Infrastructure BUsiness models, valuation and Innovation for Local Delivery
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Infrastructure Business Models (IBM) Working Paper

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Summary

The main purpose of this note is to develop a practical definition for an infrastructure business model that:

1. provides a shared working definition of the term 'infrastructure business model' for use within the iBUILD programme as a starting point for future discussions;
2. is consistent with standard uses of the term business model;
3. provides sufficient breadth and flexibility that a multi-disciplinary team are comfortable with it; and,
4. importantly in the context of iBUILD, does not only not constrain our imagination but provides flexibility to stimulate the development of new infrastructure business models.

As our research in this area develops, particularly in the light of applied case studies, we anticipate that this definition may be revised and refined.

Introduction

Theorising firms and organizations is fundamental to understanding how economies and societies function and evolve in a dynamic global economic environment. The organisation of economic activities, from firms that manufacture products or produce services to producers and managers of all types of infrastructure, is at the very heart of modern-day life. There is an infinite and ever changing variety of organisations – from transnational to small firms, branch plants and corporations, sole proprietors and partnerships, not-for-profit organisations and state-owned enterprises and public bodies. The firm or organisation is often considered to be a repository of jobs as well as creators and destroyers of jobs. Organisations are basic building blocks within society, but they are difficult to define. This difficulty is complicated by the continual emergence of new organisational forms in response to technological developments and new forms of competitiveness. The complexity of organisational forms has meant that the academic literature on organisations suffers from a lack of definitional precision. This epistemological problem, however, has not prevented social scientists from exploring the contribution organisations make to enhancing society.

The theory of the firm has its origins in the work of the French philosopher and mathematician Cournot (Cournot and Fisher ([1838] 2012). To Cournot firms were intended to maximise profit but subject to constraints imposed by existing technology and the requirements of market demand. This emphasis on profit maximisation obscures other motivations behind the organisation of firms (Elkington, 1997) and also ignores the role time plays in the creation of profit. Public bodies may be less interested in profit maximisation and more concerned with enhancing social welfare. Organisations may be managed to obtain rapid returns on deployed capital but management may also focus on investing in assets that produce returns over a long time period. A standard approach to conceptualising organizations emerged in economics during the twentieth century. In this approach organisations are described by their

'production function' which is defined as ". . . the technical relationship telling the maximum amount of output capable of being produced by each and every set of specified inputs (or factors of production)" (Samuelson, 1970: 516). This definition emphasises the importance of prices in understanding organisations and underplays the role placed by social relations, trust and contractual relationships. The production function definition of organisations has been criticised for its failure to understand the culture and politics of organisations and for ignoring the internal structure of firms (Taylor and Oinas, 2006). This approach to understanding organisations fails to appreciate the different motivations that lie behind organisational behaviour and also the complexity of organisational forms.

In a well-known statement Alfred Marshall noted that economists must not only define firms on the basis of three factors of production – land, labour and capital – but also include a fourth factor – organisation (Marshall [1921], 1960: 1: 138-139). The organisation of the economy includes many different forms of firm with each having different forms of internal structure and relationship with external organisations. Behavioural approaches to understanding firms developed to supplement conventional economic approaches and highlighted the internal decision-making processes of firms (Cyert and March, 1963). In this approach, organisations are conceptualised as sites of decision-making in the face of continual uncertainty, complication and uncertainty.

The literature on the theory of the firm is complex and multi-facetted with different approaches emphasising different aspects of firm behaviour. Firms are economic, social, cultural, political and legal entities that are created to achieve a defined objective (Elkington, 1997). Nevertheless, a firm is also a contested site of internal conflict with individuals trying to shape and influence activities, motivations and strategy. Central to an organisation should be a concern with creating value through satisfying customer needs. Value may reflect a narrow focus on profit, but organisations may be managed to create social and environmental returns. Value creation requires a robust and carefully developed, but flexible business model that is based on a narrative (Martin, 1982; Wilkins, 1983; Morgan, 2006) intended to meet customer expectations (Bryson et al., 2004). The development of the business model construct (Magretta, 2002; Teece, 2010; Zott and Amit, 2010; Baden-Fuller and Haefliger, 2013; Boons and Lüdeke-Freund, 2013) has shifted the definition of firms away from a preoccupation with accountancy and finance towards an approach that acknowledges that firms require a narrative combined with a financial model. The business model construct can be defined as an approach to understanding firms that combines a narrative or story with a value creation model. There are many different business models and new business model are constantly being created. New firms must select and develop a business model (Morris *et al.,* 2005) and existing firms must continually modify their model to meet alterations in market conditions.

The 2008 financial crisis is associated with the rise of austerity in the delivery of public services. This has led to innovations in the financing and management of public services and all types of infrastructure. New innovative business models are being developed to finance infrastructure capital projects that involve new partnerships between the private, third and public sectors. Infrastructure is a very special asset class (Sawant, 2010) that requires the development of business models that can cope with major upfront capital investments combined with long-term revenue streams. The demand for infrastructure investment continues to grow as developed market economies repair and replace aging infrastructure assets and invest in new infrastructure. Traditionally, Governments financed public infrastructure though taxation, but austerity politics had meant that the private sector has a new role to play in financing and maintaining infrastructure. The literature on business models has focussed on business models and technology (Baden-Fuller and Haefliger, 2013) or sustainable innovation (Boons and Lüdeke-Freund, 2013). Much of the focus of this literature has been on Internet and hi-technology companies (Teece, 2010) and

companies that make or sell consumer goods and services. This is a literature about companies that are using existing major capital infrastructure investments to deliver new services including e-commerce. The focus has been on the users of infrastructure rather than on the creators, funders and managers of such infrastructure.

In this paper, the business model construct is explored to take into consideration the special characteristics of infrastructure assets. The paper aims to develop a definition of infrastructure business models. Moreover, an analytical framework is created to better understand and explain the business models being constructed and utilized by agents involved in the delivery of infrastructure items, systems and services. The intention is to identify and understand the complexity of inputs and building blocks that support the development of infrastructure business models and the relationship between them.

Business Models – A Narrative Combined with a Financial Model

The term 'business model' describes the ways in which a firm engages in business activities (Chesbrough and Rosenbloom, 2010) or describes the processes by which firms try to create value (Wirtz, 2011). To Teece "the concept of a business model lacks theoretical grounding in economics or in business studies. Quite simply there is no established place in economic theory for business models" (2010: 175). This difficulty reflects the focus in economics and business studies on price. Similarly, Zott *et al*. (2011) note that there is no widely expected language to examine business models and that there is a diverse set of business model definitions (Table 1). The term business model is used in four ways in the literature. First, in many instances the concept is used to frame an empirical analysis without being defined (Zott *et al*., 2011). Second, business models are often directly related to firms that typify a particular type of approach to business – the Apple business model compared to the Samsung model (Baden-Fuller and Morgan, 2010: 157). Third, there are scholars who relate the business model concept to debates over strategy informed by the adoption of new technology (Zott and Amit, 2008). Fourth, a more recent approach is to adopt the construct to develop a comparative approach to understanding business behaviour and performance (Teece, 2010; Baden-Fuller and Morgan, 2010).

The business model construct is ambiguous and imprecise and this imprecision reflects the origins of the concept. The term 'business model' was first used in an article published in 1957 that developed a business simulation game designed for executive training (Bellman *et al*., 1957). The focus was on modelling business. In 1960, the first academic paper that used the term in both the title and abstract was published and this provided an account of business models in the context of information systems (Jones, 1960). Much of the early literature on business models developed accounts of business modelling. It is only in the 1990s with the emergence of e-commerce and the dot-com boom that the term gained wider applicability (Teece, 2010; Zott *et al.,* 2011). From the 1990s, the term 'business model' has been used to describe innovative ways of practicing or doing business with an emphasis on information communication technologies, the Internet and e-commerce.

Table 1. Definitions of Business Models

Reference	Definition
International Integrated Reporting Council, 2013	Business model: The organisation's chosen system of inputs, business activities, outputs and outcomes that aims to create value over the short, medium and long term
Teece, 2010	"… a business model embodies nothing less than the organizational and financial 'architecture' of a business".
Jonhson et al.,2008	"consist of four interlocking elements, that, taken together, create and deliver value" (p.52). These are: customer value proposition, profit formula, key resources and key processes.
Morris *et al.,* 2005	"concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets" (p.727).[…] It has six fundamental components: Value proposition, customer, internal processes/competencies, external positioning, economic model, and personal/investor factors.
Chesbrough & Rosenbloom, 2002	"the heuristic logic that connects technical potential with the realization of economic value"
Margretta, 2002	Business models are "stories that explain how enterprises work. A good business model answers Peter Drucker's age old question every manager must ask: How do we make money in this business? What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?"
Amit & Zott, 2001	" the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities"
Weill et al. (2005)	"consisting of two elements: (a) what the business does, and (b) how the business makes money doing these things." Weill et al. (2005) review 1000 US firms and propose a typology that identifies 16 classes of business models "based on two fundamental dimensions of what a business does. The first dimension—what types of rights are being sold—gives rise to four basic business models: Creator, Distributor, Landlord, and Broker. The second dimension—what type of assets are involved—distinguishes among four important asset types: physical, financial, intangible, and human."
Timmers, 1998	"an architecture of the product, service and information flows, including a description of the various business actors and their roles; a description of the potential benefits for the various business actors; a description of the sources of revenues"

A business model contains many different elements, these include: governance, a set of products and services, the resources and capabilities of a firm, the organisation of a firm and its activities, the revenue generation model, the investment model, customer engagement, value delivery, target market segments and monetisation or the value proposition that is provided or offered to customers, the firm's network with external organisations that support value creation and the organisation's strategy including motivations. It should not be assumed that profit is the central motivation behind the activities of all firms. Many firms are satisfiers and are not driven by a desire to grow; a firm may also blend a search to create profit with other forms of value.

A recent review of the academic literature on business models, supplemented by an analysis of 500 business models, identified five approaches to using the business model concept (International Integrated Reporting Council, 2013: 4):

Organizational Overview: The term business model in these accounts describes what an organisation does, how it is structured and governed and also its organisational geography.

Business Strategy: The emphasis is on identifying and understanding critical aspects of a firm's strategy.

Value Chain: The analysis highlights a firm's proposition and role within value chains and includes a focus on various forms of dependency.

Financial Performance: An analysis of the relationship between a firm's business models, revenue generation and profitability.

Value Creation: The focus is on understanding the relationship between a firm's inputs (land, labour, raw materials, finance and organisation), value creation and other required impacts or outcomes.

This review developed a broad and inclusive definition of the term that is applicable across industries and sectors: 'Business model: The organisation's chosen system of inputs, business activities, outputs and outcomes that aims to create value over the short, medium and long term' (International Integrated Reporting Council, 2013: 6, bold in the original). Most of the literature that uses the concept of a business models applies it at the level of the firm, but the concept may also be used beyond the boundaries of a firm to explore inter-organisational relationships or production chains or networks that create value (Zott and Amit, 2008).

Whilst having no theoretical grounding in economics or even in organisational and strategic studies and marketing (Teece, 2010) the construct of a business model provides a conceptual tool to explore the emergence of new organisational forms designed to capture value from customers by combining new financial models and value capture frameworks with new ways of using technology and marketing. A business model can never be static, but must evolve to meet alterations in demand and new forms of competition. This involves a process of continual innovation in which firms try to develop an approach to capturing value from customers that may be difficult to copy. The business model construct has six advantages:

1. It combines a narrative or story of doing business with a financial model. This encourages academics, practitioners and policy-makers to consider the complexity and variety of approaches to value capture in an era of ever increasing competition.
2. The construct may be used to undertake a comparative analysis of different business models intended to deliver similar products and service to clients, but with different narratives and forms of monetization. This highlights the importance of understanding differences in the processes and strategies that lead to value creation.
3. Exemplar case studies of new business models can be developed and used to understand alterations in the interplay between new or emergent narratives and financial models.

4. The business model construct can be applied at the level of the firm, but also within firms. Many firms will include different business models reflecting different forms of demand and market conditions.
5. The business model approach highlights the different forms of value (financial, social and environmental) that may be created by a firm.
6. Unusual and inimitable business models have emerged, but business models are also models or simple recipes that can act as learning tools for practitioners and policy-makers (Baden-Fuller and Morgan, 2010: 165).

An important advantage of the business model construct is that it enables academics to explore models that have been developed to meet the needs of particular industrial sectors. The development of a taxonomy of business models is challenging given the varieties of approaches to business that exist. In the next section, the characteristics of infrastructure are explored and a definition of infrastructure business models formulated.

Why infrastructure is different

There are a number of distinctive characteristics of infrastructure systems that, we argue, make them ill-suited to the business models definitions and frameworks that have been proposed to date. Moreover, if we are to develop innovative business models it is crucial that our definition of an infrastructure business model captures the full infrastructure system and does not just focus on infrastructure as an asset class.

Infrastructure life cycle: Infrastructure has a complex life cycle that covers: design, material extraction and processing, construction, finance, operation, use, maintenance, modification, decommissioning or upcycling. Each phase may require a different business model.

Long term legacy and 'lock-in': Many infrastructure assets are typically long-lived. Sewers installed in London in the 1850s are still in operation today. However, the legacy of infrastructure decisions is often more complex. When an asset is repaired or replaced the original spatial form is maintained for cost purposes (e.g. the foundations are already present) or because land use changes around the infrastructure constraining other options (e.g. resident and commercial development alongside transport corridors). Even more radical shifts can be influenced by original choices – for example in Los Angeles many of the freeways still follow the routes of the, long since dismantled, railways. A choice of a particular technology may require compatibility across the whole infrastructure system – this can lead to a path dependency which reduces opportunities to exploit alternative technologies in the future.

Necessity of service: Users typically depend on infrastructure services, and once a particular services 'takes hold' it can lead to radical shifts in user behaviour as they discover new ways to use it to their benefit.

Public sector involvement: The government are often highly proximate to infrastructure transactions. This may be via direct funding, or obtaining loans at preferential government rates. Even if the public sector does not fund the infrastructure directly, it can play a role in regulation or underwriting risks (e.g. providing a minimum return guarantee).

Natural monopolies and exclusivity: The economies of scale can benefit from monopolistic provision of services. Often this is deliberate, with the intention to avoid wasteful use of resources (e.g. duplication of systems), to ensure universal coverage of a service (e.g. water supply) and to ensure the service provider has a secure customer base. Ehrhardt and Burdon (1999) provide a detailed consideration of the relative advantages and disadvantages of monopoly models.

Financial profile: Infrastructure is typically capital intensive, with high upfront costs and periodic maintenance that can also be costly to ensure continued service (e.g. the Forth Bridge was recently

repainted, with an expected life of 25-40 years, at a cost of £130m). There are risks associated with these types of long-term investment related to obsolescence and alterations in consumer behaviour that reduce expected revenue streams.

Complex value: Many infrastructures provide a direct and tangible economic return, however they also have wider indirect economic as well as social and environmental implications. An infrastructure business model must recognise this multiplicity of values and seek to capture benefits across all dimensions of value. In particular, innovative business models must seek to capture the value of infrastructure that does not provide direct economic returns – for example, there is plenty of evidence that green infrastructure in cities provides a number of benefits including flood management, cooling during heatwaves, increased population health etc. but no clear direct mechanism for a direct income stream for green space providers.

Multiple stakeholders and agents: The number of stakeholders with an interest in infrastructure, and the nature of this interest, is considerable. These relationships and associated business models will vary over the infrastructure life cycle.

Public good: Many infrastructure systems, such as street lighting or flood defences, are often both non-excludable and non-rivalrous in that individuals cannot be effectively excluded from use and where use by one individual does not reduce availability to others.

Many of the above factors are orthogonal - throughout the infrastructure lifecycle, different agents will seek to maximise different values at each phase. Rather than considering a single business model for an infrastructure system, it is important to recognise there will be a multiplicity of, often interacting, business models.

A definition of an infrastructure business model

Drawing from the above, we propose a definition of infrastructure business models that is consistent with the International Integrated Reporting Council (2013) definition of a business model: *"The organisation's chosen system of inputs, business activities, outputs and outcomes that aims to create value over the short, medium and long term"* and the iBUILD (Dawson, 2013) definition of infrastructure to include: *"the artefacts and processes of the inter-related systems that enable the movement of resources in order to provide the services that mediate (and ideally enhance) security, health, economic growth and quality of life at a range of scales."*

Thus an infrastructure business model is: *"The system of physical artefacts, agents, inputs, activities and outcomes that aim to create, deliver and capture economic, social and environmental values over the whole infrastructure life cycle."*

Infrastructure business models: an analytical framework

Having defined what we mean in using the term infrastructure business models above, our next step is to begin to elaborate an analytical framework. This task is central to our aim of better understanding and explaining the business models being constructed and utilized by agents to deliver infrastructure items, systems and services especially at the local, regional and urban levels in an international context.

The framework aims to fill the gap in our conceptual and analytical tools between two distinct levels. First, existing approaches within the business models literature tend to sit at a macro-level. As discussed above, much of the business models literature operates at a relatively high level of abstraction and offers generalized frameworks concerned with – *inter alia* – issues of value creation, delivery and capture (for example, Teece, 2010; Zott and Amit, 2008). In addition, this work is primarily focused on goods and

services in commercial markets (for example Teece, 2010; Zott *et al*., 2011). With some notable exceptions (for example, Andrieu, 2007), it does not engage with the particular and changing nature of infrastructure and its distinctive attributes, which are described above. While generating helpful insights, this macro-level approach remains somewhat removed and under-developed for the job of interpreting new and emergent approaches, tools, models and practices for the business of infrastructure provision in different national contexts.

Second, many existing empirical studies of infrastructure are focused on the micro-level. A body of research has built up from studies of the provision of specific infrastructure types such as airports, energy, ports, rail, roads and water (Allen and Pryke 2013, Marshall 2013). This work demonstrates diversity and variety in the ways in which different kinds of infrastructure are being provided in different national contexts. It spells out the particularity, complexity and even uniqueness evident in cases of individual projects or systems. This micro-level approach has provided a rich knowledge base. But on its own it offers only some disparate and fragmented clues on the common and more generalizable features of a framework capable of interpreting and explaining more than these particular and often individual cases.

To address the gap between the macro- and the micro-level analyses in existing research, the framework here seeks to set out a meso-level approach. It is informed by the general propositions about business models while adapting them to address the peculiarities of infrastructure. And it tries to distill common and more generalizable elements from the particular cases and individual experiences of infrastructural provision in different geographical settings. Building upon emergent work in this area (see, for example, Andrieu 2007), the framework provides a preliminary step in developing a heuristic and interpretative device to support analysis of infrastructure business models. It draws directly from the definition of infrastructure business models introduced above. The framework does not address specifically how infrastructure business models have been assembled and configured in particular cases with worked through examples nor does it address issues of research methodology, design and data – both of which concerns will be the dealt with in subsequent iBUILD Working Papers.

The architecture of the framework distinguishes three different but inter-related levels: i) the central core; ii) the animating or structuring elements; and, iii) the main building blocks (Figure 1). At the heart of the framework is a central core based on a linear set of stages connected by a single feedback loop. The first stage refers to the multifarious contextual factors that demand and drive understandings of needs and wants in relation to infrastructure. This comprises economic, social and environmental issues such as investing in infrastructure to improve the capital stock and competitiveness of businesses in a national territory, providing connectivity between people and their homes and places of work, leisure and study, and climate change mitigation and adaption. It also includes policy objectives of agents in governments and other institutions, for example seeking to reduce the cost of infrastructure development and renewal, exploit inter-dependencies to improve energy efficiencies, and enhance the resilience of infrastructure systems. The second stage is the actual infrastructure business models which is the focus of the framework and the further two levels of the ii) animating or structuring elements and iii) the main building blocks explained below.

As the output of the infrastructure business models, Stage 3 is the actual delivery of the infrastructure item(s), systems and the services that they provide. This includes, for example, the heat provided by a low carbon energy grid, the mobility afforded by an integrated urban public transportation system, and the clear and potable water piped through a networked delivery system. Stage 4 is the last in the central core. It comprises the outcomes generated by the infrastructure systems. These consist of economic, social and environmental things such as improved productivity in businesses, enhanced personal mobility and

reductions in waste. Significantly, in terms of an evaluation framework for infrastructure business models, outcomes are distinguished from inputs, activities, outputs and impacts (Figure 2). The feedback loop in the central core connects the outcomes directly back into the demands, drivers and policy objectives for infrastructure in Stage 1. Such feedbacks may comprise economic, social and environmental issues that were latent or emergent in relation to existing or desired infrastructure provision. Examples might include businesses clamoring for even faster broadband networks, citizens seeking more integrated public transport systems, and governments wanting to quicken the transition to renewable energy systems.

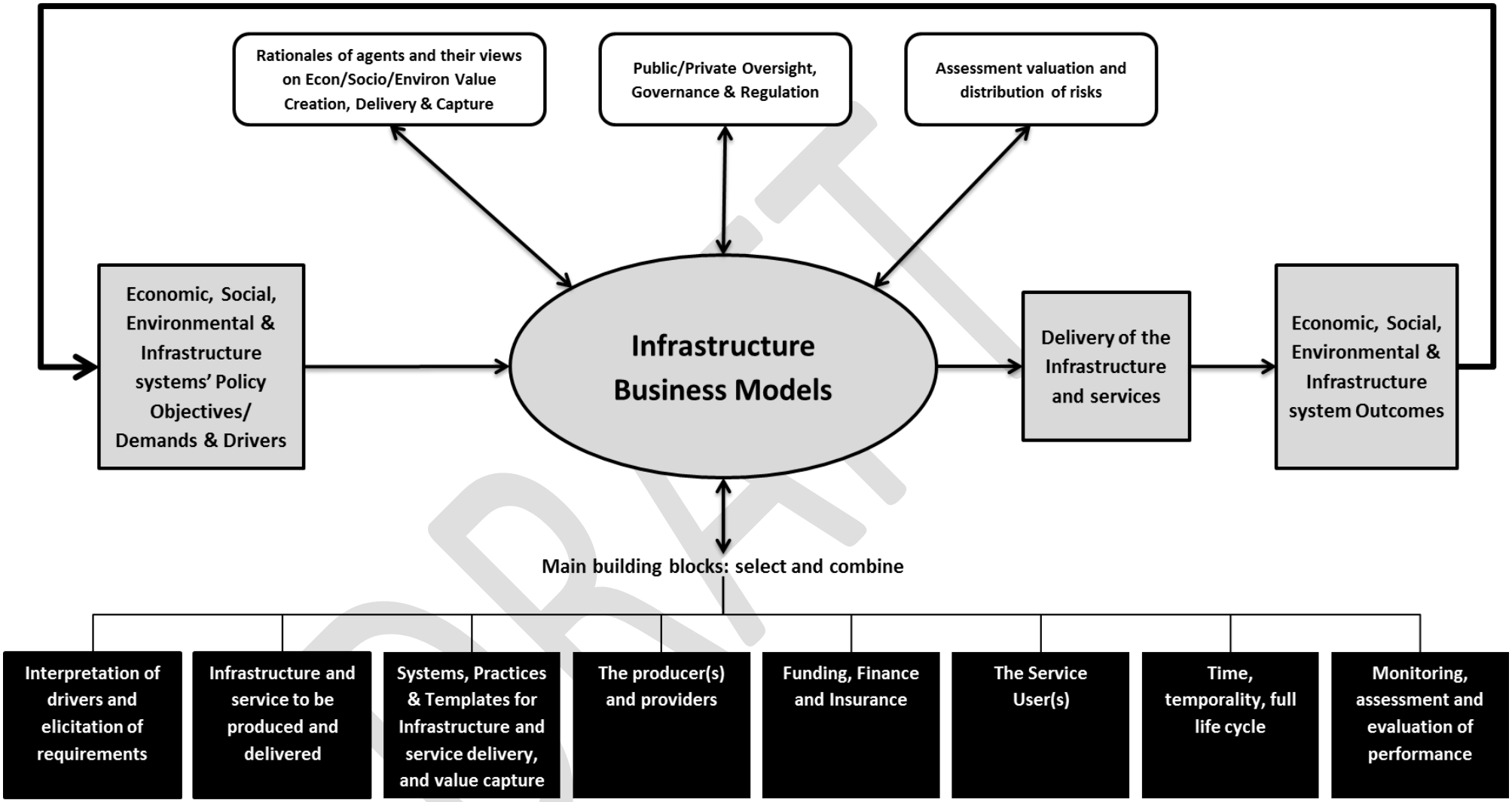

Figure 1. A framework for infrastructure business models in iBUILD (developed from an earlier figure proposed by Peter O'Brien, Andy Pike, Tom Strickland and Graham Thrower).

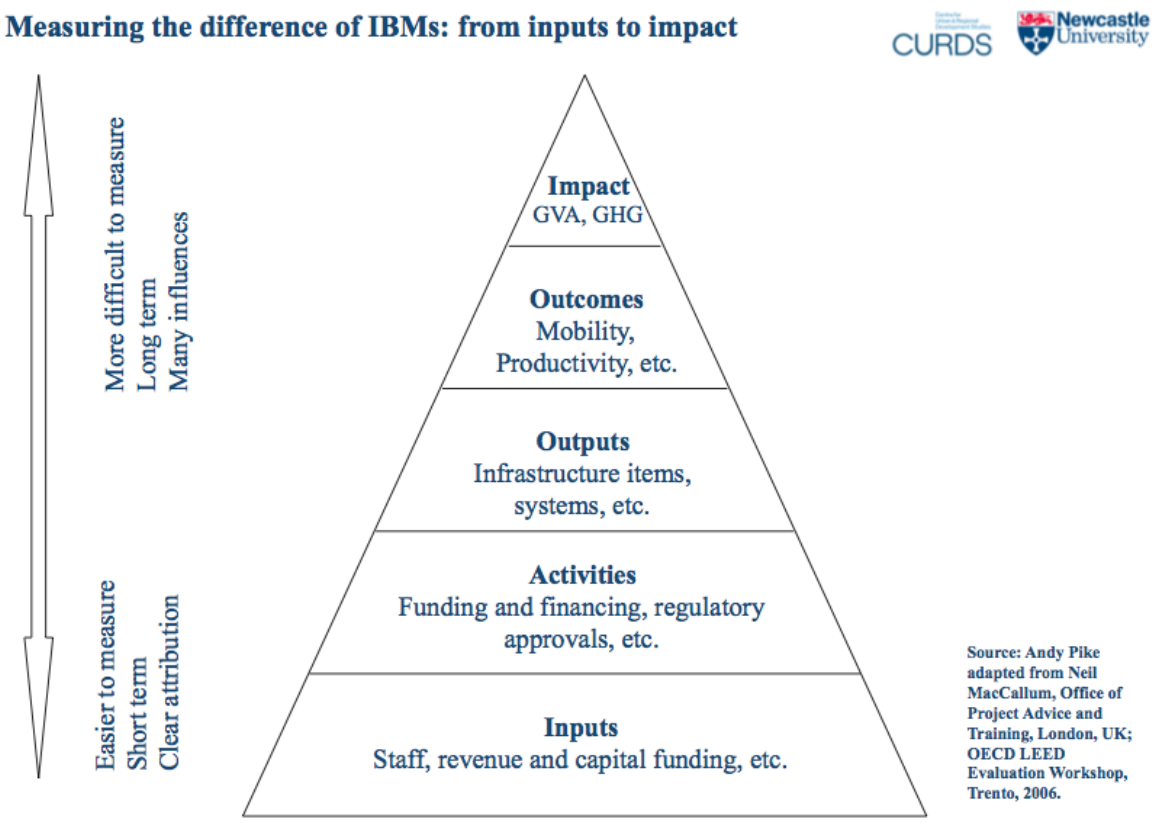

Figure 2. Measuring the difference of infrastructure business models (IBMs): from inputs to impact

The second level in the framework's architecture consists of the animating or structuring elements. These are concerns that specifically influence and shape the infrastructure business models and how their main building blocks – discussed below – are constructed and configured in particular contexts. The animating and structuring elements are grouped into three distinct sets. The first set refers to the different rationales of the agents involved in the infrastructure business model. The agents can comprise public, private and civic as well as hybrid entities. Examples include government, public-private partnerships, investment banks, pension funds, community associations, voluntary groups, co-operatives and trusts. Each actor has interests and values that motivate their actions. These behaviours are then expressed in their particular views of the macro-level aspects of how they conceive of and define value and its creation, delivery and capture in infrastructure business models. A publicly-listed investment bank, for example, prioritises the interests of its shareholders. It is focused upon the economic value of return on investment over a specific time period at a certain level of risk. This perspective directly informs this actor's particular view of any specific infrastructure business model and how it seeks to construct the main building blocks – discussed below – to create, deliver and capture economic value. At the other end of the spectrum, a community association, for example, is focused upon the needs of its local community. It is concerned with not just economic but wider social and environmental values. These may include access to broadband, transport or eco-system services. The community association's particular interests shape its views on the different kinds of values it seeks to embed within the infrastructure business model and how its building blocks can be configured to provide them.

The second set of animating or structuring elements comprise the public and/or private oversight, governance and regulation of infrastructure business models. This set involves other agents with interests

and specific responsibilities. It includes audit and assessment agencies, standard setting bodies, regulatory organisations and governance institutions operating at a range of geographical levels including the supranational, national, regional, local and urban. Such agents animate and structure infrastructure business models in particular ways. Regulators, for example, are supported by legal underpinnings and specify ranges of requirements for infrastructure items, systems and services relating to access, price, quality, reliability and safety. These specifications frame a particular space within which the agents involved in infrastructure discussed above have to operate in constructing the building blocks of their business models and it directly shapes the way in which value creation, delivery and capture is conceived and designed.

The third set of animating or structuring elements consists of the frameworks used to assess the value and risks and evaluate the effectiveness and performance of infrastructure business models. Given its particular scale and long-term nature, many agents involved in infrastructure business models have developed specialised frameworks and methods to assess value and risks. Financial institutions, for example, have increasingly been drawn to infrastructure as an asset class because of its attributes such as long-term, stable and predictable cash flows (Inderst, 2010). How such institutions assess value and risk determines how they approach and structure their involvement in business models for infrastructure. High value and risky projects, for example, might require consortia arrangements that are reorganised over the life cycle of the infrastructure from design, build, operation, maintenance to disposal and recycling.

Again given its particular characteristics, agents involved in infrastructure have developed sophisticated ways to evaluate its effectiveness and performance over time. Connected to the outcomes stage in the central core of the analytical framework, specific institutions such as pension funds, governments and co-operatives will have their own evaluation criteria such as long-term financial return, reduced public expenditure and reinvested surpluses. Such assessment methods and yardsticks then shape whether and how such agents participate in infrastructure business models, how they organise their building blocks, under what terms and in which circumstances.

The third and final level of the analytical framework consists of the main building blocks that constitute the infrastructure business models. Recognising the diversity and variety in infrastructure business models constructed and tailored to the provision of specific items, systems and services in particular geographical circumstances and contexts, the aim here is to distil and identify constituent elements or ‘building blocks’ that are put together by the agents involved. Crucially, and in ways described above, how and by whom the building blocks are configured is framed and shaped by the animating and structuring elements in the framework. The building blocks identified can be selected, assembled and configured in multiple different ways in different settings. Each of the blocks are inter-connected and in certain circumstances may be inter-dependent. Choices made in specific blocks may resonant and frame decisions in subsequent blocks. Importantly, given the desire to build a more generally applicable analytical framework, the building blocks represent the critical elements in infrastructure business models.

The eight building blocks comprise:

First, the interpretation of drivers and elicitation of requirements. Connecting to the drivers, demands and policy objectives stage in the central core and shaped by the animating and structuring element of the different rationales and value systems of agents, this block involves agents in making sense and translating myriad issues from users, customers and other stakeholders into clear requirements for infrastructure

items, systems and services. Here, for example, the aspiration for a low carbon economy gets articulated into infrastructure requirements.

The second block involves the participating agents deciding upon and selecting the specific infrastructure items, systems and services to be produced and delivered. The animating and structuring element of rationales is especially important here when different infrastructure solutions to the same problem can create, deliver and capture different economic, social and/or environmental values.

The third block involves the systems, practices and templates for infrastructure and service delivery, and value capture developed and deployed by the agents involved. This range of approaches, methods and designs is often derived from specialised and differentiated business models deployed by the agents involved in infrastructure. This can include proprietary frameworks from the large accountancy and consulting firms or investment banks as well as systems of public procurement and commissioning. Crucially, these approaches and methods afford flexibility and enable the tailoring of practices to particular circumstances, for example specific regulatory requirements, legal systems and governance arrangements.

The fourth block involves identification and selection of the producer(s) and providers of the infrastructure items, systems and services. Here the lead and co-ordinating agents make decisions about exactly who will be contracted to produce and provide the specified infrastructure. These choices will differ over the life cycle stages and will involve different mechanisms for selection for example through competitive public procurement and tendering.

Fifth is organisation of the funding, finance and insurance. This is a critical building block in the infrastructure business model. Funding refers to where the money will come from and what sources of capital will be used for example from public and/or private sources. Financing means how it will be paid for and how such payment will be structured, for example how the debt will be secured and serviced and which revenue streams will be utilised now and securitised from the future. Insurance relates to how and by whom the guarantee of compensation for any loss will be provided for a specified premium.

The sixth building block concerns the connections with the service user(s). Although addressed in the first building block in the interpretation of demands and drivers and elicitation of requirements, here the issue is how an on-going relationship and engagement with service user(s) will be secured to feedback into the infrastructure business model. Over the life time of an infrastructure system, for example, evolving user needs and patterns of usage are vital in identifying how value is being created, delivered and captured and by whom.

The temporality or relationship of the infrastructure business model with time constitutes the seventh building block. Given the long-term nature of infrastructure and its distinctive life cycle stages, the agents involved have to make decisions about how the business model will address issues including durability, maintenance and obsolescence.

Eighth and last is the building block that involves agents in the monitoring, assessment and evaluation of performance of the infrastructure business models. Such activities require consideration at the outset to enable agents systematically to evaluate how the infrastructure items, systems and services are performing. This performance relates to material and tangible things such as functionality and wear and tear, immaterial and intangible issues such as perception and reputation amongst existing and potential users as well as values such as delivering on expected economic, social and/or environmental outcomes. This

building block links to the animating and structuring element concerned with the frameworks that assess the value and risks and evaluate the effectiveness and performance of infrastructure business models.

Conclusion

- There is no clear 'theoretical home' for the term 'business model'. However, a number of definitions exist that relate to economics and business of firms and organisations.
- Hence, these focus on issues of value creation, delivery and capture of goods and services in commercial markets.
- We argue, given distinctive characteristics of infrastructure systems, for a new definition of infrastructure business models that captures the full infrastructure system, which may result in multiple, interacting business models.
- iBUILD Infrastructure Model definition: *"The system of physical artefacts, agents, inputs, activities and outcomes that aim to create, deliver and capture economic, social and environmental values over the whole infrastructure life cycle."*
- Furthermore, we propose an analytical framework to understand and explain how business models are constructed and used by agents to deliver infrastructure assets, systems and services.
- Our definition and analytical framework, when combined with our emerging value capture framework, which will enable leveraging of economic, social, environmental, aesthetic and other dimensions of value for infrastructure systems, will be used as an heuristic tool through application of iBUILD case studies.

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