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Sustainable Infrastructure Projects: Systemic versus Traditional Delivery Models

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Abstract: Sustainability involves multiple environmental, technical, social and economic factors, and such complex analysis requires systemic solutions. Delivery models are key to achieving system benefits and enhancing sustainable development in infrastructure investments. They define the phases of a project, incentive structures, risk sharing and the relationships among the actors in it. They are usually developed early in the project and determine the project dynamics and outcomes. We compared traditional delivery models with systemic ones. We identified and illustrated elements that differ between them through two cases. The contribution is an increased understanding of how systemic infrastructure delivery models can adapt to changes in their environment. We also found that sustainability is vastly under-researched in systemic infrastructure delivery, but that its potential to deliver benefits to PPP infrastructures is substantial.

Keywords: delivery model; infrastructure project; business ecosystem; system benefit; flexibility; sustainability

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1. Introduction

The UN have adopted 17 goals to transform the world towards sustainable development. These goals concern many areas, such as environmental, technical, social and economic factors. Infrastructure construction is of great importance to many of those goals, but infrastructure projects fall far behind in addressing these goals. This article is a very first step towards conceptualizing a systemic delivery model, which can be further developed to include more sustainability goals in the future. The current situation is that large infrastructure projects often fail to deliver on time, within budget and/or deliver the function that they were supposed to deliver [1]. Not only large amounts of economic resources ought to be considered when striving for better project performance, but also sustainable delivery at large [2]. One important factor for sustainable infrastructure project delivery is the "drifting environment" that may cause changes to the project over its life cycle, and the sources of these can be endogenous or exogenous [3]. There is therefore a need for delivery models that can deliver the infrastructure under changing internal and external conditions. We identified that the properties of such delivery models are to make use of opportunities that arise over the infrastructure project lifecycle, while, at the same time, mitigating uncertainty and risks for not meeting sustainability goals. Such delivery models make use of the systemic properties of the interdependence between the infrastructure project and its surrounding context, and we label such models systemic delivery models. Systemic delivery models stand in contrast to traditional delivery models, which are delivery models that deliver according to specifications at the start of the project. A road project considering the related existing and planned real estate and expected people and traffic flow or an investment in a port considering the impact on the overall logistical chain are examples of projects undertaken using delivery models with systemic properties.

The delivery model for an infrastructure defines and describes how the phases of infrastructure delivery are separated, how the phases of the project are coordinated, incentive structures, risk sharing and the relationships among the key actors in it [4]. The delivery model is usually selected early in the infrastructure project, and it defines how actors will be contracted throughout the project. In order to accomplish project delivery according to specifications and sustainability principles, delivery models can use an array of tools, such as governance, contracts, private finance initiatives (PFI), cost/benefit analysis, organization, technical or project control [5], and they can be used individually or in combination.

Traditional delivery models manage endogenous sources of uncertainty in infrastructure delivery by specifying the output requirements of the project. Key features of infrastructure projects are that they are complex, take place over long time periods, involve many different kinds of actors, and that the set of actors differs greatly from one phase to the next [6]. Endogenous sources of uncertainty are managed in projects so that the project can deliver on time, within cost and according to quality specifications [7]. Specifications are elaborated in contracts focusing on a detailed description of the design and build specifications [4], and if there are exogenous changes, then these are handled by change orders in the contract [8].

Systemic delivery models manage a dynamic interplay between endogenous and exogenous sources of uncertainty by adapting the project organization to the environmental conditions. Endogenous and exogenous uncertainty is tied together by workflows that transcend boundaries and are components of the system. Workflows within the project are interdependent on workflows in the surrounding environment, and by considering both kinds of workflows as a system, the project can strive towards a system-level goal [9], at the same, improving their ability to contribute to sustainable development. As most infrastructure projects also aim for business goals, we call the above-mentioned systems business ecosystems, where public and private stakeholders work together to achieve mutual and individual goals. Hence, systemic delivery models are, at the outset, based on public-private partnerships (PPP). However, systemic delivery models go beyond and extend conventional PPP project arrangements in a number of ways, notably by considering the entire business ecosystem when planning the investments.

As far as we know, no article has compared traditional and systemic infrastructure delivery models. Therefore, the purpose of the current article was to undertake such a comparison. In fulfilling this purpose, we investigated how delivery models can manage and adapt to the uncertainty in the surrounding ecosystem, benefit from opportunities and mitigate risk and achieve sustainability goals.

We contribute towards an increased understanding of how traditional and systemic infrastructure delivery models differ. In an ecosystem setting, the system benefits (cf. project outcome or sustainability effects) are brought to the fore, and delivery models attaining system benefits obviously need to cope with both endogenous and exogenous uncertainty. Recently there has been an interest in the concept of delivery models, featuring in a special issue in the Project Management Journal [4]. There is also a clear need for increased flexibility in the delivery models in order to cope with project dynamics [10]. Still, little is known about infrastructure delivery models in the context of a business ecosystem.

The paper was structured so that it starts with an overview of the theory on delivery models and its constitutive elements, which results in a conceptual distinction between systemic and traditional types of delivery models. This is followed by an account of our case study method. Thereafter, we present our comparative analysis of two illustrative cases. We conclude by arguing that the article adds to research on infrastructure project delivery models by presenting how such models can incorporate the surrounding business ecosystem and be sustainable.

2. Theory Overview

2.1. 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 project (typically related to conventional efficiency measures, such as cost, time and quality), there is the desired effect (typically for users, e.g., shorter transportation time) and there are the societal impacts that may be expected from the investment [11], often expressed as a vision. Increasingly, such societal impacts include sustainability goals and consideration, typically operationalized in terms of their economic, social and environmental effects. Obviously, the uncertainty about the outcome grows with the scope of the project and the type of goal (cf. Figure 1). An example of this is the development of new transportation infrastructure (e.g., an underground train, bus lanes, a tram), which is normally a demanding large-scale project. The new infrastructure may lead to societal development and associated real estate development for housing, public service, offices, shops, other businesses and space for recreational use. This example shows how a transportation infrastructure project is interdependent with a larger system, where public and private interest typically meet. In such cases, where there are enough incentives for private actors to participate in the financing of the project, the PPP project delivery model becomes feasible.

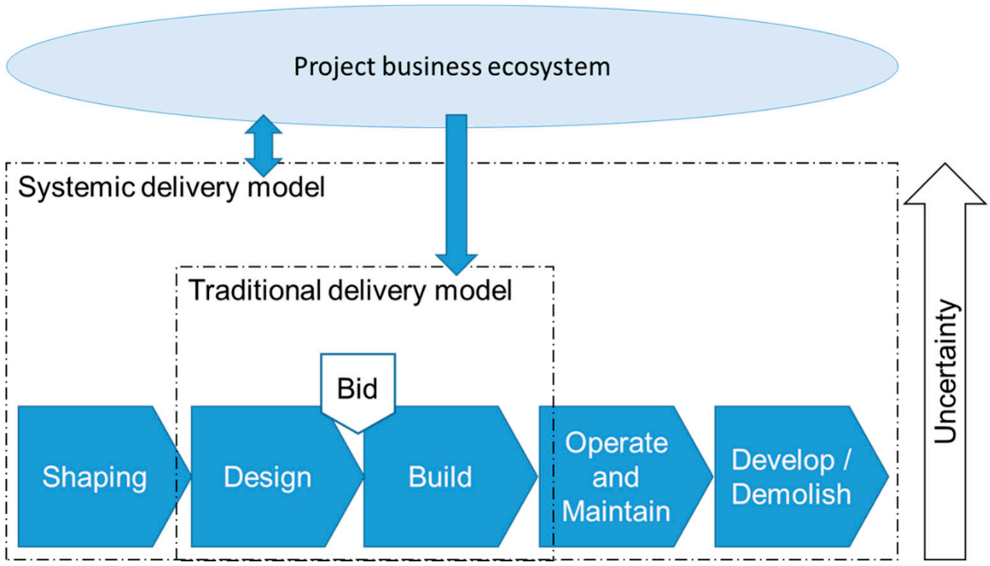

Figure 1. Traditional delivery model versus systemic delivery model.

Much of the current research on infrastructure and PPP projects has not considered the systemic effects throughout the investment lifecycle, but has focused on meeting cost and performance goals [12]. System level goals, or what we term system benefits (including those related to sustainability), seem to mainly be considered in the early project phases, for instance in feasibility studies or studies on city planning [13–15]. The same goes for project sustainability strategies [16], which are seldom taken into account in cost/benefit calculations. Still, researchers increasingly pinpoint the dynamic aspects of projects, where there are various opportunities for shaping the project in the later phases of a project as well [10,17]. Thus, rather than emphasizing rigid and long-lasting contracts to safeguard individual positions, today we witness an increasing interest in relational project arrangements [18,19]. Furthermore, there is a corresponding emphasis on not controlling the plan, but to be open for changes and innovation that seeks to ensure the success of the project at a systems level [20], including sustainability [5]. Also, integrated project organizing is advocated as a means for achieving better results, both on the project and the system level [21,22].

System benefits, in terms of the system output, can be perceived as a societal service [23,24]. To understand how that service is produced, recent research has suggested that we adopt a business ecosystem view of the service and investment at hand [9]. Such a perspective is obviously located at the nexus of various, related streams of literature. In this regard, earlier research has, for example, studied decision making and goal formation in the early phases [14,15,25] and coordination and governance mechanisms to manage interdependencies in the ecosystem [9]. Researchers have also considered integrated and relational delivery systems to enable collaborative innovation and opportunity management in projects [19,21,26].

A recent contribution by Gann et al. (2017) presented a new delivery model that seemed to capture many of the above-mentioned aspects. They called for more flexibility in delivery models used for mega-project so as to capitalize on emerging opportunities and new innovations throughout the long lifecycle of the mega project. Arguably, such an approach is apt for aiming at system level benefits. Obviously, such benefits are also subject to especially higher exogenous uncertainty.

Another way to conceptualize the difference between traditional project management and system level project management is to draw a parallel to the difference between project and program management known from the literature on organizational project management. In this regard, projects are often perceived as inward-focused and task-oriented and programs as strategy-focused and subject to emergence [27]. In fact, program management has been argued to be fundamentally different with its own knowledge bases [28], and it meets many of the requirements we have set out above for systems level project management, such as that it should account for flexibility and adaptability [27]. The synergy between program and project management is that programs consist of several subprojects. These subprojects have clear goals contributing the progress of the program. Programs are more vision- and direction-driven, whereas projects are goal-driven [28].

2.2. Systemic and Traditional 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. Based on the above discussion, and for the sake of conceptualization, we distinguish between systemic and traditional types of delivery models.

Concerning the division of roles and responsibilities, delivery models have been developed over time. Traditionally, delivery models were focused on detailed specifications of project deliverables, but that has been developed towards delivery models that are focused more on systemic properties of how the project can adapt to and benefit from its context. Consequently, more and more traditional contract types, such as design-bid-build (DBB) and design build (DB), are being replaced by contracts based on an integrated organization [21] and various forms of relational delivery arrangements [18,19]. Other examples of more flexible project management models used in delivery models are project partnering [29,30], alliance projects [19] and integrated project delivery (IPD). It is also common that a delivery system extends into financing (cf. public–private partnerships or 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 [31]. Hence, the focus on both sustainability and cooperation between public and private actors over a larger part of the lifecycle has grown, and this is one of the main differences between traditional and systemic delivery models.

With the rise of alliance and partner formations [29], the focus on contracts has been broadened to a focus on relationships or relational contracts [32]. 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, the partnering approach also seems to fail in incorporating the wider supply chain and, instead, mainly focuses on the dyadic level of the owner and contractor relationship [29]. Our ambition to adopt a business ecosystem view of the investment project calls for a further expansion of the parties to include in the analysis. The business ecosystem perspective includes not only the actors immediately involved in the infrastructure over its lifecycle, but also such actors as institutions, regulators, agencies, industry organisations, actors from complementary or related industries, etc. The business ecosystem perspective has been applied successfully by disruptive technology actors, such as Amazon, Google and Tesla, to name a few. An important difference between a traditional and systemic delivery model is, thus, also that the systemic delivery model includes the wider business ecosystem in dynamic interaction, whereas the traditional delivery model sees it as a conditioning factor, or given situation.

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

Lastly, a delivery model captures the temporal dimension of infrastructure projects. This is important, not at 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, many important decisions are made in the early phases of a project [13,14]. However, given the dynamic nature of projects, various opportunities may emerge, and there may be merit in accommodating them in the project [10]. Artto et al. [17] emphasized 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. Expanding this concept to not only consider the value creation in the life-cycle of the project, but also linking it to the surrounding systems for system benefit is a new path.

In sum, a traditional delivery model focuses the design, bid and build parts of the infrastructure lifecycle. The systemic delivery model includes a larger lifecycle, ranging from the early shaping phase to demolition and recycling. The systemic delivery model is more uncertain than the traditional one, mainly because it involves a larger part of the infrastructure, and because it involves a dynamic interaction with the project business ecosystem. The potential benefits of a systemic delivery model are great, because systemic benefits are generated from system value creation and are not limited to a part of the system.

2.3. A Comparison of How Important Elements Differ for Traditional and Systematic Delivery Models

In order to further clarify the differences between traditional and systemic delivery models, we identified a number of factors that researchers have found to be important in previous research (see Table 1 below). We do not claim that the list is exhaustive, but we do claim that it contains some of the more important factors of relevance to delivery models. The selection of a delivery model is guided by factors that have been identified as important in research on the management of large projects [9].

For example, delivery model research often refers to procurement and contracting considerations, for example, the use of relational contracts [22] and incentives [18,30] and early contractor involvement [33]. 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 [34] found that (re-) shaping institutions and regulations is common among the owners of large projects. The systemic delivery model strives to shape institutions and regulations, whereas the traditional model strives to follow institutions and regulation [34].

Another important factor is the management of risk and uncertainty, and here, large project owners manage their risks by changing their institutional setting, and they can therefore gain greater systemic benefits than projects using a more traditional delivery model, where they take the institutional and regulatory contexts as given. In traditional delivery models, project uncertainty management (dealing with complexity and unknown, and oftentimes exogenous, uncertainties) views uncertainty as a risk, and defines that it needs risk management (dealing with known and oftentimes endogenous uncertainties) [35,36]. Systemic delivery models view the risks associated with uncertainty as an opportunity, and that uncertainty management ought to be complemented by processes for opportunity management [26,37].

Table 1. Traditional and systemic delivery models characterized in terms of how they differ in common elements.

Element	Traditional Project Delivery Model	Systemic Delivery Model	Key Reference
Institutional frameworks	Strives to follow	Strives to shape	[34]
Uncertainty	Views as a source of risks	Views as a source of opportunities	[36,37]
Innovation	Considers as contractor's business	Actively seeks innovation among all parties	[10]
Contracts	Risk transfer mechanism	Mechanism for establishing a cooperative culture at systems level	[22]
Incentives	Used to gain time and cost reductions	Used for cost reduction, new business, and value creation.	[9,18]
Contractor involvement	Involvement at bidding	Early involvement, and/or continuous involvement	[33,38]
Integration	Low	High	[39]
Flexibility	Low	High	[10,20]
Workflows	Limited system view	Focus on workflows between subsystems; central to the business case	[9,40]
Technology	Looks at most profitable solution under current circumstances	Uses flexibility to widely explore new technology during the project	[41]
Economic assessment	Looking at immediate economic effects, cost control	Looking for more extensive system effects and life-cycle value	[42,43]
Buffering	None	Uses buffers to explore emergent opportunities	[9,44]
Management and leadership	Project management	Program management	[27,28]
Financing	Public	Public and private	[45,46]
Strategy	Project-level goal-oriented	Vision-oriented and system-level goal-oriented	[47]
Owner role	Controls contractor	Strong owner that assumes systems governance	[48]
Sustainability	Meets immediate requirements	Strives to integrate sustainability into a core aspect of managing the project	[2]

Innovation in a traditional delivery model is viewed as the responsibility of the contractor, and such innovations focus on the system as given and improve the overall efficiency of the project. The systemic delivery model, on the other hand, may create innovations if the delivery model is flexible enough to accommodate changes [10], and innovations may require system reshaping, especially if the innovations will be radical and create significant value [9]. This would inevitably require closer cooperation between public and private actors, especially in the case of system innovations, such as those typically related to sustainability. This is also why we considered the PPP project delivery model as an outset for the systemic delivery model.

The traditional and systemic delivery models also differ on contracts and incentives, where the traditional delivery model focuses on contracts and incentives for transferring risk between the contractor and the owner and in order to reduce costs and deliver on time. The systemic delivery model uses contracts to foster a collaborative culture across the system, and the incentive is to strive for benefits from cost reduction, new business, value creation and other system-level benefits.

The owner role in traditional delivery models is to control the contractor, and the contractor is involved in the bidding phase and then executes according to specifications if awarded the contract. In a systemic delivery model, the (public) owner is involved throughout the project and governs the project in the system together with the (private) contractor. The systemic delivery model requires a strong and involved owner during project execution [48]. The systemic delivery model either involves the contractor in early stages of project shaping or it involves the contractor throughout the lifecycle of the project.

Compared to systemic delivery models, traditional delivery models have less integration, because actors in the system do not adapt workflows flexibly to each other. The systemic delivery model is organized to flexibly resolve lock-ins that impede systemic value creation through flexible workflow integration. The traditional delivery model employs technology for current project work, whereas the systemic delivery model uses technology for system-level goal attainment, and this often involves technology innovation.

Buffering of workflows is done in the systemic delivery model by building a preparedness for the unexpected in the business ecosystem [9]. Although the unexpected may require unique action, preparedness can be built by actors in the system build and 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. The traditional delivery model has less buffering mechanisms.

Management and leadership in traditional delivery models are focused on the project, whereas systemic delivery models focus programmatic management and leadership, meaning that several projects are tied together as a program that contributes towards system-level goal attainment. In tandem with this, the traditional project delivery strategy focuses on project-level goal attainment and efficiency in resource utilization. The strategy for systemic delivery models is vision-oriented for the attainment of system-level goals.

Economic assessment in traditional business models is focused on cost control and immediate benefits, whereas the systemic delivery model focuses on life-cycle value and systemic benefits. The financing structures also differ: traditional infrastructure delivery projects are, in majority, publicly funded, whereas systemic delivery projects are funded by both public and private capital, hence making it a(n extreme) type of PPP delivery model.

3. Method

The research method used in this article was clinical research, which originates from the tradition of action research, although clinical research focuses explicitly on solving problems that are relevant to the industry [9,49]. In clinical research, the researchers help companies diagnose and solve problems in the practice. Thus, the main aims of a clinical inquiry include solving a clinical problem and triggering organizational change [50,51]. The main mechanism for clinical research is solving business problems through a collaborative process between research and practice, and that process allows for good access to data and constant validation of research results with the practitioners [49]. The outcome of clinical research is not known beforehand, but rather, the collaboration between researchers and practitioners usually results in an interesting outcome [50].

Our analysis was set to compare two different concepts of delivery models in infrastructure investments. This was done by selecting two investment cases that were in the planning phase. Both cases aimed, in the start, to achieve systemic benefits by focusing on benefits in the business ecosystem that could be achieved from the investment case.

The case selection was labelled "paradigmatic" because the cases were chosen so that they were helpful in establishing a school of thought [52,53]. In the research process, we analyzed 1. a ropax ferry between Finland and Sweden and 2. new cargo ships for short-sea logistics. Both were in the planning phase; the ferry project was moving into execution and the cargo ships were in the feasibility phase.

In both cases, our role was, together with practitioners, to develop solutions for increasing the investments' efficiency and sustainability by focusing on alternative delivery models. The practitioners included shipping companies, key technology providers for vessels, a shipyard, port company, authorities and cargo owners. The research was conducted through research funded by the Finnish innovation authorities (Business Finland). The research was carried out during 2014–2017.

The research contract stipulated the commitments, work and conflict resolution in the project. Industrial companies did not provide monetary resources, but rather considered the time used by staff as a commitment.

The clinical research focused on the development of the investments and business with industry actors and used meetings, workshops, interviews and documentation as tools to bring the business development process forward. Conceptual reports and calculations were produced to align the development concepts and visions among the participating companies. Involvement of the practitioners took place on several layers, including continuous validation of results (see Table 2).

Table 2. Overview of collected data and collaborative effort.

	Case Ferry	Case Cargo Ship
Time period	2014–2017	2014–2016
General meetings	17	22
Weekly reviews	20	32
Workshops	37	In combination with general meetings
Number of interviews	20	60

For this paper, we used the elements listed in Table 1 to analyze in detail the two different delivery models selected for the two cases to highlight the differences in the approach. In the analysis, we focus on the planned governance and delivery models and their linkage to the related business ecosystem.

4. Case Description

4.1. Case New Ferry in the Baltic Sea

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

A new ferry was then in the planning phase, and the arguments to build and finance it were partly based on various studies of the positive regional impact. The regional studies had not, in detail, considered the planned ship investment; the methods to capture and quantify the systemic benefit would have required a more detailed analysis of the linkage of the investment to various actors and functions in the region. The planning phase had 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 was approximately 160 million euro, including the new ferry and improvement in the ports. The ferry included several new key technologies for a more sustainable logistic, lowering the stress on the vulnerable Baltic Sea [54]. The financing was mainly based on public funding from both governments and cities and, possibly, the European Union, as the ferry link was included in EU TEN-T and Motorways of the Sea priorities.

The regional impact was based on multiple areas, such as health sector, work mobility, supply chains, industrial collaboration and tourism. According to an official assessment of the investment, it was challenging to quantify the potential benefits and how the systemic benefits could impact design of the ferry and the delivery model.

The sustainability goals were to minimize the stress on the Baltic and maximize the utilization 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 organization 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 changed the direction of the investment towards a more traditional delivery model. Could this have been avoided by having buffered it 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.

4.2. Case Cargo Ship for Seaborne Logistics

The second case was a 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. The target was to increase the freight transported on ships as it is regarded as the most environmentally friendly logistics. Still, studies have shown the deficiencies and potential for more sustainable freight (Eide et al., 2011).

The current short-sea logistics ecosystem in the Baltic Sea was characterized by a number of inefficiencies that made shipping economically and environmentally challenging [55]. 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 [56–58]. 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 [58] idle time in the ports.

The number of organizations involved in moving a consignment from producer to buyer has increased gradually and now ranges from 16 to 19, creating a 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 [55].

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 imposed 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 has been 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 has entailed that the ship cannot be optimally designed. Present structures have focused 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—was embedded in the ecosystem. The vessel investment and development was the project. The workflows of a more permanent character in the ecosystem impacting the project were cargo owners, material flows, and existing port infrastructure. It was 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 are discussed in more detail below.

4.3. Cross-Case Analysis

Table 3 summaries the delivery model characteristics of the two cases in terms of the determinants presented in the literature review above. We used it as illustrative evidence of the two ideal types of delivery models conceptualized in the previous chapter.

Table 3. Characteristics of the delivery model in the two cases (elements from the traditional delivery model marked with *).

Element	Ferry	Cargo Ship
Institutional frameworks	Strives to shape: New innovative technical solutions which demanded changes, both in classification societies' rules and also the governmental rules. The responsibility of this was pushed to the suppliers of technology.	Strives to shape: The investment was based on a reshaping of the way that the investment was planned and executed and required 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 was also an opportunity, but gradually moved to a more traditional view that it was 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 innovation among all parties: Has actively encouraged innovation, but as the financing became uncertain, the innovations have been partly dismissed towards a more traditional solution.	Actively seeks innovation among all parties: Innovations builds on an actively collaborative approach as the rewards were based on jointly innovating and by striving to increase the value and annual return of the investment.
Contracts	* Risk transfer mechanism: A collaborative relational concept was developed, but due to changes in financing mechanisms, the contract forms became more traditional and transactional.	Mechanism for establishing a cooperative culture: Based on collaborative, relational contracts and governance structures that encourage 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 towards long-term value-adding through further investment and actions to improve the performance of the investment.
Contractor involvement	Early involvement: Contractors had an active involvement from the beginning of the project and brought many new innovative ideas that had now been partly taken away due to financing.	Early involvement: Contractors were involved from the early beginning.
Integration	High: Integration has been high and the local involvement of the relevant actors both in Finland and Sweden was significant; also, the main contractors were closely integrated as they had local embeddedness.	High: Strong integration in governance and relational actions.
Flexibility	* Low: Had decreased from the original setup, and today, the governance model was built for a traditional investment.	High: Flexibility built into governance and contracts and by involvement of the surrounding ecosystem.

Table 3. *Cont.*

Element	Ferry	Cargo Ship
Workflows	* Limited system view: Even if impact and ecosystem analysis had been done, the linkage to the surrounding ecosystem was weak. The local communities were involved at an early stage.	Focus on workflows between sub-systems; central to the business case: The investment had been planned by involving relevant actors from the ecosystem.
Technology	Actively seeks innovation among all parties: Has actively encouraged innovation, but as the financing became uncertain, the innovations have been partly dismissed towards a more traditional solution	Uses flexibility to widely explore new technology during the project: Incentives encouraged to focus on the long-term life-cycle and new technology to gain life-cycle value
Economic assessment	Initially extensive impact analysis, including impact on tourism, industry, hospital and university collaboration between the countries. *Finally, the decisive calculations were based on traditional cost/benefit analysis	Impact assessment with cost/benefit analysis, including benefits largely to the overall logistical ecosystems (export industry, road traffic, ports, environment)
Buffering	Traditional contingency	Buffering based on financial reserves for innovation
Management and leadership	Project management	Program management consisting of subprojects that were managed with project management
Financing	Public financing	Combination of public and private
Owner role	Strong owner that assumes most risks and buffers for opportunities: Owner have had a strong role and extended view; regional development continued but the actual investment focused mostly on controlling the contractor. The contractor did not buffer sufficiently early enough for alternative financing.	Strong owner that assumes most risks and buffers for opportunities: Ownership was based on collaborative structures where the risk and gains were shared, fast response to deviations.
Sustainability	Minimize negative effect on the Baltic Sea Ecosystem	Reduce sulphur emissions by more effective cargo transport

As can be seen from Table 2 above, the Ferry case eventually adhered to a more traditional delivery model, whereas the cargo ship exhibited many instances of a business ecosystem delivery model. The main differences in the cases were the approach to uncertainty, contracts and incentives. While this may be a mere coincidence of the selection of cases, it highlights the difference of the exogenous and endogenous sources of uncertainty described in the introduction of this paper.

All in all, the above two cases pinpoint the difference between what we have termed a traditional delivery model and a business ecosystem delivery model. In terms of sustainability, both cases seemed not to put it at the forefront of the goals of the systemic infrastructure delivery model, meaning that they vastly underutilized the opportunity to develop a sustainability-based systemic delivery model.

5. Discussion

The point of departure for this article is that sustainable infrastructure investments require systemic infrastructure delivery models. As a first step, we compared traditional and systemic infrastructure delivery models. We identified elements of infrastructure delivery models and illustrated how these elements differ for traditional and systemic delivery models in two infrastructure cases. Our arguments, the elements and the case analysis all showed that traditional and systemic infrastructure delivery models differ, and it also provided some insight into how they differ. Although far from conclusive, our research does indicate that more research is needed into systemic infrastructure delivery models. We argue that a delivery model can play a crucial role in enabling system benefits (such as sustainability transitions) by integrating with the surrounding ecosystem and by incorporating the uncertainty inherent in it. This, in turn, builds on closer collaboration between public and private actors. We have developed a systemic model consisting of elements that determine the ability of infrastructure delivery models to adapt to the surrounding business ecosystems in a sustainable manner. Using the analysis model, we presented two archetypical models for infrastructure delivery: a traditional model, which is project-focused, and a systemic model, which is program-focused.

The traditional model does not adapt dynamically to uncertainties in the environment, whereas the systemic model integrates the project with the surrounding business ecosystem. We illustrated the two archetypical cases in two real field scenario cases that were in the planning phase, and the cases showed the differences between the traditional and the systematic model. The traditional and systemic delivery models differ in institutional frameworks, uncertainty, innovation, contracts, incentives, owner role, contractor involvement, integration, flexibility, workflows, technology, economic assessment, management approach, financing, strategy and sustainability.

We put forth that the systemic model is more suited to dynamic adaptation to uncertainty and changing environmental conditions. The systemic 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. The systemic model contains project governance that identifies lock-ins that prevent the creation of system-level value creation and resolves those in a systematic hierarchical order, starting with those that prevent the most value creation.

The main components of the delivery model are, thus, the governance of processes for program or 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 to maintain flexibility in the face of uncertainty. Through the inbuilt flexibility, the model has properties, such as shaping direction over requirements, which resonate with the ambition for greater system benefits.

We also identified that, although sustainability is part of the factors considered in the systemic delivery model, the potential benefits of sustainability are vastly underestimated. The potential benefits of making sustainability a central factor for the systemic delivery model pertains to that it has benefits for the business, finance, regulatory compliance, long term value, resilience and utilization of the infrastructure.

6. Conclusions

6.1. Theoretical Contribution

This paper contributes to the recent call for research on flexible delivery models [10]. Hence, we contributed with a theoretically derived and empirically illustrated model for analysis of delivery models. In doing so, we contrasted a traditional delivery model with a systemic delivery model that is more flexible and adaptable, to account for inevitable and value-increasing changes to the investment over its lifecycle. Key in the systemic model is that it considers the project as embedded in a business ecosystem, in addition to being a PPP type of delivery model at the outset. Thus, we also extended the emerging literature on project business ecosystems [9]. The business ecosystem delivery model is connected through its governance to the surrounding ecosystem that impacts and can impact on the planned investment. The business ecosystem delivery model adopts a management model that relies on program management, which puts more emphasis on project outcomes (i.e., system effects), rather than the immediate results (meeting specifications and efficiency targets). A systemic delivery model is likely to be more apt for cases where sustainability and sustainability transitions are among the desired outcomes.

6.2. Managerial Implications

The key practical message of our paper is that an investment project striving for a greater impact ought to adopt a program management approach towards the investment and choose the delivery model accordingly. As with the management approach, one size does not fit all when it comes to the delivery model (Lycett et al., 2004). In this regard, the two delivery model types can be used by project owners and the project business ecosystem when planning a major investment. The elements listed in Table 1; Table 3 can be used as a checklist for choosing an appropriate and fit-for-purpose configuration of the delivery model.

6.3. Future Research

This paper constitutes an initial probe into new terrain. We conceptualized and illustrated two distinct and fundamentally different types of delivery models. In this regard, more case studies on the systemic delivery model are needed to better understand the constitutive elements of the model we outlined (and others that we may have omitted) and their interplay. Preferably, such a study ought to be longitudinal in order to capture the dynamic governance that is likely to occur over the life cycle of an investment.

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