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GOVERNING WORKFLOWS IN BUSINESS ECOSYSTEMS: THE CASE OF BALTIC SHORT SEA SHIPPING

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ABSTRACT

Investments in large projects in infrastructure, logistics, or energy often fail to generate their intended value. There is a need to develop alternative models for analyzing large industrial investments where their ability to deliver maximum value in a sustainable business ecosystem for users and stakeholders is the main success criterion for their functionality. Maximizing stakeholder value across the business ecosystem will often require purposefully reconfiguring the way ecosystem actors collectively create value across industry sectors and over project development phases. This requires coordinating workflows among the actors involved in delivering and operating the investment over its lifecycle in the business ecosystem. In this paper, we show how such an analysis can be made. We analyze workflow interdependence in a project aiming to invest in a vessel for short sea shipping. We consider both the lifecycle of the investment and its embeddedness in the larger business ecosystem. The outcome of our research implies that our analysis method can be used to design enhanced governance mechanisms that can optimize system-level return on investment and value creation.

KEYWORDS: workflow, governance, business ecosystems, functional investments

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INTRODUCTION

Observers have frequently questioned whether investments in large projects in infrastructure, logistics, construction or energy generate the value they were intended to generate (Flyvbjerg *et al.* 2002, Miller and Lessard 2001). There is a need to develop alternative models for the analysis of these kinds of large project investments (Walker and Lloyd-Walker 2015), where their *functionality*, i.e., their ability to deliver value for users and stakeholders, is seen as the main success criterion. We propose that the functionality of investments can be better understood when they are studied as parts of a business ecosystem. Previously, business ecosystems have been defined as evolving communities that consist of interacting organizations producing goods and services of value to customers (Moore 1996). In this paper, we draw specific attention to the notion of interaction and therefore define a business ecosystem as a network of interconnected workflows of several organizations that aim to deliver value to the businesses and users in the business ecosystem. We utilize both research on workflow coordination (Zajac *et al.* 1993, Holm *et al.* 1996), and workflow interdependency theory (Thompson 1967) when we define a business ecosystem as a system of interdependent workflows. Because of their systemic properties, business ecosystems require analysis, and governance of workflow interdependencies with the aim to create value.

The need to consider the business ecosystem in investment in a large project is illustrated by a new type of vessel investment within the context of the short sea logistics business ecosystem in the Baltic Sea. The Baltic short sea shipping is particularly interesting because it is a test bed for new, and more stringent sulphur emission requirements that will be implemented globally in the future. Finland is by the Baltic, and the Finnish government and industry see the new regulations as an opportunity to reconfigure the entire short sea shipping and logistics infrastructure. The Finnish government and industry see these changes as an opportunity to develop industry innovations that will have a first-mover competitive advantage internationally. We focus our analysis on the short sea shipping vessel as an engineering project. The vessel is a project that is embedded in the short sea shipping business ecosystem.

The multitude of business actors involved in marine, port, and land logistics, as well as in shipbuilding, are part of a business ecosystem that needs, as a whole, to achieve the goal of reliable and efficient transportation, generate value at the system level and capture value for the individual supply chain participants. However, as mature industry structures become settled through differentiation and specialization processes (Porter 1980, Hagel and Singer 1999), and increasingly constrained by explicit or implicit institutionalized system architectures, the industry logic and the way investments are delivered get locked in. This allows the value chain to achieve local efficiencies and subsystem technological enhancements, but the rigidity of the system architecture then creates a formidable barrier to systemic innovation (Sheffer 2011, Sheffer *et al.* 2013) and prevents ecosystem actors from responding collectively to evolving demands in an efficient manner (Moore 1993, 1996)(Dalziel 2007). One of the foremost challenges to creation of value creation is the analysis that identifies rigid barriers, or lock ins in the workflow interdependence system. Once such analysis has been made, appropriate governance can be designed.

However, there are few examples of business ecosystem analysis. It is against this background that this paper uses workflow interdependencies related to a particular investment, the vessel, and its business ecosystem. The boundary of the vessel's business ecosystem is

defined based on which interconnected workflows affect the functionality or dysfunctionality of the vessel investment. *The purpose of this paper is thus to analyze project investments in business ecosystems through workflow interdependencies.* Our analysis of workflow interdependencies is structural functional, since the nature of the workflow determines the need for coordination and interdependence.

The implications of our analysis is that we take steps towards a framework for the analysis of workflow interdependencies, and this analysis can be used to assess the need for governance of business ecosystems for good return on investments.

LITERATURE REVIEW

Functionality of investments within business ecosystems

Most research on organizational systems has emphasized individual value appropriation over system value creation (Järvi 2013). For instance, there is extensive research on business systems and system innovation that explains how industries are altered due to the actions of individual companies (Normann and Ramírez 1993, Gulati and Singh 1998, Echols and Tsai 2005, Sarasvathy and Dew 2005, Jacobides *et al.* 2006, Pisano and Teece 2007, Gulati *et al.* 2012). That is, the focus of exploring system “shaping” efforts revolves mostly around, for example, the way companies profit from system innovations by appropriating a larger share of total value creation (Teece 1986). Business ecosystems thus contribute to research by the development of an applicable analytical framework that takes a simultaneous systems and workflow perspective that is not confined to the value creation of individual companies.

When investments are made, their functionality is defined by how they are embedded in workflows, i.e., the overall business ecosystem, and their potential to create value through that embeddedness. Business ecosystems can frequently generate more value by improving workflow coordination at the overall business ecosystem level, but actors may have conflicting goals, and resources may be scarce, so that the full potential of the entire system for value creation is not realized. Business ecosystems are usually governed by a combination of contractual and relational mechanisms. Workflow coordination is done in the context of governance in business ecosystems, implying that governance in a business ecosystem may coordinate goals and workflows at the business ecosystem level.

Workflow interdependence is an integral part of value creation, as system-wide workflow coordination can unlock benefits of value-creating business organizations, such as complementarity in resources (Dyer and Singh 1998), supply chain efficiencies (Zajac *et al.* 1993), network externalities (Katz and Shapiro 1994), and relationship value creation (Holm *et al.* 1996). Efficient workflow interdependence is achieved by the appropriate coordination of interdependent workflow activities with different kinds of interdependency (Thompson 1967, Bailey *et al.* 2010). In business ecosystems, workflows are observed to connect across multiple actors, effectively forming networks of interdependence that transcend firm boundaries (Zott and Amit 2010). However, workflows have traditionally been analyzed within the confines of a single organization, or a specific business relationship, but not previously at the larger level of the business ecosystem.

We propose that the analysis of the interdependencies between workflows that in one or another way affect an infrastructural investment has to be made on ecosystem, rather than individual project, level. In such a case, it is possible to reveal shortcomings of the current workflow governance that can potentially affect the value created by the investment throughout the project lifecycle. Analysis of interdependencies in workflows can thus be used to determine

the functionality of investments in engineering projects in business ecosystems. In order to understand the nature of workflow interdependencies and the appropriateness of mechanisms currently applied for their governance, we utilize the taxonomy proposed by Thompson (1967), which was further developed by Levitt (2015).

Types of workflow interdependencies and workflow governance

As the scale and scope of a product or service grows, there is a natural tendency for the tasks to be subdivided into smaller tasks, and for the workers who execute them to become increasingly specialized. From the earliest days of organization theory, it has been observed that this division of labor, with the resultant specialization, produces three kinds of outcomes: The expertise to perform particular subtasks becomes isolated to the local experts who perform them; each set of specialized workers develops its own terminology; and the specialized workers tend to develop local subcultures with their own parochial subgoals (Lawrence and Lorsch 1967, Heath and Staudenmayer 2000). This creates a need for either centralized or distributed coordination to achieve an integrated system-level outcome.

James Thompson (1967) defined three kinds of interdependence between tasks in the workflows of complex, fragmented tasks performed by specialized workers. Each requires a different coordination mechanism, and governance needs to match workflow interdependencies with the appropriate coordination mechanisms.

Pooled Interdependence

The simplest type of workflow involves “pooled” interdependence, in which a set of activities are needed to achieve the desired system-level outcome, but there are no technical or timing interdependencies between them. Any task required for completion has at least pooled interdependence with other tasks in the project. The system integrator of a fragmented workflow can coordinate pooled interdependence among subtasks by specifying tasks’ required outputs and the skills required by the workers who will carry out those tasks. Unless the scope of the required system changes, the activities can be performed relatively independently of the system integrator or other actors, because there are no technical or timing interdependencies between tasks.

Pooled interdependence is the least costly form of interdependence to coordinate. Mature industries evolve highly institutionalized “system architectures” to define standard component functions and subsystem interfaces. The industries that deliver office buildings, PCs, and smartphones are examples of mature and fragmented industries.

Sequential Interdependence

If a given task that already has pooled interdependence with all other tasks in the project faces the additional constraint that it cannot be initiated until one or more prerequisite tasks have been partially or fully completed, the two or more involved tasks exhibit “sequential” interdependence as well as pooled interdependence. Sequential interdependence arises from physical, topological or shared resource constraints, so that the involved tasks need to be executed in a sequential manner—for example, in conventional manufacturing and assembly or construction.

A system integrator can coordinate sequential interdependence centrally by: (1) scheduling tasks to occur in a specified sequence and requiring them to be completed by specified times, and (2) rescheduling tasks as needed to accommodate variance in the completion of prerequisite tasks or shortfalls in the availability of required shared resources. Inserting

buffers between tasks that have high variance in their durations is a commonly used strategy to avoid the need for frequent rescheduling (Goldratt 1997).

Reciprocal Interdependence

The third type of workflow defined by Thompson involves “reciprocal” interdependence between two or more subtasks. Thompson stated that coordination of this type of interdependence requires “mutual adjustment” between the interdependent parties, but did not clearly explain how it arises or what would be required to assure that decentralized mutual adjustment occurs effectively and reliably. Thus his definition of interdependence and its required form of coordination is somewhat tautological.

Following Levitt (2015), we note that reciprocal interdependence can take two forms—“compatible” vs. “contentious”—each requiring additional governance mechanisms to foster mutual adjustment in ways that optimize system level performance while minimizing the need to escalate decisions to the system integrator in case of an impasse.

“Compatible-reciprocal” interdependence requires mutual adjustment to achieve a spatial or functional fit between the task outputs of the interdependent workers; however, achieving mutual adjustment to obtain the fit does not invoke conflicting sets of sub-goals for the involved actors. Compatible-reciprocal interdependence can thus be governed simply by requiring that frequent communication and confirmation occur between the involved actors, initially in choosing, and subsequently if and when revising, each of their detailed component specifications in order to maintain alignment between their respective components or subsystems.

In contrast, “contentious-reciprocal” interdependence also requires mutual adjustment to achieve a spatial or functional fit between the outputs of the interdependent tasks; however, achieving alignment now invokes conflict between one or more of the sub-goals held by each actor—i.e., a given choice of the output that is more desirable to one is less desirable to the other, and vice versa.

Although this workflow coordination and governance framework was originally developed for project-based tasks carried out by individuals and subgroups within a single organization, or teams employed by separate firms within projects, we posit that it can be extended to business ecosystems.

METHODOLOGICAL APPROACH

The research process behind this paper is based on a clinical inquiry. Clinical research originates from the research tradition of action research and implies engaging in solving problems that are relevant to the industry (Coget, 2009; Coghlan, 2000; Schein, 1993, 1995, 2008; Schön, 1995). In this mode of research, the researchers help companies to diagnose and solve problems. Thus, the main aims of a clinical inquiry include solving a clinical problem and triggering organizational change (Schein, 1995). The main feature of such an approach is that tight cooperation with business actors occurs throughout the process and is iterative. The reason for choosing such approach was that the study object, the private and public actors in the business ecosystem, has much knowledge of their work, and can participate in analysis of their work. It allows for better access to data and constant validation of research results with the practitioners (Coghlan, 2011).

The framework proposed in this paper has been developed based on literature studies, conceptual, and empirical work. The researchers have been involved in an ongoing project that aims to analyze the short sea logistics business ecosystem in the Baltic Sea and, together with practitioners, develop solutions for increasing its efficiency and sustainability. The project

participants included two shipping companies, two key technology providers for vessels, a shipyard, and three cargo owners. A contract was signed between a number of universities, industrial companies and a financing research-oriented company, whose shareholders are a cluster of industrial companies, and which financed the project. The contract stipulated the commitments, work, and conflict resolution in the project. Industrial companies did not provide monetary resources, but instead put the time used by staff as a commitment.

The clinical research focused on the development of business with industry actors, and used meetings and documentation as tools to bring the business development process forward. Researchers used three kinds of meetings to drive the agenda forward together with the corporations:

- Annual meeting, which is a meeting to discuss the achievements during the year, and to lay out the goals for the future. Annual positioning reports lay out future work and a common vision for the project participants.
- Monthly meetings are to follow up the previous months work, and to plan work for the month ahead. Input to the work is minutes from the previous month, and an agenda for discussions.
- Operative meetings are for meetings with one or more corporations to address matters of operative importance. Operative meetings frequently happened on weekly basis.

In addition to project meetings there were a number of workshops and discussions that involved not only project participants, but also companies outside the project. The actors and the number of interactions with them are listed in Table 1.

Table 1 Major communications with industry representatives during the project

Actor type	Number of companies	Total number of individual interviews and discussions with researchers	Total number of participation in joint workshops
Companies working in the project	8	More than 150	More than 25
Cargo owners	7	13	12
Ship agencies	1	1	
Cargo brokers	2	2	
Ship pool operators	1	1	
Port management companies	12	12	1
Stevedoring companies	3	3	1
Ship operators	2	5	
Ship owners	2	5	
Technology (ship systems) providers	3	6	2
Policy-makers	5	10	1
Financiers	3	6	1
IT solution providers	1	1	
Labor union for port workers	1	2	
Various marine associations	1	1	
Various marine experts	8	8	5
TOTAL	60	More than 226	More than 48

During the project, the challenges related to the current short sea logistics ecosystem and the way vessel investments are governed were identified through these extensive discussions. After confronting the challenges thus discovered with theoretical insights regarding business ecosystems, shipping, and project management, we developed the initial conceptual framework. We used this framework for in-depth analysis of the focal short sea logistics case, and refined it based on the findings of empirical analysis, as presented in in the last chapter.

The governance models were designed and approved as project continued partly based on theoretical presuppositions described in this paper, and partly based on business viability. Thus, they were continuously tested and verified. A number of governance models proposed in this paper are already being implemented, while others are still developed conceptually within the ongoing clinical inquiry.

CASE ANALYSIS

The case of a functional investment in a Baltic short sea shipping vessel offers an example of how the success and functionality of an investment is highly dependent on the surrounding business ecosystem. The current short sea logistics ecosystem in the Baltic is characterized by a number of inefficiencies that make shipping—i.e. operation of vessels—economically and environmentally infeasible. At the same time, the shipbuilding process rests on a highly low-cost-oriented logic, creating impediments for designing and delivering vessels that are able to create greater benefits during operations over their lifecycle (Fayle 2013, Wu 2012). A functional vessel, in this context, is an investment that fulfils its main function, i.e. transportation of cargo by sea, while showing good lifecycle performance in terms of sustainability – economically, environmentally, and socially – and generate greater value.

The investment is analyzed along the dimensions of the vessel's lifecycle and ecosystem part (Figure 1). The first lifecycle phase is planning, which is the phase before and up to orders are placed for design of the vessel. Planning is followed by design, which is where the detailed designs are produced, and the design phase ends with the placement of orders for construction. The construction phase involves building the vessel, and this ends with the delivery of a vessel that is used in operations. The operations phase is when the vessel is used in short sea shipping. The business ecosystem parts that we identify are: the vessel development, which is the functional investment, and the port operations and cargo logistics being parts of the business ecosystem that have workflows that are interdependent with the vessel development.

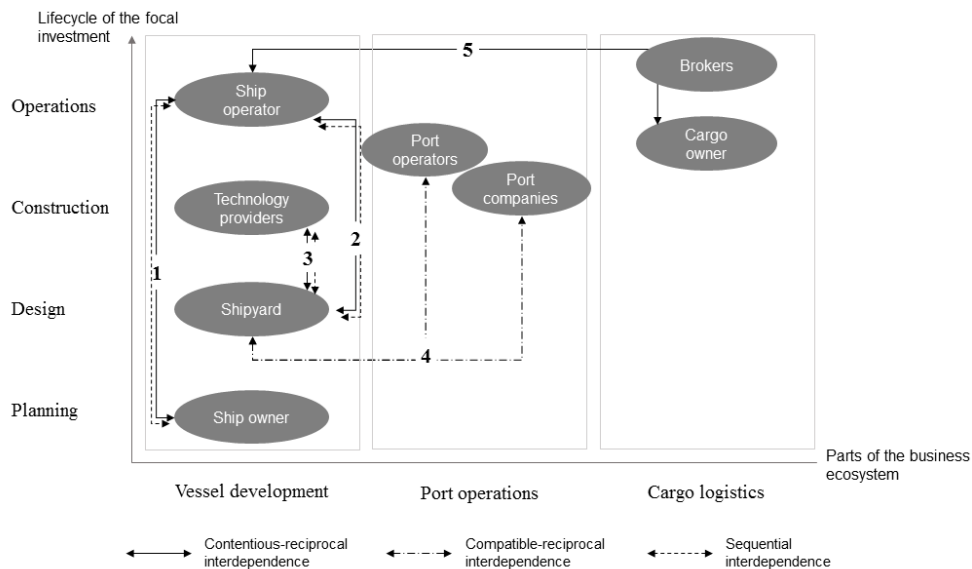


Figure 1 Mapping of critical interdependencies in business ecosystem of a functional vessel investment. Problematic issues marked by numbers are analyzed in Table 1 and discussed in this section.

Analysis of workflow interdependencies over the lifecycle of vessel development and ecosystem parts provides five examples of sub optimization of business ecosystem value creation (numbers 1 to 5 in Figure 1), and we will go into detail on these below. While there are probably more workflow interdependencies, we contend that our research method has made it possible for us to identify some of the most critical workflow interdependencies that prevent from efficient functioning of the vessel within the overall short sea logistics business ecosystem.

Most of the interdependencies that we have identified are contentious reciprocal. These are the most costly to coordinate, and so they represent a need for considerable investment in terms of the coordination effort needed. Understanding whether the character of the reciprocal dependency is compatible or contentious was key to evaluating whether the currently employed governance is adequate or whether new governance mechanisms could be designed to resolve the tensions between different actors and their activities more optimally, while ensuring the functionality of the focal investment. We put together the analysis of workflow interdependencies with the current governance, and required governance in Table 2.

The first workflow interdependence analyzed is between the ship owner, in the planning phase, and the ship operator, in the operations phase (interdependency #1 in Table 2). The shipowner is the actor that makes the decision about key characteristics of the vessel during the design and planning phase, such as its size, tonnage, suitability for certain cargos, while the ship operator is the one to operate the vessel during operations phase. Most often the two actors are connected by a rather transactional time-charter party agreement, which allows ship operator to charter and use the vessel of the shipowner for a certain price and during a period of time. In this situation, the information about actual operations is not communicated back to the shipowner, no “feedback for design” is generated, and thus the ship design workflow does not take the efficiency of the ship operations workflow into account. About half of all liner boat charters are

bareboat charter, where no crew or provisions are included (Fan and Luo 2013). Bareboat charter is preferred by ship operators because it reduces their risk, because they can put their own crew on the ship. However, bareboat charter also reduces the need for integration between the workflows of ship owners and ship operators. Since the shipowner is not involved in, nor benefits from, the operations of the vessel, there is no motivation for the shipowner to invest in more innovative, efficient, advanced and potentially more expensive technology that could lead to greater lifecycle benefits, such as reduced fuel consumption, decreased costs of cargo, fewer cleaning requirements during operations, and timely vessel maintenance to reduce operating time lost due to downtime.

Further vertical fragmentation along the vessel lifecycle is caused by the highly low cost-oriented business model of a yard, which is a technical integrator and the major actor in designing the vessel (Alfeld et al. 1998). While the shipowner is focused on building the least expensive vessel that can be chartered out, the shipyard strives to reuse existing designs and bid for the lowest construction cost among the multitude of technology providers (interdependency #2 in Table 2). For instance, models are developed to make shipyards standardize and share proprietary information on ship production (Wyman et al. 1997). Information sharing is also done by that engineering consulting companies advice and share information with several shipyards. In this information sharing, low cost production is the primary objective, and there is little consideration of workflows outside of the shipbuilding. For instance, the shipyard does not consider that they provide a ship operation service to the ship operator. Rather, the ship yards goal is to produce a low cost vessel for the ship owner (Fafandjel et al. 2013).

An adjacent problem is the lack of a link between the technological knowledge of various technology providers to the design and planning process (interdependency #3 in Table 2). Due to the low cost-oriented bidding, there is no forum for proposing more advanced designs by technology providers. Even if technology providers have the requisite knowledge, there is little interest in change, because the shipyard thinks it may increase costs.

Table 1 Analysis of critical dependencies and their governance

Critical interdependency	Type and character of interdependency	Current governance	Required governance	Enabled value creation
1 Vessel planning – vessel operation	Sequential and Contentious-Reciprocal Shipowner invests in low-CAPEX standard vessel, while ship operator would benefit from more advanced vessel that shows lower operating costs and higher revenue potential.	Dependency is governed as sequential by excluding ship operator from planning phase. Transactional time charter contract between shipowner and ship operator does not facilitate resolving conflicting subgoals of actors in the value chain	The dependency needs to be governed as sequential and contentious-reciprocal through an alliance between actors: <ul style="list-style-type: none"> • Forum for negotiation between shipowner and ship operator or merging the shipowner with ship operator. • Mechanism for redistributing benefits from the lifecycle performance of the vessel among ecosystem actors. 	Focus on life cycle performance of the vessel, alignment of interests
2 Vessel design – vessel operation	Sequential and Contentious-Reciprocal Yard follows requirements set by shipowner, reuses standard designs and bids for lowest-CAPEX systems from technology providers. Ship operator would benefit from more advanced vessel that has higher CAPEX, but shows lower operating costs and higher lifecycle revenue potential.	Dependency is governed as sequential by excluding ship operator from design phase. No formal relationship between yard and ship operator.	The dependency needs to be governed as sequential and contentious-reciprocal through an alliance between actors: <ul style="list-style-type: none"> • Forum for negotiation between yard and ship operator. • Mechanism for redistributing benefits from the improved lifecycle performance of the vessel. • Simulation of vessel operations during design phase 	Focus on life cycle performance of the vessel, alignment of interests
3 Vessel design – vessel construction	Sequential and Contentious-Reciprocal Yard follows requirements set by shipowner, reuses standard designs and bids for lowest-CAPEX systems from technology providers. Technology providers would like to provide their latest innovations, but are not involved in vessel design.	Dependency is governed as sequential with information being exchanged only through the bidding process. Technology providers provide systems according to requirements.	The dependency needs to be governed as sequential and contentious-reciprocal through an alliance between actors: <ul style="list-style-type: none"> • Forum for negotiation between technology providers, yard and ship operator. • Mechanism for redistributing benefits from the lifecycle performance of the vessel. 	Focus on life cycle performance of the vessel, alignment of interests
4 Vessel design – design of port facilities and equipment	Compatible-Reciprocal There is a need for compatibility of vessel and port facilities and equipment in order to enable logistic operations.	Dependency is governed as sequential by considering port facilities and equipment as a constraint for vessel design. Scarce information exchange.	The tasks should proceed in parallel and the dependency needs to be governed as compatible-reciprocal through: <ul style="list-style-type: none"> • Early and profound information exchange. • Co-design of vessel and port systems motivated by higher port fee for compatible ports. 	Ensured compatibility or system innovation

<p>5 Vessel operation – cargo transportation</p>	<p><i>Contentious-Reciprocal</i> Cargo owners are interested in lower freight rates and suitable delivery schedules, while ship operator is interested in higher freight rates and high vessel utilization.</p>	<p>Brokers act as intermediaries. However, they exploit the opacity of information flow between cargo owners and ship operators and do not facilitate efficient utilization of vessels or efficient transportation of cargo.</p>	<p>The dependency needs to be governed as contentious-reciprocal through resolving the conflict between parties:</p> <ul style="list-style-type: none"> • Electronic market place for cargo that enables more transparent information exchange and sets optimum freight rate. • More long-term contracts between cargo owners and ship operator in order to facilitate logistics planning. 	<p>System-level optimization of cargo flows and efficient value chain</p>
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The analysis of the first three dependencies reveals that the activities and interests of actors controlling the vessel at the early planning and design phases and those involved in the later operations phase are currently not only sequential, but also contentious-reciprocal. This dependency is currently governed by organizing the activities as sequential, thereby removing the need for mutual adjustment, but at the same time reducing the potential for achieving lifecycle benefits. Thus, in order to increase the potential for increased lifecycle performance of the vessel, there is a need to address, rather than avoid, the contentious nature of workflow interdependency. We suggest that this can be done by moving into a concurrent co-design mode, where coordination is done over life cycle phases.

One potential governance solution designed during this research project is to create an alliance that would virtually integrate the actors that are critical during the lifecycle of a vessel. This could take place using forms of contracting that align the actors' interests and incentivize them to invest their best knowledge and resources in: (1) creating a vessel that will have the potential to achieve greater lifecycle performance, and (2) ensuring that the vessel operates in the intended manner. Such actors would include the ship operator, the yard, and key technology providers. The alliance would be responsible for the design and construction of the vessel, on one hand, and for the operation and maintenance, on the other hand.

By sharing the profit generated during lifecycle vessel operation, the participants should be motivated in a number of new and more globally optimal ways. Technology providers are incentivized to adjust the capital expenditure for a vessel based on a value-driven rather than cost-driven logic and to use their best knowledge to design and maintain the vessel in such a way that operations are not disrupted. Ship operators utilize their knowledge to provide input for the design of the vessel based on the current market situation rather than being driven purely by first cost concerns. With this combined input, designers can simulate vessel construction and operations to help align the planning activities of a number of crucial actors within the alliance, as well as with potential consumers of logistics services.

The analysis now turns to the interdependencies with other parts of the business ecosystem which are crucial for the functionality and sustainability of the focal vessel investment. One such link in the vessel investment case is the dependence of vessel operations on the workflows involving port operators and port companies. The design of ports, port facilities, and equipment. There is a direct technological link between the vessel and port facilities and equipment in terms of, e.g., the size of vessels that are allowed to a certain port quay, capacity of cargo handling facilities in the port, compatibility of cargo handling systems on the vessel with those at the port, etc. (interdependency #4 in Table 2) (Cariou et al. 2014). Since such interdependency is compatible-reciprocal, there is a need for more proactive governance, which would enable coordination between the design of the vessel and the properties of equipment and facilities in relevant ports. This can be achieved by adjusting vessel design to fit certain conditions related to ports as well as by jointly designing vessel-port solutions. One of the solutions proposed within the project is to develop a specific technology for separating, storing, and transporting cargo on vessels, which would potentially require a different cargo handling process in ports. Although this requires a system-wide shift and naturally brings uncertainty, the attempt to achieve technological alignment between vessels and ports can spur more intensive information exchange and workflow alignment as well.

Yet another dependency between vessel and port activities of the ecosystem exists in the operations phase. Currently, the system for managing vessel arrivals at ports significantly undermines the value creation potential of a vessel. For example, the complicated reporting and

notification procedures, as well as highly inflexible working time of stevedoring companies force vessels to spend significant time in ports idling, while not generating any profit. In addition to that, the current “first come first served” principle creates the incentive to increase sailing speed when approaching ports, which increases fuel consumption and therefore the economic and environmental costs of operating a vessel. The relationship between ship operators and ports is transactional, and the processes at ports are highly institutionalized, making it extremely challenging to alter the current ways of working. Greater transparency and the elimination of unnecessary processes would increase overall efficiency and could be achieved by increased information exchange with port operators. This would not only facilitate communication but enhance planning, scheduling, and parallelization of port operations.

The last critical workflow interdependence analyzed within this case are those between vessel and the cargo transported at different phases of the vessel’s lifecycle. Industrial cargo owners are the ultimate users of logistics services. Thus, vessel operations need to be compatible with industrial operations, including type of cargo transported, frequency, and routes. Already during the design phase, it is crucial to identify operating profiles in order to design a functional vessel. In order to do so, designers need information on cargo flows during the planning stage. However, the demand uncertainty for many kinds of cargo makes it economically unadvisable to build vessels dedicated to one type of cargo or one customer. Currently, cargo owners are reluctant to combine their shipments with others, due to the assumed quality risks and prospective schedule delays. Our research identified the potential of introducing new cargo handling technology on the vessel, which would address the conflicting interests of various cargo owners. The opportunity to safely separate different types of cargo and efficiently combine different cargos on different routes would resolve the contentious character of this interdependency and allow for increased vessel utilization while still delivering greater value to the end customers. Coordination can be further facilitated by a new resource – an electronic marketplace for cargo transport. This solution would address the existing lack of efficient governance of the contentious-reciprocal interdependence between cargo owners and ship operators, which is currently bridged by cargo brokers in a somewhat opaque and non-optimal manner (interdependency #7 in Table 2).

We have identified which workflow interdependencies affect the value created by a functional vessel and analyzed how the governance of interdependencies between respective actors and activities needs to be adjusted. One of our major findings is that value creation is being hindered by ignoring the contentious-reciprocal character of some interdependencies. This reduces ecosystem efficiency and functionality of a given investment. New governance structures and systems that address the contentious character of existing interdependencies and create a shared interest for the crucial actors in the value chain can enhance the lifecycle performance of the investment.

The interdependencies spanning the boundaries of other sub-systems in the business ecosystem usually require compatibility of those systems and open avenues for system innovation and network externalities. Proper governance mechanisms for such compatible-reciprocal interdependencies should support extensive, transparent information sharing and thereby facilitate mutual adjustment for optimal outcomes at the ecosystem level. A remaining key challenge is to identify mechanisms that would incentivize the actors that are currently outside the boundaries of the focal investment value chain to engage in transparent communication and information sharing.

SUMMARY OF CASE ANALYSIS

The case of planning and construction of a vessel for Baltic short sea shipping shows how fragmentation and parochial sub goals lead to system level sub optimization. The method for analysis that we used to analyze improvements needed to reduce sub optimizations is analysis of workflow interdependencies. By and large, this method of analysis seems to be effective, as exemplified by that we managed to identify several interdependencies in need of change. We are cautious about the extent to which our method for analysis can be generalized, since it is one case, and since the changes we suggest have not yet been implemented. Further research is needed to substantiate our claim that workflow interdependence analysis is a good analysis technique for increasing business ecosystem value. In the present, we put forth our analysis of the case as support for that workflow interdependence analysis can potentially be a useful tool for investments in business ecosystems.

Functional investments require holistic ecosystem governance that focuses on the ecosystem performance, and not that of the individual firm or project. To design such governance systems, it is essential to understand how the focal investment is embedded in a larger business ecosystem, both in terms of the multitude of actors involved in the workflow, and in terms of the duration of the lifecycle of the investment. The mapping of ecosystem structure needs to be guided by the recognition of which interdependencies define the functionality of the functional investment and thus the efficiency of the larger business ecosystem. As demonstrated in the case analysis, mature business ecosystems can become very fragmented and hence suboptimal. As governance models become institutionalized over time, it is increasingly challenging for actors to cooperate in achieving system goals. Moreover, such fragmentation may lead to the situation where various actors, all of whom are part of a value chain or business ecosystem, acquire conflicting goals. If governance of these interdependencies is not adjusted, this can lead to failure in achieving systems value creation and the success of an investment.

Our research represents a first step towards value creation and capture analysis of functional investments through workflow analysis in business ecosystems. Future research could make a more fine-grained analysis of value creation and capture through functional investments in business ecosystems. Several options are possible, such as using different flows (information flows, physical flows, and value flows), or to use design structure matrices(DSMs), or network models.

IMPLICATIONS FOR BUSINESS ECOSYSTEM GOVERNANCE

Investing in a project that is embedded in a business ecosystem requires the investor to analyze the risks and returns of the project in the context of the business ecosystem. Our research shows how an engineering project, a vessel for short sea shipping, can be analyzed by how it ties in with the workflow interdependencies in the business ecosystem. The findings are that there are contentious reciprocal, compatible reciprocal, and sequential workflow interdependencies that result in suboptimal ecosystem performance of the short sea shipping vessel. For the vessel investment to perform well, there is a need for suboptimal workflow interdependence issues to be resolved. We point to potential governance solutions that can be used, but while research firmly point to how a given workflow interdependence should best be coordinated, the state of research on which governance to apply is less deterministic. We can therefore consider several governance mechanisms that will result in the same coordination mechanisms being used. In the

following, we discuss implications for business ecosystem governance functional investments, and we also outline future research in that area.

Compatible interdependence can be governed through contracts and networks of relationships. In some cases, governance does not have to provide much intervention, since the interdependence is compatible, and the potential for generating higher system value by aligning activities is readily apparent to all participants. Decentralized self-organized relationships and transparent and timely information sharing should suffice in such situations. However, large, complex business ecosystems often lack the formal mechanisms to align the interests of actors from different parts of the system. In such cases, effective governance requires more deliberate attention to relationships within the system.

Compatible interdependencies require regular and transparent information flows between relevant actors and tighter interconnections between their activities. For sequential interdependencies, this can be achieved through formal agreements between different actors in a value chain to exercise “just-in-time” operations, or through careful relationship management to achieve higher transparency and improve the scheduling and sequencing of various actors’ activities. In reciprocal interdependencies, early involvement of actors—for example, in the design of a vessel—can ensure compatibility throughout the business ecosystem. Absent a formal mechanism for involving certain actors, relationship management can take the form of incentives based on expected system benefits. Compatible interdependence governance creates value by integrating the value chain and establishing incentives across the business ecosystem.

Contentious-reciprocal interdependence can be governed by contract and by managing networks of relationships. The governance has to intervene when there are contentious interdependencies and mutual adjustment may result in local vs. global optimization or impasse. Often these situations require escalation of issues, and the governance needs mechanisms to reconcile conflicting subgoals among ecosystem actors. Hierarchical mechanisms are effective in resolving such incompatibilities, and the most common example is the management hierarchy with a chain of command and/or delegated responsibilities. However, hierarchies can also be virtual, meaning that the network of contracts among the parties can contain terms that incorporate routines, principles, and rules that encompass several organizations (Stinchcombe 1985).

In the case of the short sea logistics ecosystem, a number of contentious-reciprocal interdependencies were initially coordinated as compatible, through self-organizing networks. Conflicting subgoals of different actors, whose activities were reciprocal, sequential, or pooled, led directly to underperformance in overall ecosystem efficiency. This kind of result, all too common in complex long-term projects, can be explained by misalignments within business ecosystems and industry fragmentation—both of which evolve naturally over time as actors’ goals differ and local optimization efforts lead inexorably to sub-optimization of the overall business ecosystem. When making a functional investment, it is therefore crucial to identify such contentious interdependencies and address them. Concrete governance mechanisms can include alliances and other means to alter actors’ identities and relationships; simulation and co-creation ICT tools can help resolve conflicts between different actors and their activities. Contentious-reciprocal interdependence governance creates value primarily by restructuring business ecosystems for virtual integration that combines the fragmented network into a single “macrofirm” (Dioguardi 1983). Done correctly, virtual integration creates life-cycle long, system-wide economies of scale and realigns the activities of actors so they are not contentious, but rather are aligned towards a common system goal.

Vertical integration could certainly be an alternative solution. However, shipbuilding is an industry where national policy and government subsidies disturb competitive market forces (Kalouptsidi 2014; Lewis and Vellenga 2000). Vertically integrated private companies would therefore find it difficult to be profitable. Vertically integrated state owned, or subsidized companies could certainly be an alternative governance mechanism for resolving workflow interdependencies.

This paper analyses functional investments in a business ecosystem, followed by decisions on appropriate governance. We thus contribute to the research on business ecosystems by proposing a practical framework for embedding an ecosystem perspective in the governance of individual investments. We also uncover the logic for the intentional shaping of business ecosystems towards higher efficiency as opposed to perceiving them as purely evolutionary and dependent on individual companies taking the lead in their restructuring in order to appropriate maximum system value (Moore 1996).

Our method of analysis keeps the focus on efficiency over the life of the investment. We propose that constantly monitoring the physical state of the investment can enable system integrators to adapt their governance modes to realign the ecosystem with changing real-world conditions over time. Sustainable systemic performance improvements can be achieved by connecting the performance measurement of the actual physical investment to the ecosystem (Sundholm *et al.* 2015). Future research should expand the view on the focal investment to cover larger parts of the ecosystem (ports, export industry) and to identify the overall benefit of maximizing ecosystem efficiency.

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