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Towards Flexible Delivery Models for Infrastructure Projects

Magnus Hellström; Åbo Akademi University, Finland
Kim Wikström; Åbo Akademi University, Finland
Kent Eriksson; Åbo Akademi University, Finland and KTH Royal Institute of Technology, Sweden
Ray Levitt; Stanford University, USA

Proceedings Editors
Paul Chinowsky, University of Colorado Boulder and John Taylor, Georgia Tech

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TOWARDS FLEXIBLE DELIVERY MODELS FOR INFRASTRUCTURE PROJECTS

ABSTRACT
Large infrastructure investments often aim for extensive system benefits. A key concept in this regard is the project delivery model. The delivery model for an infrastructure defines how the phases of the project are coordinated and the relationships among the key actors in it. Delivery models are usually described by how they separate the phases of an infrastructure delivery. The delivery model is usually decided early in the infrastructure project, and it defines how actors will be contracted throughout the project. The delivery model frames the competences, various motivational and responsibility factors and generally some of the interaction patterns that are needed. Recent research identifies a need for more flexible delivery models that can handle uncertainties and enable innovation. The management of uncertainty and innovation in infrastructure projects is especially important in order to achieve system benefits. Our purpose is, therefore, to present a model for the analysis of what needs to be considered when creating infrastructure delivery models in business ecosystems that is flexible in the sense that it can accommodate uncertainties in its environment over its lifecycle, and also enable innovation so as to achieve system benefits beyond that of more limited conventional approaches. We illustrate our model by contrasting two types delivery models, a limited and a systemic.

KEYWORDS

Delivery model, infrastructure project, business ecosystem, system benefit, flexibility.

INTRODUCTION
Large infrastructure investments often aim for extensive system benefits. One challenge is the uncertainty inherent in achieving such system benefits. Still, many of the tools used for assessing these benefits are based on an idea of a stable state that does not account for technological change and innovation (Nelson and Winter 1982). Moreover, benefits do not take adequate account of the business ecosystem. Hence, also the governance paradigm tends to build on rigid contracts and control against a set plan. Recently, a need for more flexible delivery models enabling innovation has been recognized (Gann et al. 2017). The aim of this paper is to develop a delivery model that is flexible in the sense that it can accommodate uncertainties in the surrounding ecosystem over its lifecycle.

The delivery model for an infrastructure defines and describes how the phases of an infrastructure delivery are separated, how the phases of the project are coordinated, and what the relationships among the key actors in it are. The delivery model is usually selected early in the infrastructure project, and it defines how actors will be contracted throughout the project. On a soft perspective, the delivery model frames the competences, various motivational and responsibility factors and generally some of the interaction patterns that is needed.

Delivery models are important because they determine the development of the infrastructure project, and the goal is for them to enable project delivery according to the specifications stipulated in the tender. As the project delivery is executed, there will inevitably be challenges, such as delays, quality deviations, or market or political/institutional issues, and the delivery model should ideally make it possible for the project to be successfully executed despite challenges. There is a need for continuous re-shaping of the infrastructure project, because of uncertainty around future lifecycle events (Miller and Lessard 2001). In order to accomplish project delivery according to specifications, delivery models can use an array of tools, such as governance, contracts, finance, cost/benefit analysis, organization, technical, and they can be used individually, or in combination.

One of the biggest sources of uncertainty for infrastructure delivery models is the environment, or the context surrounding the infrastructure project (Perminova et al. 2008). It is common that there will be changes in the project and/or the context over the lifecycle of the project. Here we consider the business ecosystem as the context of the infrastructure project. A business ecosystem is defined as 'a system of workflows that contributes toward a common system-level business goal' (Eriksson, K. et al. 2019, p. 1). The workflows of the infrastructure project are interdependent with the workflows in the business ecosystem. An example is that a construction component in the project may be the result of work that has been done outside the project, for instance much earlier in the construction and logistics chain of the component.

Little is known about infrastructure delivery models in the context of a business ecosystem. It is against this background that the purpose of the current article is to present a model for the analysis of what needs to be considered when creating infrastructure delivery models in business ecosystems. The research question addressed is especially how to create delivery models that are flexible to manage and adapt to the uncertainty both in the defined scope of the investment and the surrounding ecosystem to maximize the value from the investment rather than minimize the cost.

The paper is structured so that it starts with an overview of the theory on delivery models and its constitutive elements, followed by an account of our case study method. Thereafter we present our analysis of two cases and, and finally we present the results and conclusions. The article adds to research on infrastructure project delivery models by presenting how such models can incorporate the surrounding business ecosystem.

THEORY OVERVIEW

SYSTEM BENEFITS

The goals of large, public projects can be perceived as a layered set of different types of goals on various levels: there are the immediate results of a projects, there is the desired effect (typically on or for users), and there are the grand societal impacts that may be expected from the investment (Rolstadås et al. 2015). Obviously, the uncertainty about the outcome grows with the scope of the project and the type of goal (cf. Figure 1).

Whereas the effect and societal impact may be very much desired, much of our current theories and tools mainly deals with the result goals and how the can be achieved or safeguarded. Higher level goals, or what we term system benefits, seem to mainly be considered in the literature on early project phases (Edkins et al. 2013; Williams and Samset 2010; Matinheikki et al. 2017). Still, researches increasingly pinpoint the dynamic aspects of projects resulting in various opportunities for shaping the project also in the later phases of a project (Artto et al. 2016; Gann et al. 2017). So rather than emphasizing rigid and long-lasting contracts to safeguard individual positions, we today witness an increasing interest for integrated project organizing (Davies et al. 2009; Gil 2009) and relational project arrangements (Lahdenperä 2012; Walker and Lloyd-Walker 2015). And rather than emphasizing control against the plan we should be open for changes and innovation that seeks to ensure the success of the project on a higher level (Dvir and Lechler 2004).

System benefits in terms of the system output can be perceived as a service (Dalziel 2007; Adner 2017). To understand how that service is produced recent research suggest we adopt a business ecosystem view of the service and investment at hand (Eriksson, K. et al. 2019). Such a problem is obviously located at the nexus of various, related streams of literature. In this regard, earlier research has, for example, looked at the decision making and goal formation in the early phases (Williams and Samset 2010; Matinheikki et al. 2017), coordination and governance mechanisms to manage interdependencies in the ecosystem (Eriksson, K. et al. 2019), as well as integrated and relational delivery systems to enable collaborative innovation and opportunity management in projects (Walker and Lloyd-Walker 2015; Davies et al. 2009; Hietajärvi et al. 2017).

A recent contribution by Gann et al. (2017) present a new delivery model that seems to capture many of the above mentioned aspects. They call for more flexibility in mega project delivery models so as to capitalize on emerging opportunities and new innovations. Arguably, such an approach is apt for aiming at higher level system benefits.

DELIVERY MODELS

A delivery model defines how a project is organized in terms of phases and in terms of the division of roles and responsibilities between the key actors in the various phases of a project (cf. 'delivery system'). The benefits of the concept of a delivery model are many.

Firstly, a delivery model defines the relationships between and responsibilities of the various actors in a project. It, hence, builds on the established notion of delivery systems, which conventionally is used to define the relationships between the owner, the (main) contractor and the designer, especially in terms of who bears the responsibility for coordinating the project. More and more classical contract types such as design-bid-build (DBB) and design build (DB) are being replaced by contracts based on an integrated organization (Davies et al. 2009). Various forms of relational delivery arrangements are a sign of this (for an overview, see Lahdenperä 2012; Walker and Lloyd-Walker 2015). Project partnering (Bygballe et al. 2010; Eriksson, P. E. 2010), alliance projects (Walker and Lloyd-Walker 2015), and Integrated Project Delivery (IPD) are all examples of such arrangements. It is also increasingly common that a delivery system extends into financing (cf. PPP/PFI projects) and operations through for example Build-Operate-Transfer (BOT), Design-Bid-Build-Operate-Maintain (DBBOM) contracts or what in general can be referred to as service-led or lifecycle projects (Leiringer and Bröchner 2010).

With the rise of alliance and partner formations (Bygballe et al. 2010) the focus on contracts has been broadened to a focus on relationships or relational contracts (Macneil 1978). This is an aspect that the conventional notion of delivery system does not capture. Moreover, a delivery system mainly considers the relation between the three main stakeholders in a construction project, that is, the project owner, the (main) contractor, and the designer. However, also the partnering approach seem to fail in incorporating the wider supply chain and instead mainly focuses on the dyadic level of the owner and contractor relationship (Bygballe et al. 2010).

Secondly, a delivery model captures the temporal dimension of infrastructure projects. This is important not the least given the rising interest in integrated solutions or “lifecycle projects”. The lifecycle of an infrastructure project includes phases, such as identification, planning and design, construction, and operation and maintenance. In terms of decision-making, lots of important decisions are made in the early phases of a project (Williams and Samset 2010; Edkins et al. 2013). However, given the dynamic nature of project various opportunities may emerge and there may be merit accommodating them in the project (Gann et al. 2017). Artto et al (2016) emphasize the potential for value creation throughout the system life-cycle, with a special focus on the operating phase. Hence, a delivery model that facilitates new decisions at different stages of a project seems to be called for. In that sense, a delivery model can be perceived as a decision-making model that explicates what decisions are to be made, when and by whom.

To all this we can add the question of how to finance the project, given that private finance initiatives and public-private partnerships are becoming more common.

In sum, a delivery model covers issues such as how and when key decision in a project are made, how the project is financed, who shapes and decides on the investment, who coordinates the projects and makes decisions during its implementation, and who operates the facility. It also relates to typical governance issues, such as: specification format, incentive schemes and compensation/pricing format. The incentives and compensation format essentially establishes the risk responsibility or sharing scheme for a project. Given the growing focus on relational arrangement, procurement strategy becomes an important part of a delivery model (Ahola et al. 2008). It is concerned with how needed capabilities are procured from the market, that is, whether we use an open or closed bidding process, whether we contract our partners at arm’s length or through a relational process, and how we specify the input we are looking for. A procurement strategy may thus also be concerned with when we want to involve various actors in the project (cf. early involvement of suppliers, see e.g. Eriksson, P. E. et al. 2007).

DELIVERY MODELS FOR SYSTEM BENEFITS

The relation between delivery models, in their conventional framing, and system benefits is illustrated in Figure 1.

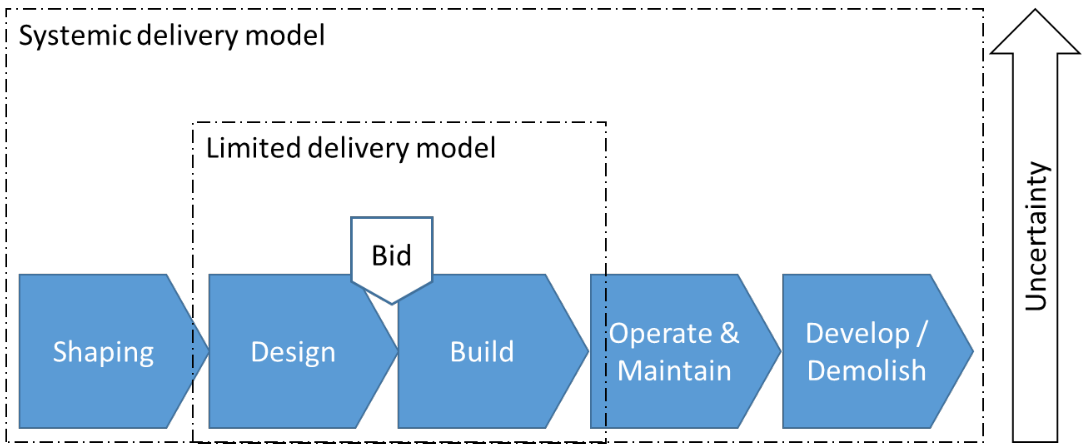

Figure 1 Traditional delivery model versus systemic delivery model

Many aspects in the above account on delivery models refers to procurement and contracting considerations, for example: the use of relational contracts (Gil 2009) and incentives (Eriksson, P. E. 2010; Lahdenperä 2012), and early contractor involvement (Eriksson, P. E. et al. 2007). To effectively make the call for system benefits these rather well-known elements of a delivery model need to be complemented with certain aspects brought up in the more recent literature. Miller and Hobbs (2005) found that (re-)shaping institutional and regulatory is common among the owners of large projects. The attitude towards risks and uncertainty is clearly has a potential source of greater (systemic) benefits. Traditional project risk management (dealing with known uncertainties) and uncertainty management (dealing with complexity and unknown uncertainties) requires very different approaches (Loch et al. 2006; Ward and Chapman 2003). To make the most benefit out of uncertainty, uncertainty management ought to be complemented by processes for opportunity management (Hietajärvi et al. 2017; Perminova et al. 2008), form which innovations may arise if the delivery model is flexible enough to accommodate changes (Gann et al. 2017).

Such flexibility can is likely to require a strong owner during project execution (Winch and Leiringer 2016) and making use of various buffring strategies in the projects. From a workflow perspective (Eriksson, K. et al. 2019), buffering unknown uncertainties is done by building a preparedness for the unexpected in the business ecosystem. Although the unexpected may require unique action, preparedness can be built by that actors in the system build an awareness of a portfolio of common systems level buffering processes. These are: a) escalation of contentious lock ins to a system level integrator, or authoritarian structure that resolves contentious lock ins for the benefit of system level goals, and b) contractual changes and contract resolution mechanisms that allow for resolution of contentious lock ins.

Against this background we conceptualize two types of delivery models. One, which we term “Limited infrastructure project delivery model” (or simply “limited delivery model”, and another with the properties of being able to harness system benefits. The latter one we call “Infrastructure project in business ecosystem delivery model” (or simply “systemic delivery model”). The two types are characterized and distinguished in Table 1. Although we present the idea of two fundamentally distinct delivery models, it is important to bear in mind that this distinction is a weberian ideal type, that is, a construct designed to illustrate a theoretical point.

Table 1 The two ideal type delivery models characterized in terms of common determinants

Element	Limited project delivery model	Systemic delivery model	Key reference
Institutional frameworks	Strives to follow	Strives to shape	(Miller and Hobbs 2005)
Uncertainty	Views as a source of risks	Views as a source of opportunities	(Ward and Chapman 2003; Perminova et al. 2008)
Innovation	Considers as contractor's business	Actively seeks for innovation among all parties	(Gann et al. 2017)
Contracts	Risk transfer mechanism	Mechanism for establishing a cooperative culture	(Gil 2009)
Incentives	Used to gain time and cost reductions	Used for exploring both cost reduction and new business	(Lahdenperä 2012)
Owner role	Controls contractor	Strong owner that assumes most risks and buffers for opportunities	(Winch and Leiringer 2016)
Contractor involvement	At bidding	Early involvement	(Eriksson, P. E. et al. 2007)
Integration	Low	High	
Flexibility	Low	High	(Dvir and Lechler 2004; Gann et al. 2017)
Workflows	Limited system view	Focus on workflows between subsystems; central to the business case	(Eriksson, K. et al. 2019; Anastasia Tsvetkova et al. 2019)
Technology	Looks at most profitable solution under current circumstances	Uses flexibility to widely explore new technology during the project	
Economic assessment	Looking at immediate effects	Looking for more extensive system effects and life-cycle value	
Buffering	None	Uses buffers to explore emergent opportunities	
Financing	Public	Public and private	

METHOD

In the empirical part we analyse two infrastructure investments based on the framework outlined in Table 1. Our empirical analysis is based on a multitude of methods: collaborative research, archive studies and interviews. In the analysis we focus on the planned governance and delivery models and their linkage to the related business ecosystem.

The two infrastructure investments are located in the Baltic Sea, one is a new ferry combined with refit of the port equipment and the second is new cargo ships for short-sea logistics. Both are in the planning phase, the ferry project is moving into execution and the short-sea is in feasibility phase. Both projects have the aim to impact on the surrounding ecosystems.

CASE NEW FERRY IN THE BALTIC SEA

A new passenger and cargo ferry between the cities of Vasa, Finland and Umeå, Sweden, is under design. There is a long history of close collaboration between these cities and easy access plays a central role enabling shared activities and various types of collaboration. This collaboration is based on functioning logistical solutions where the ferry link is essential. The existing ship does not fulfil that function anymore as it is outdated.

A new ferry is now in the planning phase and the arguments to build and finance is partly based on various studies of the positive regional impact. The regional studies have not in detail considered the planned ship investment, the methods to capture and quantify the systemic benefit would require a more detailed analysis of the linkage of the investment to various actors and functions in the region. The planning phase has involved a large set of local actors to engage and involve them into the project by various types of seminars, meetings and studies.

The overall investment is approximately 160 million euro including the new ferry and improvement in the ports. The ferry includes several new key technologies for a more sustainable logistic lowering the stress on the vulnerable Baltic Sea (ref to artikeln som Erik B var med om). The financing is based on mainly public from both governments and cities and possible European Union as the ferry link is included in EU TEN-T and Motorways of the Sea priorities.

Regional impact is based on multiple areas as health sector, work mobility, supply chains, industrial collaboration and tourism. It is challenging to quantify the potential benefits and how the systemic benefits could impact design of the ferry and the delivery model (Westin & Westin, 2016).

Sustainability goals is to minimize the stress on the Baltic and maximize the utilisation of the ferry. Initially the investment was mainly planned from the view of which type of ship would be desirable rather than what benefit the ferry could bring to the regional areas. As the financing structure was based on arguments for regional positive effects the governance around the investment was extended by involving an organisation that links the specific investments to the regional development.

The financing structure had a setback when the EU refused to finance a major part of the investment. This also changed the direction of the further planning and the new financial prerequisites impacted on the planned delivery model.

The changes in financing structures came as a surprise and did change the direction of the investment towards a more traditional limited delivery model. Could this have been avoided by having buffered with alternative paths for the financial structures?

The preparedness to tie the investments governance structures to the surrounding business ecosystem was strong in the early phases of the project and became weaker after the redirection of the financing.

CASE SEABORNE LOGISTICS

The second case is case in shipbuilding for short sea operations. Short sea shipping refers to coastal shipping without crossing an ocean, including the movement of freight and passengers. It accounts for 40% of all freight in the European Union and 59% of all its sea freight (Eurostat 2017). The target is to increase the freight transported on ships as it is regarded as the most environmentally friendly logistics. Still, studies show the deficiencies and potential for more sustainable freight (Eide et al. 2011).

The current short sea logistics ecosystem in the Baltic Sea is characterized by a number of inefficiencies that make shipping economically and environmentally challenging (Gustafsson et al. 2015). The utilization rate of many ship types (e.g. bulker) is below 40% because of inefficient cargo space utilization, communication between actors, and the amount of idle time in ports (Eide et al. 2011; Johnson et al. 2014; Johnson and Styhre 2015). Structural problems in queuing logic to the ports cause unnecessary energy consumption, as the ships often increase speed to reach earlier slots. Labor unions cause (Johnson and Styhre 2015) idle time in the port.

The number of organizations involved in moving a consignment from producer to buyer has increased gradually and now ranges from 16 to 19, creating higher cost and fragmented information flow. The transportation system forming the core of the business ecosystem includes the cargo owner, land transportation, ports, shipowner, and the end customer receiving the cargo. Included in the ecosystem are also ship brokers, technology providers, ship designers, shipyards, and authorities (Gustafsson et al. 2015).

In 2015, the International Maritime Organization (IMO) activated a new strict environmental regulation on the Baltic Sea and the English Channel: the sulphur directive. This directive imposes cost pressures on the industry, either in terms of using cleaner but more expensive fuels such as LNG or investments in cleaning technologies such as scrubbers.

The shipbuilding process is heavily biased toward a “low cost–oriented” logic, creating impediments for designing and delivering vessels that would be somewhat costlier to build, but would produce much greater benefits during operations over their lifecycle. Lack of communication between relevant parties entails that the ship cannot be optimally designed. Present structures focus on economizing the investment not considering market needs, operating profiles, available technologies, and future legislation.

Disruptive product and digital technologies such as autonomous ships and ports and digital open marketplaces will transform the project by impacting the future information and workflows, governance structures, and regulations in the overall ecosystem, which should be taken into consideration when planning new ships.

The specific project - the investment in short sea shipping vessels - is embedded in the ecosystem. The vessel investment and development is the project. The workflows of a more permanent character in the ecosystem impacting the project are cargo owners, material flows, and existing port infrastructure. It is important for the relationships between actors to have existing technologies, legislation, and regulations, the most important of which are environmental regulations. The various governance tools to connect the project workflows with the ecosystem and to govern the actual project is discussed in more detail below.

AN ILLUSTRATION OF A TRADITIONAL AND BUSINESS ECOSYSTEM DELIVERY MODEL

Table 2 summaries the delivery model characteristics of the two cases in terms of the determinants presented in the literature review.

Table 2 Characteristics of the delivery model in the two cases (elements from the limited delivery model marked with *)

Element	**Ferry**	**Cargo ship**
Institutional frameworks	Strives to shape: New innovative technical solutions which demands changes both in classification societies rules and also the governmental rules. The responsibility of this is pushed to the suppliers of technology.	Strives to shape: The investment is based on a reshaping of the way how the investment is planned and executed and requires an active dialog with both authorities and classification societies to shape new regulation and policy.
Uncertainty	*Views as a source of risks: Started with a view that uncertainty is also opportunities but has gradually moved to a more traditional view that it is mainly about risk as the financing became uncertain and a more conventional form for investment was required.	Views as a source of opportunities: The governance model is geared to actively work with uncertainty both within the project and its surrounding context as a source of both risk and opportunities.
Innovation	Actively seeks for innovation among all parties: Has actively encouraged for innovation but as the financing became uncertain the innovations have partly been dismissed towards a more traditional solution.	Actively seeks for innovation among all parties: Innovations builds on an actively collaborative approach as the rewards are based on jointly innovating and by striving to increase the value and annual return of the investment.
Contracts	*Risk transfer mechanism: Collaborative relational concept was developed but due to changes in financing mechanisms the contract forms became more traditional and transactional.	Mechanism for establish a cooperative culture: Based on collaborative, relational contracts and governance structures that encourage to active long-term involvement.
Incentives	*Used to gain time and cost reductions: Traditional incentives.	Used for exploring both cost reduction and new business: Incentives geared to long-term value-adding through further investment and actions to improve the performance of the investment.
Owner role	Strong owner that assumes most risks and buffers for opportunities: Owner have had a strong role and extended view; regional development continues but the actual investment focuses mostly on controlling the contractor. Contractor did not buffer sufficiently early enough for alternative financing.	Strong owner that assumes most risks and buffers for opportunities: Ownership is based on collaborative structures where the risk and gains are shared, fast response to deviations.
Contractor involvement	Early involvement: Contractors had an active involvement from the beginning of the project and brought many new innovative ideas, that has now partly been taken away due to financing.	Early involvement: Contractors are involved from the early beginning.

Element	**Ferry**	**Cargo ship**
Integration	High: Integration has been high and the local involvement of the relevant actors both in Finland and Sweden is significant, also the main contractors are closely integrated as they have local embeddedness.	High: Strong integration in governance and relational actions.
Flexibility	*Low: Has decreased from the original setup and today the governance model is built for a traditional investment.	High: Flexibility built into governance and contracts and by involvement of the surrounding ecosystem.
Workflows	*Limited system view: Even if impact and ecosystem analysis have been done, the linkage to the surrounding ecosystem is weak. The local communities were involved in an early stage.	Focus on workflows between sub-systems; central to the business case: The investment has been planned by involving relevant actors from the ecosystem.
Technology	Actively seeks for innovation among all parties: Has actively encouraged for innovation but as the financing became uncertain the innovations have partly been dismissed towards a more traditional solution	Uses flexibility to widely explore new technology during the project: Incentives encourages to focus on the long-term life-cycle and new technology to gain life-cycle value
Economic assessment	-	-
Buffering	-	-

CONCLUSIONS

The point of departure for this article is the argument arguing that a delivery model can play a crucial role in enabling system benefits by integrating with the surrounding ecosystem and by incorporating the uncertainty inherent in it. We have presented a model for the analysis of what needs to be considered when creating infrastructure delivery models in business ecosystems. Using the analysis model, we have presented two models for infrastructure delivery, one traditional one and one including its business ecosystem. One part of the model defines the relationship between workflows in the project and workflows in the surrounding business ecosystem. Our model recognizes that it is difficult, or impossible to define detailed outcome criteria for infrastructure projects, because of their long lifecycle and the complex project management. Our model contributes towards resolving this problem in two ways:

1. The processes for project management are criteria for the delivery model. The process is for project managers to identify lock-ins in the workflows in the business ecosystem, and resolve those in a hierarchical order starting with the most costly ones.
2. Simultaneously with identifying lock-ins our model also embrace uncertainty with focusing on opportunities to improve the value of the infra investment over its life-cycle.
3. Definition of the output as an infrastructure service, rather than a physical assets with certain performance specifications.

The main components of the delivery model are thus the processes for project management, and that it should perform infrastructure service over a specified time period. The model does not go into detail on the specifications and requirements for physical assets, because those will be best decided before and during the lifecycle of the project. The project will deliver plans for delivering the infrastructure at various phases, but the revisions of those plans will no longer need to be part of contract re-negotiations, or change orders, between the government and the concessionaire for providing the infrastructure service.

With these features integrated in the delivery model, it ought to enhance the project's ability maintain flexibility in the face of uncertainty. Through the inbuilt flexibility, the model has properties, such as shaping direction over requirements, which resonates with the ambition for greater system benefits.

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