others, who sub-contract again and buy their materials and components from a network of builders' merchants. The merchants compete on selling catalogue items where the competitive advantage is price. The range of items is limited to reduce overheads and remain competitive. The sub-sub-contractor is not motivated or incentivized to buy anything but the cheapest product for installation, unless their contract

specifies precisely what they are to install, through one of the contractual techniques for overcoming the process discontinuity.

In some cases, particularly in sectors other than construction, rather than contracting-out the labour, a customer may just buy something in an instantaneous transaction. This transaction involves the supplier in all aspects of design, labour, manufacture and production. For this transaction to happen, the supplier must have been engaged in product development in the expectation of finding a customer, perhaps with this specific customer. A question that arises is, how could the buyer maximize the benefits of using innovative product development, before the event of establishing a contractual relationship? To illustrate this with an imaginary example. This example concerns the plight of an imaginary, specialist, engineering design company who has a new product that they wish to bring to market. To develop such a product, investment is needed. To find customers, requires contact with those responsible for making decisions in a project. If the designers and contractor are contracted to a client, the situation is difficult. The client has delegated decisions about what to build to the design team. The designers have professional indemnity insurance that precludes them specifying untried technologies, the contractor makes decisions about who to buy from based on their own supply chain and tendering processes. This leaves the innovative product designer with no route to market. So, how do innovative technologies in construction find their way to market in the light of the process discontinuities described so far?

The problem we confront is that the specification of specialist technical work often takes place at a point that is either too early or too late, caused by the horizontal discontinuities present in all projects and exacerbated by vertical discontinuities in the supply chain. This seems to preclude the technology provider from influencing the choices that are made about what to incorporate into a building. Technology providers are brought into a project via a contract and technology procurers must decide whether to make or buy each kind of technology that is to be incorporated. Thus, the opportunities for introducing innovative technology into buildings are compromized by both kinds of discontinuities in many or most projects. A key question is, therefore, how an innovative technology gets to market.

## Conceptual framework

### Transaction cost economics

The ideas for this research are, essentially, rooted in transaction cost economics (TCE). While this is not analytical basis of the research reported here, it provides a useful context for some of the key issues. A series of ideas are brought together in TCE.

- TCE analysis involves considering the cost of tendering vs costs of employment. All things being equal (ceteris paribus) the balance between these costs will dictate the choice that is made. In the construction sector, the difference between making and buying results in a serious inequality in the extent to which resources are kept fully occupied. Due to the diverse nature of buildings, the requirements for skills and materials are not consistent across projects. This makes life very inefficient for a main contractor who seeks to keep the resources in-house. Thus, they can successfully keep one trade in-house, such as concrete or steel, but no more than that. The flow of work must be regulated to keep that in-house resource fully occupied and the other resources are sub-contracted. The practice is so widespread at all stages and levels of construction that the result is a complex contractual network, or a “nexus of contracts”

(Reve and Levitt 1984). The involvement of different participants through contracts between businesses, rather than contracts of employment, only serves to exacerbate the discontinuities between organizational units.

- It is not claimed that firms make TCE calculations, but that "the invisible hand of the market" (as discussed in Thornton 2009) means that common business practices emerge because of natural self-interest and the market mechanisms of profits and prices (among other things). For example, firms who choose unwisely will be uncompetitive and inevitably become bankrupt. This is a compelling argument, but what if practices have become so entrenched, there is no competitive opposition to customary practices in the organization of projects?
- TCE analysis involves considering costs under a range of headings. Hughes *et al.* (2006) listed these as market costs (buyers and sellers searching for information about each other); contract preparation costs (specifying requirements, choosing suppliers, fixing a price); monitoring and supervision costs (ensuring that what is being produces matches the specification); and dispute resolution costs (dealing with non-conformances). These costs are extremely variable, difficult to capture and *very small in relation to production costs*. Therefore, it is not the costs of transactions that are significant, but the specificity of assets that creates the economic difference between make of buy decisions.
- The narrative around TCE also involves ideas of bounded rationality, opportunism, hold-ups and information asymmetry. It is held that these ideas may also account for why the make-or-buy decision is sometimes problematic but, for our purposes, they do not define the discontinuities; in the process, they merely compound them.

The construction sector seems to be characterized by a series of regular problems such as change orders, claims for extensions of time and for loss and/or expense. It may be misleading to characterize them as problems, since they are often a solution to a more profound problem, which, in its simplest sense, is the impossibility of predicting the future or creating certainty of information. Moreover, there are frequent problems brought about because of the discontinuities introduced into the construction process through sub-contracting. One key problem is that there is a time lag between creating the specification for construction work to be put to the market (tendering with general contractors) and carrying out the work of installation by sub-contractors. Worse, the sub-contractors who are installing complex equipment that requires detailed design and specification are faced with the difficulty of co-ordinating this information with the design team. Third, the responsibilities for deciding the specification of the building require decisions about what to build to be taken by a design team, the decisions about who is to install the equipment to be taken by the main contractor and the decisions about how to install it to be taken by the sub-contractor. Fourth, construction planning and cost planning are surely instrumental in managing projects to a predictable conclusion. However, the traditional focus in contracting requires a focus on time, cost and quality, apparently to the exclusion of overarching agendas, such as stakeholder management, health and safety law, environmental impact, and intermittent supply of resources. These other agendas often lead to the basic scope requirements being missed, since they impose inescapable obligations on contractors and other suppliers. Importantly, the responsibility for the means of production does not lie with the actors who are taking the decisions about design specification or sub-contractor selection. Given this, TCE provides some insights into how and why construction work is organized the way it is. Essentially, the problems caused by the necessary separation of work into different organizational units are heightened when each organizational unit is a different firm enrolled through a transaction. This sets up the complex nexus of contracts scoped on a small sub-set of the governance

issues in projects. Ultimately, it is this that presents the major co-ordination and control issues. A contractual, transaction-based focus, alone, does not provide a sufficiently rich picture for overcoming the lack of innovation and low productivity that we often see in construction. A fuller picture requires a broader focus, such as that offered by the business development literature.

**Business development in construction**

Parts of a business development framework provide additional insights for this work by offering a business model lens. The aspects of how business models explain the operation of the kind of firms considered in this work are:

- A business model conceptualization considers how actors define the market they operate in. At the centre of market position is value-creation for customers and customer satisfaction but also the ability to be a legitimate actor in the business and institutional networks in the market. Following (Brege, Stehn and Nord, 2014), market positions are related to customers; but, also, to the business network and the surrounding institutional network. Indicators for how market position is attained are the customer and market segmentation/specialization; and the role in the building process (or in generic term supply chain). From a client point-of-view the business model notion of 'offering' boils down to how clients present demand to the construction market.
- Salient business model literature (e.g. Zott and Amit, 2007) following Mintzberg's (1983) notations about fit and congruence, view the business model as the money-making logic and the 'blue-print' of how companies operate. Firms who do not consider the internal and external fit between the business model and the business environment (congruence) and between the business model elements and connections between the offering and market position to the source of funding for their work ultimately become uncompetitive.
- The contingency idea of a fit business model may also help to explain how firms define and organize their supply chains.

Construction businesses tend not to provide entire buildings to their customers, except in certain markets, such as housebuilding and commercial developments. There are many examples of so-called turnkey projects where the idea is that buyer finds a seller who will indeed provide everything (Lessing, Stehn and Ekholm, 2015). Most construction projects are not provided on a turnkey basis. The client has a make-or-buy decision that may be made at any point in the process, not simply at the first point of contact with the construction sector. Some clients carry out their own design; some co-ordinate their own construction sites; some provide and install their own specialist equipment, and some provide their own building services and operational aspects of the finished building. Some take on the responsibility for procuring stages of the process themselves, rather than asking a firm to take control of the whole process. Generally, large portions of the work are procured from the market, using suppliers who have developed an expertise in the relevant area. It is for the supply companies to consider what stages of the process they are providing and how they identify clients, secure contracts and set prices. This is what their business development activities entail. The point here is that it is difficult to make assumptions about how a project is being procured, even after a construction client has taken the procurement decision. Further, different types of firm in the process have distinct and different business models.

In summary, the TCE framework helps us to understand why the complex contract network occurs and the business model framework helps us to understand how each business operates within the contract network.

## Research question

The empirical question that arises from the discussion so far is about how an innovative construction technology gets to market, when multiple contractual interfaces exacerbate the discontinuities throughout the stages and layers of the process by setting up a focus on contractual deliverables rather than fulfilling client and end-user needs with the best possible solution. To put this more simply, what would the construction process look like if those discontinuities were removed? Would innovation become a regular part of such a process, as the discussion implies? Do horizontal and vertical integration involve different business models? Following contingency reasoning there is not one best way to organize (Woodward 1965), so what happens in different forms of organization? Under what circumstances can an innovative product be introduced into the design and construction processes? What kind of processes exist and are they amenable to the introduction of new products?

Again, TCE provides an interesting insight into the operation of markets when work is contracted out, as discussed in Hughes *et al.* (2006: 16-20). To re-cap: for a buyer to approach the market, they need to carry out the work of ascertaining what is available to buy in the market. On the other hand, the seller needs to put information out into the market for buyers to discover. Second, there are costs associated with the task of negotiating the deal, specifying the work, choosing the supplier (perhaps through competition) and settling the terms of the contract. Third, the work must be monitored by the buyer to ensure that it conforms with the specifications. Finally, there are dispute resolution costs. The latter are not relevant in this paper. The point of the TCE argument is that it helps in identifying how the market operates. It raises interesting questions about how buyers find sellers and sellers find buyers. In many markets this is straightforward but, in the construction supply chain, there are added complexities. The processes that are described in TCE provide the context for the business models of those firms operating in the construction sector. TCE is about the transactional interfaces in the market; business models are about how a firm within the market operates.

Much of the literature on TCE focuses on interfaces around a single organization (e.g., Williamson 1979). Similarly, much of the literature on Business Models focuses on how a single business organizes itself in relation to a market (Osterwalder, Pigneur and Tucci, 2005; Zott and Amit, 2007). From a production point-of view, what defines construction is the project-based type of production where the key points about construction work are that:

- Construction tends to be a production factor for its customers;
- The organization of construction is about the relationships between temporary and complex network of firms (the temporary multi-organization discussed by Cherns and Bryant 1984), held together with a network of contracts (Hughes *et al.* 2015), that creates complex interdependencies between organizations often lacking a single authoritative actor putting demands for or allowing for innovations … (Harty, 2008: 1032);
- The process occupies significant periods of time, which makes it difficult to predict the outcome;
- The inputs and outputs of construction represent significant proportions of the annual turnover of buyers and sellers. This means, potentially, that every project, every

transaction for some parties, has the possibility of threatening the business survival of every participant.

To investigate the questions effectively, it is useful to reduce the variables. The empirical work for this research will focus on discovering and describing the business model and innovative tendencies for one case study company in a specific market. As an example, we focus on a Swedish housebuilding firm with an unconventional form of organization. Using the three-element business model construct of Brege *et al.* (2014), we sought empirical data on:

- The offering: Market into which they are selling, price determination and revenue/capital mix;
- Market position: Supply chain relationships and contractual interfaces;
- Operational platform: Forms of organization.

These elements are interconnected in the business model approach. The empirical questions are around whether certain combinations of these business model elements are associated with the emergence of innovations in the case study firm.

**Empirical questions**

Leaning on the TCE and BD frameworks lead to a series of practical questions. In examining the activities of a firm in the construction sector, these questions evolve into an analytical framework. The purpose is to examine the way that this construction firm defines its market(s). We want to understand how they position themselves and what kind of supply chains they set up. By investigating a range of projects in the firm, the aim is to identify the points at which the client approaches the construction firm. Thus, the questions that provided direction for the case study were:

1. How does the construction firm strategize and position itself in the market?

- For each market, how do they find buyers?
- To what extent does each market involve sub-contracting?
- How does the firm introduce its own productivity-enhancing innovations in the supply chain, in each market it operates in?

2. How do clients present demand in this specific construction market?
3. What are the processes of market-making, marketing and business development?

## Empirical case

The selection of the case study company involved identifying a firm in Sweden, whose business is developed around improved productivity and technological innovation. Data collection is a combination of secondary data published by the company in relation to how they see their own market position and interviews with directors of the firms to clarify and augment this information and ascertaining the details of specific innovation introduction incidents. Transcribed interview data was examined for specific innovations that result from how the firm positions itself in the market, especially in relation to entry points for innovative solutions.

The focus of the interviews has, therefore, more to do with barriers and enablers in the organization of the process (horizontal discontinuity) and the supply-chain fragmentation (vertical discontinuity) than to do with the definition of the innovation *per se*. We argue that, to bring an innovative product to the market, the innovator must overcome these discontinuities. Successive contracting-out decisions may make it almost impossible for innovation to take place, such that innovation and productivity rely on a series of interconnected (and, potentially, incompatible) business models, potentially different for each firm in the supply chain. By selecting a firm that seems to operate without these discontinuities, the arguments in this paper would lead us to expect to see easier paths for innovation.

**The case of Lindbäcks Bygg**

Lindbäcks Bygg is a family-owned business. The original business, in the first generation (from 1924) of Lindbäcks, was a small sawmill. The emerging contracting business was separated from the sawmilling business in 1948 and in 1964 Lindbäcks Bygg was formed and worked as a local construction company. In 1982 they developed a planar-wooden-elements method of construction. In 1992, during in the Swedish Big Recession, Lindbäcks Bygg decided to move most of their on-site work inside a factory and then transport completed units to the building site. Lindbäcks Bygg constructs multi-storey dwellings in timber and the first project was built in 1994. About 11,000 units have been built, to date. A substantial part of the engineering work and assembly work on-site are made by their own personnel. Depending on the geographical market, Lindbäcks' own personnel do all the assembly work on site; in other geographical market about 70% of the assembly work may be sub-contracted. However, the proportion of their own work (assembly and design/engineering) is steadily increasing. But exact figures are not known. In 1994, everything was built for their own real-estate company. Nowadays, about 70% of the production output is sold as projects, preferably under long-term partnerships and as a main contractor, and about 30% to their own real-estate company, where the real-estate company deal directly with the end-users.

Lindbäcks Bygg concentrates it total business around a series of technological and process innovations collected into their building system platform. At the centre of the technology and productivity-driven platform are the volumetric elements. The volumetric elements consist of wall, floor, and ceiling elements assembled into a closed three-dimensional structure and various support systems. The volumetric elements are as complete as possible, including interior finishing, before being transported to the construction site. Every house is unique for each developer/contractor, but the platform is always the same. Substantial improvements to refine the platform in both specific methods employed as component and technical developments have taken place over the years. Based on a working method for experience feedback, the gradual refinement of the platform has been concentrated on, supporting IT-systems and investments in automation of the production lines and business development forming subsidiary specialized products companies (for bathroom pods, balconies etc.).

The market-restraining factor is the need to convince real-estate owners (other than themselves) to buy houses in this way. The traditional house in Sweden still tends to be a concrete house based on the developer/contractor specifications. Lindbäcks have to get into contract with a developer/contractor very early in the development processes, so that their requirements (thermal performance, balconies, height of building etc.) can be met by Lindbäcks' platform requirements. The game-changer, or key selling point (much dependent on the developer/contractor's choice of façade), is the payment method. The customer pays

90% of the settled price when Lindbäcks starts the assembly process on the building site. The remaining 10% is paid when tenants start moving in. The customer needs only a very short-term building loan to finance the construction part of the project, usually only 4-5 months. (the time on site is dependent on the choice of the type of façade). Since most of the work (about 75%) includes all resources put into the pre-work (winning projects, pre-design and the substantial part of pre-manufacturing in the factory) Lindbäcks have a bank guarantee to protect themselves against non-payment in case of the customer, for example, becoming insolvent.

**Analysis of Lindbäcks Bygg**

Lindbäcks Bygg have all but eliminated the horizontal and vertical discontinuities between stages and layers of the process of work that typifies the construction process; especially when they are suppliers to their own real estate business. This means that finding a customer and securing funding for a development is in their own hands. Thus, they control the demand for the products. By developing the off-site, volumetric-wooden-elements method of construction, they bring the fundamentals of the design and specification process in-house, removing the traditional horizontal discontinuity between responsibility for design and responsibility for construction. By making fully-finished volumetric units in their factory, they have complete control over the installation of the technological equipment in the completed buildings. This control of the means of production has also removed barriers for innovative product development, whether by themselves or by other suppliers/installers. By subcontracting specialist products to subsidiary specialized companies (for example, for whole bathroom pods), they control the specification and quality of the more complex technological aspects of the house. And by operating as a landlord, they are dealing directly with the final consumer of the product, i.e. the tenant. This provides them with direct feedback on the performance of their buildings. This results in an integrated process with very few contractual interfaces, limited to interfaces with subsidiary companies. As a single integrated company that owns, and takes responsibility for, its entire supply chain, one way or another, dealing directly with end-users, Lindbäcks Bygg represents an archetype for the idea of completely removing discontinuities in the processes that surround construction and development. Thus, they have opportunities for technological innovation that are more far-reaching than those available to most construction companies, particularly in the area of production engineering.

## Discussion

The case displays interesting empirical evidence of effects of short-circuiting the omnipresent discontinuities in construction. The case shows that innovative solutions and developments of productivity improvements could be brought to the market. The off-site volumetric and development of complete building solutions was developed through a long-term series of entrepreneurial product and process innovations that created a direct link between the client and the producer. Through an integrated business model, Lindbäcks is acting as the client, technology provider and contractor. Lindbäcks Bygg clearly have a strategy to not only remove horizontal discontinuities between stages in the work but also the vertical discontinuities by removing most layers of sub-contracting. With the business development lens, it is clear we could see how Lindbäcks Bygg defined the market they operate in. They have created a business model that includes control of the stages and layers in the process, thereby putting themselves in control of the demand for the product through their control of the means of production. Control of the means of production, in this house- building sense,

implies not only control of the stages of developing, funding, designing, managing construction and installing but also implementing technology innovations *per se*, e.g. the volumetric construction method or the building system platform. In other words, the Lindbäcks entrepreneurial innovation is their success at removing the horizontal and vertical discontinuities by creating an integrated supply chain, becoming suppliers to their own real estate business and making the decisions regarding design specifications and installations. In this way, they have used integration of the process as a purposeful integrating mechanism.

Taking responsibility for all of the processes involved in a construction project, including the competing priorities between management control systems. One way to achieve a single point of governance and responsibility is the way that Lindbäcks Bygg have achieved it, but it is not the only way. Indeed, there are many construction sub-sectors where this could not work. But in those sectors, some of the other techniques for actively overcoming the process discontinuities are needed. It is not sufficiently clear from the research literature that the need for these techniques is more than just a slight increase in productivity or the continuation of long-term business relationships for their own sake. Indeed, it is the most imperative problem in the modern construction sector; someone has to have a role of governance and be in command of the decision-making processes, especially in relation to management control systems. It is this governance that it the key to successful completion of projects, whether innovative or not, and whether in-house, like Lindbäcks Bygg, or not.

## Conclusions

Specifications required for contracts are often written before the technology installer is known. They focus on a limited range of criteria for success, which limits the opportunity for contracted suppliers to innovate in their process or their product. The technology installer is often restricted to providing something that has already been specified. The economics of construction tend to make sub-contracting inevitable. The independence of the design function prevents specifiers from engaging in dialogue with those who own the means of production. Because of this, contractors are generally not adding value, or they are disabling innovation, or they are preventing improvements in productivity.

The case study shows a different approach for overcoming the conventional contractual boundaries in the development and supply of buildings. They are bringing highly innovative solutions to market and claim to make great productivity improvements. Full-scale off-site fabrication offers an opportunity to make this more like a manufacturing business than a traditional construction business. Vertical and horizontal integration open up the option of focusing on satisfying customer needs and requirements with every resource of the organization, rather than focusing on fulfilling narrowly defined contractual obligations.

Our example shows how the perennial construction problems have been overcome in practice. Indeed, several techniques have emerged to overcome discontinuities in the process. This shows one route to enabling more effective dialogue between producers and buyers. But this requires much more sophistication than a mere contract. While much of this is self-evident to practitioners, we hope that this paper provides a useful rationale about why their instincts for collaborative working practices seem to be effective.

## References


Banwell, H. (Chmn) (1964) *The placing and management of contracts for building and civil engineering work*. London: HMSO.

Black, C., Akintoye, A. and Fitzgerald, E., (2000) 'An analysis of success factors and benefits of partnering in construction', *International Journal of Project Management*, 18(6), 423-434.

Cherns, A.B. and Bryant, D.T. (1984) 'Studying the client's role in construction management. *Construction Management and Economics*, 2(2), 177-84.

Brege S., Stehn L. and Nord T. (2014) 'Business models in industrialized building of multi-story houses', *Construction Management and Economics*, 32(1-2), 208-226.

Chiang, Y-H. and Cheng, E.W.L. (2010) 'Construction loans and industry development: the case of Hong Kong', *Construction Management and Economics*, 28(09), 959-69.

Cox, A. and Ireland, P. (2002) 'Managing construction supply chains: the common-sense approach', *Engineering, Construction and Architectural Management*, 9(5/6), 409-418.

Egan, J. (1998) *Rethinking construction: the report of the Construction Task Force to the Deputy Prime Minister, John Prescott, on the scope for improving the quality and efficiency of UK construction*, London: Department of the Environment, Transport and the Regions Construction Task Force.

Emmerson, H. (1962) *Studies of problems before the construction industries*. London: HMSO.

Fischer, M., Ashcraft, H.W., Read, D. and Khanzode, A. (2017) *Integrating project delivery*. Hoboken, NJ: Wiley-Blackwell.

Gil, N., Tommelein, I.D. and Ballard, G. (2004) Theoretical comparison of alternative delivery systems for projects in unpredictable environments. *Construction Management and Economics*, 22(05), 495-508.

Green, S.D., Newcombe, R., Fernie, S. and Weller, S. (2004) *Learning across business sectors: Knowledge sharing between aerospace and construction*. Reading: University of Reading.

Harty, C. (2008) 'Implementing innovation in construction: contexts, relative boundedness and actor-network theory', *Construction Management and Economics*, 26(10), 1029-41.

Hughes, W.P. (1989) *Organizational analysis of building projects*, unpublished PhD thesis, Liverpool: Department of Surveying, Liverpool Polytechnic.

Hughes, W.P., Champion, R and Murdoch, J.R. (2015) *Construction contracts: law and management*, 5th ed. London: Taylor & Francis.

Hughes, W.P., Gray, C. and Murdoch, J.R. (1997) *Specialist trade contracting: report*. London: CIRIA Publications.

Hughes, W.P., Hillebrandt, P.M., Greenwood, D.G. and Kwawu, W.E.K. (2006) *Procurement in the construction industry: the impact and cost of alternative market and supply processes*. London: Taylor & Francis.

Johnsson, H. (2013) 'Production strategies for pre-engineering in house-building: exploring product development platforms', *Construction Management and Economics*, 31(09), 941-58.

Latham, M. (1994) *Constructing the team: final report of the government/industry review of procurement and contractual arrangements in the UK construction industry*, London: HMSO.

Lessing J., Stehn L., and Ekholm, A. (2015) 'Industrialised house-building: development and conceptual orientation of the field', *Construction Innovation*, 15(3), 378-399.

Mintzberg, H. (1983) *Structure in fives: designing effective organizations*, Englewood Cliffs, NJ: Prentice Hall.

Osterwalder, A., Pigneur, Y. and Tucci, C.L. (2005) 'Clarifying business models: origins, present, and future of the concept', *Communications of the Association for Information Systems*, 16(1), 1-25.

Pan, W. and Goodier, C., (2012) 'House-building business models and off-site construction take-up', *Journal of Architectural Engineering*, 18(2), 84-93.

Reve, T. and Levitt, R.E. (1984) 'Organization and governance in construction', *International Journal of Project Management*, 2(1), 17-25.

Song, L., Mohamed, Y. and AbouRizk, S.M. (2009) 'Early contractor involvement in design and its impact on construction schedule performance', *Journal of Management in Engineering*, 25(1), 12-20.

Thornton, M. (2009) 'Cantillon and the invisible hand'. *The Quarterly Journal of Austrian Economics*, 12(2), 27-46.

Williamson, O.E. (1979) 'Transaction cost economics: the governance of contractual relations'. *Journal of Law and Economics*, 22, 233-61.

Woodward, J. (1965) *Industrial organization: theory and practice*. London: Oxford University Press.

Zott, C. and Amit, R. (2007) 'Business model design and the performance of entrepreneurial firms', *Organization Science*, 18(2), 181-199.