Network Interdependencies in a Logistics Service Network: a Case Study of Offshore Oil and Gas Supply Bases

Ingrid O. Uthaug and Per Engelseth
Molde University College

Abstract

Logistics services has in literature and by logisticians been characterized as support functions; often considered peripheral to supply chain management as well as logistics research. Offshore oil and gas supply bases (OSB) is a vital networked actor supporting petroleum logistics operations. This network role calls for viewing this network actor as analytically focal in the studied network. OSBs are classified as "logistics service providers" (LSP). From a supply chain management (SCM) perspective, the LSP literature encompasses the role LSPs have in a supply network as well as focus on logistics as outsourced operations. LSPs at core represent services involving industrial particularities, including interdependencies with other firms. The Unified Service Theory (UST) states that services are dependent on input from the customer; indicating reciprocal interdependency. In OSBs this is obvious and evident in their daily practice; carrying out materials handling operations for a range of companies. The quality of these many and varied operations is dependent on quality interaction with its customers and customers suppliers; mutual adjustments. In supply chains the goods handling activities performed by the OSBs are intermediate between the freight deliverer and onward transport to offshore platforms. Only one of these actors is actually a customer to the OSB; the goods owner. This indicates that the market and trading is not an immediate concern of the OSB; trading relationships secondary to actual interaction to support the goods flow through the OSB, often from trucks, through terminals to ships. Interaction in this network accordingly supports the transactions and logistics flows of the goods owner implying need to develop an adapted model of what characterized interaction to support the logistics processes carried out by the OSB.

Introduction

Offshore oil and gas supply bases (OSBs) function as a hub for all material and supply to and from oil and gas (O&G) rigs, installations, and vessels. O&G companies has operation organizations nearby, or at, the OSBs and it is often a contract claim that main suppliers establish a department nearby. Some companies even establish a department in front of tendering processes. The amount of services offered by OSBs has increased in both volume and type during the years. This has attracted several service suppliers. In our research we have found that the OSBs are part of a service network for the O&G supply chain, where the outsourcing strategy of the O&G companies determines their role in the network. Also, the phases in developing a field can be divided in exploration, field development, and operation, demanding both different services and logistic focus from the OSBs. In the exploration phase geological surveys and test drilling are performed. For the field development phase the procurement phases described by Olsen et al. (2005) is useful: 1) engineering, 2) fabrication, 3) installation and 4) commissioning. The operation phase includes daily operations and repair and maintenance. In this paper we explore the network relations and interdependencies in this service network, placing the OSB as the focal company, and ask the question “how can interdependence be managed in an industrial network to tame uncertainty?”

Logistics services has in literature and by logisticians been characterized as support functions, often considered peripheral to supply chain management as well as logistics research. Few studies has the logistic company as the focal firm (Cui and Hertz 2011). Research on service supply chains have the basis in supply chain management literature developed for production companies and the translation into service industries has lacked an understanding of the special features of services. “*Therefore, it is argued that taking a logistics service provider as the focal firm may contribute to our understanding of logistics management.” (Cui and Hertz 2011)*

Theory review

LSPs and OSBs

Cui and Hertz (2011) refers to Hertz and Macquet p. 1006, (2006) and state that "*logistics firms are networking firms in the sense that their business idea is based on connecting organizations, coordinating activities, and combining the resources of different organizations."* As such they have become a manager of a logistic service network (Berglund et al. 1999; Fabbe-Costes, Jahre, and Roussat 2009; Lai 2004). Uthaug and Engelseth (2016) found that OSBs can be conceptualized as a LSP, based on Berglund et al's (1999) taxonomy of value creation. Offshore oil and gas supply bases are "*logistic service provider with the role of facilitating and coordinating the offshore oil and gas supply chain's service network. Enabling processes in the role of network management are the processes of coordination, management, integration, sourcing and contracting*" (Uthaug and Engelseth 2016).

OSBs create values in all four of the value creation categories; 1) operational efficiency, 2) integration of customer operations, 3) vertical or horizontal integration, and 4) supply chain management and integration. They had found few examples of companies in their fourth group, in such the OSBs are an interesting unit of analysis. OSBs have the capabilities of supply chain management and integration, but it is their customers outsourcing strategy that defines their role in the O&G service network (Uthaug and Engelseth 2016). Where O&G companies establish operation organizations, their suppliers follow. In such there is an agglomeration of O&G related companies close to OSBs. Hervik (2008) found that the O&G related activity around the OSB Vestbase in Kristiansund has the characteristics of an industrial cluster.

Service supply chain

A way to approach networks is through the supply chain management (SCM) research. SCM and supply network (SN) research aims to identify and manage the processes between supply chain/network members (Lambert, Cooper, and Pagh 1998) for the purpose of strategic competition (Lamming et al. 2000). The research in SCM and SN is dominated by research of production of gods (Gripsrud, Jahre, and Gøran 2006; Janvier-James 2012; Vargo and Lusch 2004; Sampson and Froehle 2006). In manufacturing, the supply chain has a sequential order, where physical goods flow through the supply chain. However, research in supply chain management, operation management and marketing has in the recent years included research in services (Vargo and Lusch 2004; Spring and Araujo 2009; Ellram, Tate, and Billington 2004; Sampson and Froehle 2006). Ellram, Tate, and Billington (2004) define supply chain management, modified to include professional services: *"Supply chain management is the management of information, processes, capacity, service performance and funds from the earliest supplier to the ultimate customer"*. They also present a service supply chain model, where they identify six managerial processes; (1) capacity management; (2) demand management; (3) customer relationship management; (4) supplier relationship management; (5) service delivery management; and (6) cash flow management.

Vargo and Lusch (2004) address the goods-dominant view of marketing and present a service-dominant logic, where they define services as "the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself". Further they present eight fundamental premises (FPs) forming the framework of the emerging service dominant logic of marketing.

FP1: The application of specialized skills and knowledge is the fundamental unit of exchange.
FP2: Indirect exchange masks the fundamental unit of exchange (meaning that the highly specialized competence of persons not are offered on the marketplace directly, but are collected in e.g. companies that make use of several specialized competences in their offerings).
FP3: Goods are distribution mechanisms for service provision (meaning that products embodies specialized competence, e.g wheels, pulleys, internal combustion engines, and integrated chips).

FP4: Knowledge is the fundamental source of competitive advantage.
FP5: All economies are services economies.
FP6: The customer is always a co-producer.
FP7: The enterprise can only make value propositions (meaning that the value is determined by the consumer).
FP8: A service-centered view is customer oriented and relational.

Regarding to Sampson and Froehle (2006) all service processes needs customer input. The customer inputs are customer-self (co-production as employment of the customer labor), tangible belonging (as property or physical objects) and customer-provided information (Sampson and Froehle 2006). Sampson and Froehle (2006) use the definition of customers by Sampson (2001): *"the individuals or entities who determine whether or not the service provider shall be compensated for production."* (p. 332). The decision maker and the buyer (payer) of the service may not be the consumer of the service. There is also a distinction between paying customers and indirect customers. Airline safety institutions are given as an example of an indirect customer. Service supply chains are bidirectional, since the customer also is the main supplier (Sampson and Froehle 2006). Production cannot start before the customer brings the input. Other special feature with service supply chains is that they tend to be a hub, not a chain, and they are short, more than two levels are rarely seen.

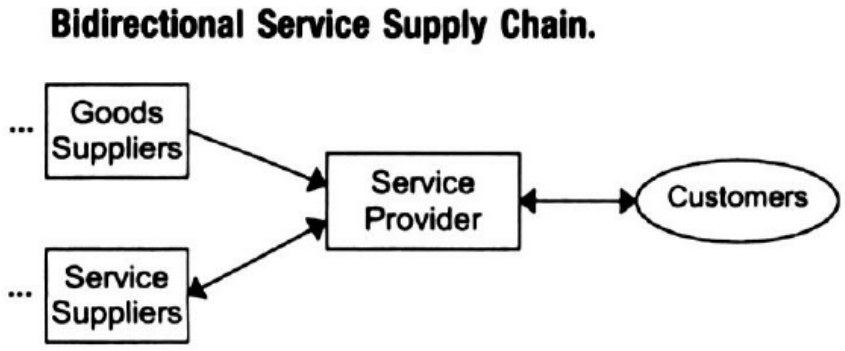


Figure 1: Bidirectional service supply chain (Sampson and Froehle 2006)

Customers supplying inputs have operational implications. Sampson and Froehle (2006) mention random arrivals, inconsistent specification, and varying input quality that influence service processes as capacity and demand management and quality management. Reservation systems, price incentives and promotion of off-peak demand, and customer self-service are examples of capacity and demand management actions (Sampson and Froehle 2006). The quality of customer inputs can also vary.

Clusters, industrial districts and networks

The location of offshore oil and gas supply bases is in Norway regulated by the government as a mean for regional development. O&G companies establish operational organizations in these locations, and their suppliers follow. Thus, there has been an agglomeration of companies in those places. Michael Porter defines clusters as "geographic concentrations of interconnected companies and institutions in a particular field". Cluster theory describes competitive advantages firms gains just being a cluster member (Porter 1998) and do not include companies strategic and managerial decisions at company or supply chain/network level. Industrial districts and parks emerged as a mean of political driven regional development (Vidová 2010) and thus research has been focused on regional economic impact. However, recent research has focussed on the industrial network these companies form (Ebers and Jarillo 1997). Ebers and Jarillo (1997) define an industry network as "a set of organizations that have developed recurring ties when serving a particular market."

The constitution of networks "is to provide a shared system of conventions that guide interaction among actors" (Mouzas and Ford 2009). When studying networks that happen to lie in a cluster or industrial district, this may influence the strategic possibilities companies have in create their own network culture. Gadde, Håkansson, and Persson (2010) explicate how network interaction involves features of complementarities, completion and independence. In addition, supply relationships may vary in strategic importance (Kraljic 1983) impacting on how logistics processes are configured (Gadde, Håkansson, and Persson 2010).

Thompson (2003) conceive complex organizations as open systems, *"hence indeterminate and faced with uncertainty, but at the same time as subject to criteria of rationality and hence needing determinateness and certainty."* In such, system dependencies and uncertainty can be identified, but the system contains an inherent ability to react upon this. Links between actors can both be interdependencies and collaboration. Hakansson and Persson (2004) refer to Thompson (2003) as the first to distinguish between three forms of interdependencies between firms: pooled, sequential, and reciprocal interdependence.

Pooled interdependence describes the dependence the part has to the system by being a part of the system (Thompson 2003). Hakansson and Persson (2004) describe this as an indirect dependency, where activities share a common activity or resource, as shared resources, where economy of scale can be obtained where the activities are identical and economy of scope is similar. Regarding to them these two activities constitutes a technological or managerial system. Sequential or serial interdependence is where one activity is dependent of a previous activity (Thompson 2003, Håkansson and Persson 2007). Time, technological and administrative interdependencies can be exploited between activities (Håkansson and Persson 2007). Reciprocal interdependence is where the output of each becomes input for the others (Thompson 2003). Thompson (2003) mention airline maintenance as an example while Håkansson and Persson (2007) mention development projects, dependent of mutual learning and continuous exchange of information.

Interdependencies put forward the need for coordination, and different forms of interdependencies needs different devices for coordination (Thompson 2003). Håkansson and Persson (2007) describe three forms of collaborations between companies: Distributive collaboration, functional collaboration, and systemic collaboration. Distributive collaboration refers to allocation of volume, activities, and resources (Håkansson and Persson 2007), and it what Thompson (2003) refers to as coordination by standardization. Functional collaboration normally involves the coordination and adaptation of sequential activities and functions, by sharing plans, forecasts, production- or market plans, and may involve performance reviews on a regular basis, joint performance measurement, as well as leveraging resources, capacity and the sharing of skills and knowledge. Thompson (2003) use the term coordination by plan, and is more appropriate for more dynamic situations than standardization. Systemic collaboration involves a combination of all the different interdependencies, and collaborative actions may be information sharing, performance measurement, adapting resources and skills, and joint problem solving (Håkansson and Persson 2007). Thompson (2003) use the term coordination by mutual adjustment.

The biggest difference in the three new service-oriented views presented by Vargo and Lusch (2004), Sampson and Froehle (2006), and Ellram, Tate and Billington (2004) are fundamental: Vargo and Lusch (2004) discard the "old" school totally by taking the total opposite direction: "All economies are services economies", and instead of adjusting the goods-dominated framework, they attempt to build a new. Ellram, Tate, and Billington (2004) modify the production oriented definition and framework so that services are not excluded by their nature and propose a framework that should fit both the production of goods and services. Missing in their article is a clear presentation of what services are and how services are different from goods. Vargo and Lusch (2004) and Sampson and Froehle (2006) share the impression that the customer has a significant role in service production. Following Vargo and Lusch (2004) services are always co-produced with the customer. Customer co-production is by Sampson and Froehle (2006) only one type of input that might take place in service production; the other two is physical products and information. The unit of analysis regarding

Sampson and Froehle (2006) is the process, not the firm or the industry. This is a narrow focus that might miss industry specific informal rules and culture, and do not consider interdependencies among customers. Thompson (2003) and Håkansson og Persson (2007) explore the interdependencies between companies and dived them in three groups that give different actions to manage uncertainty and exploit the interdependencies by different forms of collaborations. The focus on business relationships between contracting firms may miss the "shared system of conventions" (Mouzas and Ford 2009). Ellram, Tate, and Billington (2004) have separate managerial processes for demand management, customer relationship management and service delivery management, which not indicate a co-production process.

Research method

The case study research strategy is conducted in line with Yin (2009) to create focus and order regarding OSB logistics and supply chain management in a complex network setting. This network is accordingly the unit of analysis of this study. Taylor (2005), Fernie and Thorpe (2007), Scott and Anthony (2007), and Holweg and Pil (2008) stated that this method is appropriate for describing actors, structure and agency relations taking place through real social interaction. This single case approach was chosen since this allows detailed process descriptions and in-case comparison of conceptually similar processes (Voss, Tsikriktsis and Frohlich 2002). In accordance with Eisenhardt (1989) qualitative approach, the study was used to derive theoretical understanding associated with two form of IT development and use, traceability and quality assurance, and consider conceptually how these two distinct supply chain functionalities could be regarded integrated in a real life setting associated with our case study of IT use in an EPC context.

Few studies are found where a logistic service provider is the focal firm in a network setting. Thus, this called for an exploratory approach. Semi-structured interviews were conducted with four OSB managers with management responsibility for 12 OSBs. This entails a sequential interdependency of this process, preceding understanding developed through iterations between substance, theory and the empirical directing research in a clearly stepwise and piecemeal manner.

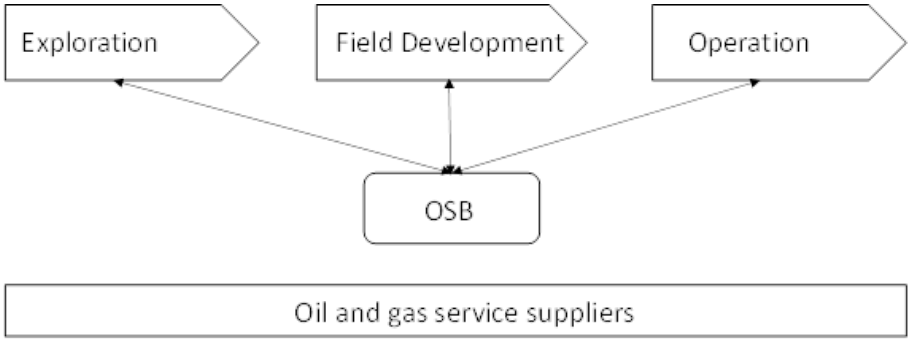
Theoretical direction was not clear when the research started. Research in logistics includes companies such as Maersk, Nor-Cargo and Bring, which primarily provide transportation between destinations. Port services has developed to include managerial services, but are handling standardized cargo. SCM research considers logistics as support functions and has been focusing on production of goods. Thus, the matching of theoretical data and empirical findings has been a reciprocal process. At the end, several theories are combined to make sense of the logistic service network that OSBs represent.

Findings

OSBs function as a hub for all equipment, material and supply to and from the rigs, installations and vessels for the O&G exploration and exploitation. Oil and gas service suppliers are various service providers delivering diverse services to the oil and gas supply chain. Where the oil and gas companies establish operational organizations, their suppliers follow (Uthaug and Engelseth 2016). This could also be a contract requirement. Some suppliers even establish nearby the oil companies in front of the tendering process. In such, both the OSBs customers and the customers' main suppliers have organizations or representatives at or nearby the OSBs.

The OSBs scope of work is dependent on their customers outsourcing strategy. We have divided the scope of work in three categories, dependent on the complexity and managerial level; (1) traditional logistic services; (2) logistic management services; and (3) logistic service management. Traditional logistic service is what forms the basic OSB service, as loading and unloading of trucks and vessels, internal transportation, co-ordination, goods reception, packing of containers, handling of equipment, eg tubes and risers, forwarding and customs. Examples of logistic management services are management of warehouse and storage for customers, document control, management of tubes and

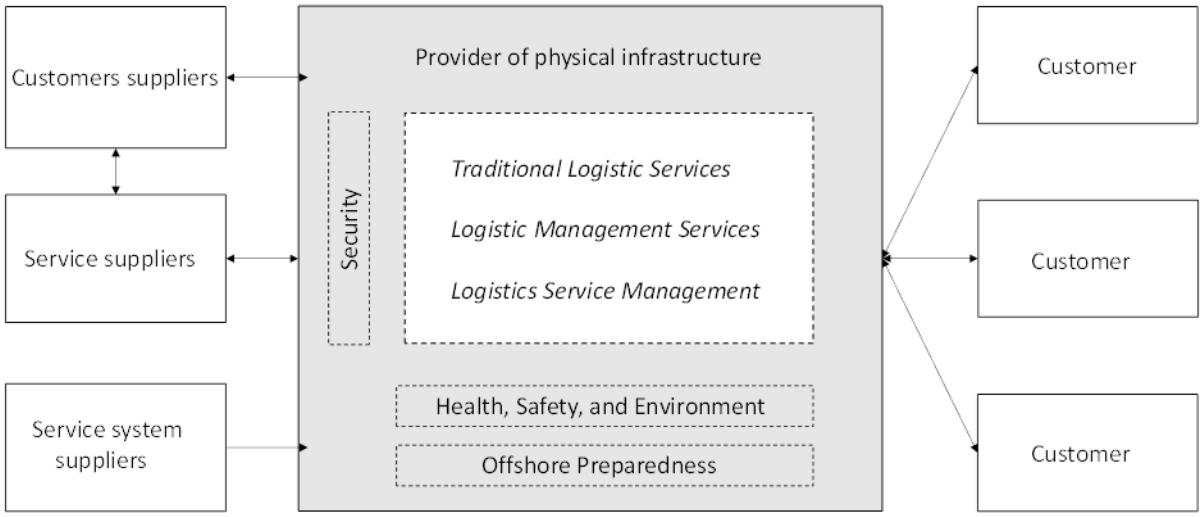
risers, logistic personnel provider, coordination of vessels and helicopters, customer center/logistic center, and management of heavy lift operations. By logistic service management, we refer to operations and services where the OSBs are given the total responsibility for a particular area or operation. Where companies outsource these operations and services, the OSBs are given same responsibility as being an own department of their customers. Examples of this is project management, logistic planning and optimization, health, environment and safety (HES) services, security, management of maintenance network, and sourcing and contracting. The OSBs one-stop-shop strategy demands more services than the OSBs produce by themselves. Examples of such services are supplies and material, fuel and bulk products, cleaning services, inspection services, preservation services, maintenance services, waste management, weather forecasting, mud purification plant, transportation, Cargo Carrying Units (CCU), and oil spill response (storage and preservation of Blowout Prevention Unit (BPU))(Uthaug and Engelseth 2016).



"What we do are outsourced – the companies, our customers, have done this themselves to a certain extent, and then they said that now can you do it."

"No contracts are similar. They are different with respect to customer demands. …. They (the operator companies) present finished drafts as they want them to be, and then we bid in accordance with that."

Offshore Oil and Gas Supply Bases Service Supply Chain



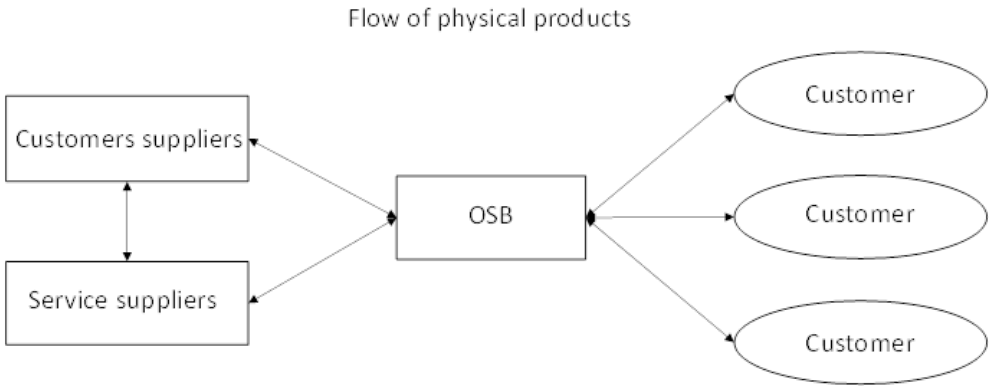
"Through our models we can deliver a total logistic service to an operator or rig-consortium, that includes helicopter, vessels, total transportation, forwarding, custom store, supply base, coordination, CCUs, waste management, and weather forecasting."

O&G installations and ports have strict regulations of security. All material and personnel have to be approved and registered to enter the base area. Because of the potential for catastrophic events the government and the industry has implemented strict regulations, rules and industry standards. Suppliers have to be pre-qualified in accordance with specific regulations and procedures in order to be considered as a supplier, and they are measured on specific targets and undergo revision to maintain their approval. There are strict regulations and procedures that have to be followed to ensure the quality of material, parts, tools and processes, and there is a strict regulation of documentation of equipment, parts and processes. All companies must be certified in accordance to HES regulations and has to commit to the O&G companies own specific rules and targets. The OSBs have a responsibility to oversee and manage those procedures and processes for involved actors are in accordance to these requirements. OSBs also have roles in oil spill response and emergency preparedness.

The OSBs have an important role in the infrastructure development. The OSBs areas are owned by other actors within the same company group or by other actors. Customer demand and OSB strategy are the main sources for development of infrastructure. Physical infrastructure includes quays, offices, warehouse, indoor/outdoor storage, subsea hall, workshops, fuel and bulk plants, and handling and lifting equipment. Some OSBs has established an industrial park, where they rent out buildings and area to customers. Vestbase in Kristiansund is an example of an OSB that has established an industrial park. Approximately 60 companies are represented at the OSBs area. In Stavanger many of the oil related companies has their main office. Thus, the need for an industrial park is not present.

Flow of physical products

All materials and supply to offshore operations are sent through an OSB. The ultimate customer in the upstream O&G supply chain is the O&G companies. Products that should be sent out to offshore operations come from customer's suppliers, service suppliers and O&G companies. The OSBs receive goods from several companies that shall be sent out by different vessels to different installations. The demand for OSB services are driven by the offshore O&G activity and are dependent of the phases in O&G exploration and exploitation. Drilling operations have intense activity over a limited period, and the demand is unsure, dependent on what challenges the drilling operations face. Supply to operating installations are more regular and standardized. However, due to the risk of offshore operations OSBs must be able to respond to some demand on short notice, 24/7.



For offshore operations almost all material sent out are returned as waste or parts and tools for repair and maintenance and are addressed to different service suppliers. The O&G companies operations determine the flow of goods. For OSBs the inbound logistics are delivered from the customers suppliers, in which they have no formal business relationship with.

"It is to receive a commodity, register it in some system, take care of it for a certain time and send it out with right vessel. And also make sure that you have necessary resources available, both human and machines and area."

However, what is received vary a lot, depending on the phases in O&G exploration and exploitation.

You have ordinary supply - operating supply which is loaded in containers – supply, spare parts and such things. That goes in standard containers, and very much of it is "direct goods" that come in, are checked, packed and going out. And you also have spare parts which go in to warehouse and out and new is coming in, and some is sent to repair and returns back to store again. We manage the inventory for operator companies. And then you have drilling supply…. Njord (an oilfield) is drilling continuous. … And Heidrun (another oil field) have been drilling since it was new. So you have drilling operations on permanent installations and mobile installations."

"Where Dusavik is an OSB characterized of regular supply to the installations… They (the vessels) goes like a bus, only interrupted by weather and delays out in the field."

"Tananger is an OSB that do not have that type of activity. There it is project based. There it is huge differences in activity level. High activity from April to September/October, then it is relatively quiet."

"One thing that is certain is that the drilling operations plans change almost from hour to hour."

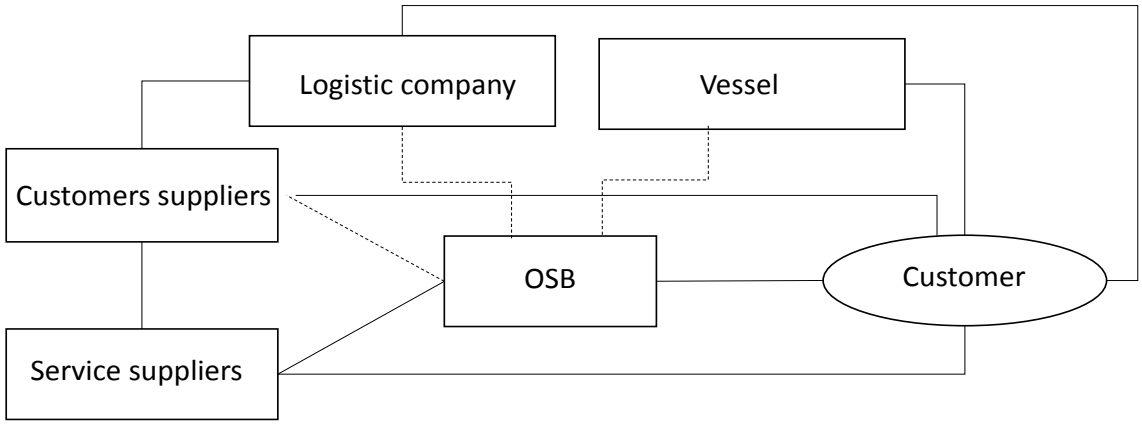
"… If you see over there, there is among other the preparation hall for pipes, all pipes that is going in and out of the North Sea. That is, approximately, 25-35 % of what we do – handling of these pipes. The handling is in front of loading them on the boat. It is on storage some place before they come in, then they going through inspection, cleaning, threading…."

"About service of tubes: "We handle assignments from orders - transportation, storage and bundling. That is … the lowest level of input factors we have in this. …. For some customers we have what we call one-stop-shop. Then the company order what they need for the well, the types of pipes, length and the variations within the scope. They send it to us; we pick the tubes from their storage, because we manage their storage, we inspect and then prepare in accordance to their specification. We document material quality, strength, that the threads are good, that they have the right type of lubrications for the well, and all the necessary technical details. And then you have what Oss-Nor does (a company specialized on tubes) – they cut, thread, screw together, and prepare the pieces that are not standard tubes. …. We manage all this in accordance to order, document it and load it on the vessel, and then report to customer that we have delivered in accordance to order."

Business relationships

Freight arrangements to the OSBs are regulated by the contracts between O&G companies and their suppliers. These contracts often include freight to the OSB, meaning that the oil company supplier arrange the freight to the OSB. It is also the O&G companies that contract vessels. The dotted lines are dependent of the extent of the oil companies outsourcing strategies. Rig consortiums often outsource all logistic and related service operations to OSBs. In such situations the OSB source and contract, manage and coordinate the logistic service network (Uthaug and Engelseth 2016). The rig consortium (customer) then only has one contract with the OSB for those services.

Business relationship (contracts)



Information flow

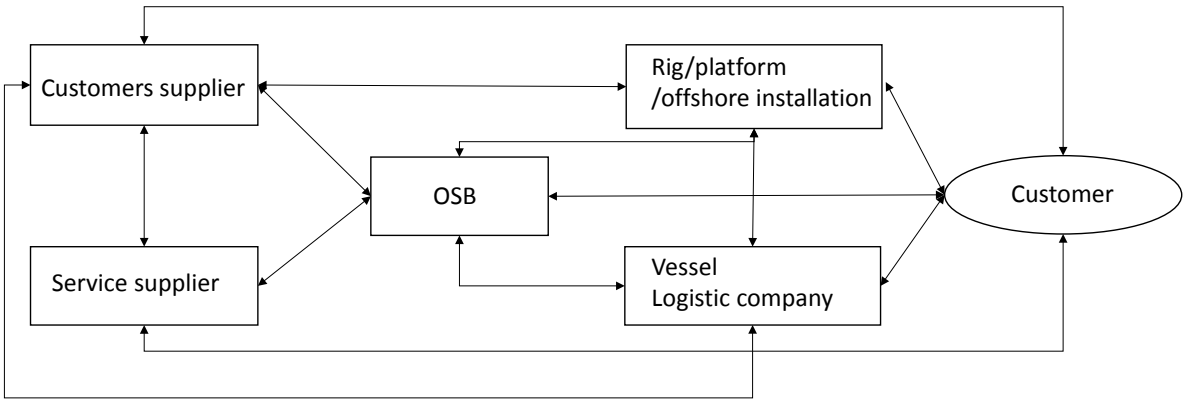
Customer information is an important customer input. The formal contract is between the OSBs and the customer. However, the OSBs are dependent on information also from customers suppliers, logistic companies, vessels and from the rig/platforms and installations in addition to information from the customers. The OSBs does not have formal contracts with these companies. Delivery times and conditions are regulated in contracts and information are exchanged between the contracting parties. Information about arrival of products, trucks and vessels are essential for the planning horizon of the OSB.

With several actors involved, the coordination task is of importance. Customer or logistic centres are found at both OSBs and customers. Logistic coordinators, often employed by the OSBs, work at customers' office and have the responsibility for logistic operations.

About customer centre: "*We have own coordinators that work against their customers. The operator companies also have a logistic centre, an operational council. The dialog is often there."*

'Today one operator speaks with the vessels themselves. For another operator we speak with the vessels. We have established an own company for coordination and planning of vessels – group company" (name of companies removed by authors)

Flow of information



Rigs and installations have limited space. Thus, they are dependent on regular supply. Supply is time-critical due to that delays in supply can delay or stop the offshore operations and production and the vessels and rigs have a high rental cost. The cost of OSB services is small compared to this. However, delays and mistakes onshore influence the offshore operations.

"There are a lot of tubes that comes in and out all the time, and there is easy to do mistakes. It is the least popular work. Physical heavy and monotonous, because you stand strapping, lifting and holding. It is very little variation. Thus we have to rotate people, to avoid they got tired or incurs strain injuries."

"And then we sit here, and often have a full-loaded vessel and just sit and wait for that package."
"The operator has left it over to their supplier, and then it's up to the supplier to prioritize according to their sub-optimization."

"I see that many of the challenges we have is poor communication between these actors. As a classic example on feedback is; that crane only is utilized five hour of a day, while we have others that is utilized eight hours. Why? That is because we are waiting for the others. The load is not coming, it comes too late. …. At the end this is causing that the vessel leaves to late, and maybe not reach the weather-window out in the sea."

"He told a vessel was delayed today. That happens often, that is something you really can not control. But what we can control, if we receive earlier information, because it takes eleven to twelve hours to sail, is to change plans."

"If they should be able to pack the containers, the suppliers have to deliver in accordance to a time table... All goods that are going out next day should be delivered at the OSB before two o'clock the day before. That means that 70-80% of the load should be ready."

"It is due to this (the waiting) we have introduced a substantial Lean initiative. … It is quite expensive to sit and wait, and then we are not able to finish to four o'clock, it will be overtime. We do not get paid for overtime, we get paid per ton."

"Still the most frequent cause of waiting, that the planned time is not in accordance to the actual time, is that you wait for documentation, don't follow the manifests, do not manage to perform, or that the goods is not ready."

Analysis

As both Sampson and Froehle (2006) and Vargo and Lusch (2006) point out, services are dependent of customer input. OSBs receive customer input in form of physical products both from the customer it selves and the customers suppliers. In both cases, the OSBs customer initiates the input. Input from service suppliers are initiated of the OSBs, the OSBs customers or the OSBs customers' suppliers. In such they are an example of a bidirectional supply chain (Sampson and Froehle 2006).

OSBs have three categories of service type; traditional logistic services, logistic service management, and logistics management services. In offshore operations, some operations are more time-critical and has a higher uncertainty and risk than others. Logistic operations vary from standardized operations to special or heavy lift operations. The planning horizon vary, both regarding to the special features within offshore operations but also with the planned information of shipments.

Interdependencies

Due to the nature of the OSB as a service provider, the companies will experience pooled interdependencies in the industrial network (Thompson 2003, Hakansson and Persson 2004). OSB's role as a one-stop-shop requires that they have service suppliers available to meet customers needs.

Service suppliers will also have advantage of the OSBs ability to fulfill the one-stop-shop strategy, because it attracts more customers to the OSB, and thus to them. As the services are dependent of customer input, there is a sequential interdependency between actors. As reported through the interviews the OSBs experience delays in deliveries, and that they receive information of delays too late to change their plans. Delays in deliveries can be caused of sub-optimization from both the O&G companies' suppliers and the carrier. Sub-optimization from the O&G companies' suppliers was explained caused by the contract between the supplier and the O&G company, in which the freight to the OSB was included in the contract. The supplier was believed to reduce own total freight costs, and would thus plan freight with other deliveries. Also, the carrier would seek to optimize own utilization of trucks and thus plan the transport according to this. Documentation is also required for offshore shipments. Physical products cannot be sent if the required documentation is not present. Documentation sometimes follow the physical products and sometime exchanged between contracting parties. Due to limited space on offshore operations, and the cost of shutting down production, it is important that all parts and equipment necessary are present. Delay from one supplier thus will have consequences for many actors. For OSBs this means they have to change plans according to this. Not delivering is not an option.

Late deliveries cause delays in the loading process. Vessels have to be loaded in a certain manner and one late delivery can stop the entire loading process. In such there is a reciprocal interdependency between several actors. Services such as maintenance, repair, and testing also provide a reciprocal interdependency. The owner of the equipment often is the O&G company while product information is given by the original manufacturer. The nature of services makes demand and thus capacity management challenging. For OSBs the demand is derived from offshore operations. Regular supply and planned repair and maintenance operations have a longer planning horizon, however still influenced by the weather conditions. As described, drilling operations are more unpredictable. Also, unplanned repair gives short planning horizons. Failure in offshore operations can have huge consequences. Shut-down of production or delays in operations have economic consequences. Failure also has the potential to create disasters. Evacuations of installations due to gas-leaks happens. In addition to reacting to sudden incidents, OSBs also have a role in offshore preparedness. Thus, there are also industry or operations specific uncertainties.

Uncertainty reduction

Uncertainties caused by interdependencies can be reduced by collaboration (Thompson 2003). However, several of the interdependencies described over is not between contracting partners, but between network actors with no formal relationships. In such also network interdependencies has to be taken into account.

OSBs carry out as a networked service provider demand and supply management. They do this by managing equipment, inventories and spare parts. Repair, maintenance and preservation can be done in lower activity periods and they have control of the total logistic process when call-off. An example of capacity management for OSBs is that they have set delivery times for supply to the OSB for different types of supply. However, much of the OSB activity has a short planning horizon. Services on material and equipment in stock is not time critical and can have a longer planning horizon. Material and parts in OSB managed stores reduces the uncertainty of late delivery from outside customer suppliers.

OSBs have own customer or logistic centres that coordinate base activity. They also have dedicated personnel assigned to some of their customers. They also rent out logistic personnel to customer to fill logistic positions in customers' organizations and to customers logistic centres. These persons will have hands-on information of customers' plans, and access to logistic information from O&G suppliers. This has potential to reduce network uncertainty between the OSB and the customers' suppliers. In addition, they know the OSBs routines and requirement, and have the ability to bring this forward in the offshore operations plans. As told by one manager, O&G companies have they core competency in finding solutions for extracting oil and gas. Logistics operations thus often become a

secondhand job. By providing logistic personnel, they achieve to consider logistic challenges during the development process. This is a form of integration and goes beyond the collaborative actions described by Thompson (2003) and Håkansson and Persson (2007).

Vestbase in Kristiansund is an example of an OSB that has established an industrial park. Approximately 60 companies, as O&G companies, their suppliers and service suppliers are established inside the OSB area. Companies at the OSB thus can be customers, suppliers and competitors. Vestbase and the property company develop the infrastructure based on future expectations and strategy and together with specific customers. The pooled interdependency between these companies will differ from the interdependency between companies outside the OSB area or other OSBs. Collecting companies in an industrial park is also a form of integration. Vestbase also arrange cultural activities including all companies at the OSB.

"For our part, it is clear we wants to develop infrastructure and build a more solid industrial cluster – that is important for building a good environment."

There are also examples of network initiatives. One OSB has established a network connecting companies with the purpose to offer total services for rig maintenance. In Kristiansund a public organization arrange a meeting every 14th day where oil and gas related issues is on the agenda. An OSB in Stavanger told that oil related companies in the region have asked to take up the practice of informal meetings again. Several industry actors arrange industry specific conferences, as oil and gas-, HES-, offshore logistics-, and preparedness conferences. Companies use these meeting places as networking arenas, but they also have important for manifesting unformal rules and ways of conduct.
Where OSBs have management responsibilities, for example document control or managing inventories and spare parts, they work on the customer ERP system, which is mostly SAP. This is a form of integration of managerial processes. The industry acknowledges that there is issues with traceability of parts and equipment. Oil companies have for several years worked with implementation of a common RFID system to be able to track and trace goods. However, this is not yet agreed upon. Where O&C companies outsource the entire processes or areas, the OSBs role is similar to the role of internal departments. They plan and manage the processes and report to the customer. This can also include sourcing and contracting to service suppliers. This is also an integration of managerial processes, but with wider authorization. In such situations, the OSBs increase their planning horizon.

Conclusion

Theory on interdependencies between contracting parties and supply chain interdependencies is weakly developed regarding the special features of logistic service networks.

This research also brings forward the differences in SCM and the network approach including notion of management in networks. In SCM interdependencies are described between contracting parties in a sequential matter. As is the case for the service network that OSBs have a central part, is that each companies supply chain influence other companies supply chain. Companies internal managerial processes as logistic planning and information flow is interdependent with other companies processes even if there is not a business relationship. Thus network interdependencies have to be taken into account. This involves interaction widening the scope of investigation from a single dyad to multiple and interacting dyads of business relationship that an industrial network comprises of.

The business relationship OSBs have with the O&G companies includes providing services to customers suppliers. This brings forward some challenges: (1) OSBs cannot regulate the relationship through contracts, and thus have no formal tools for follow up and corrective actions; (2) Information does not follow the flow of physical products, thus information about cargo and delays may be delayed to the OSB; (3) Customers suppliers have through contract with O&G suppliers an incentive for sub-optimization; and (4) OSBs receive payment per ton load, and when there is delays and change in plans, they hold the cost.

OSBs and service suppliers has a networked interdependency. The more complete network, the more activity is obtained in the network.

OSBs manage several processes that reduce uncertainty. These include setting delivery time, customer/ logistic centres, dedicated employees to customers and management of inventories are examples of actions that reduce SC uncertainty. Renting out logistic personnel to customers, industrial park services and network initiatives are examples of actions that reduce network uncertainties. Rig consortiums outsource all logistic services to OSBs. This reduces OSBs uncertainty with delivery and delivery information. The supply network is a flexible organization since it encompasses several interacting realms of interacting management. This is because it comprises of different complementary actors.

Understanding this complementarity may be enhanced through considering interdependencies between firms in the particular studied oil and gas industry supply network. Findings point in the direction that SC and network bring forward different interdependencies and thus require different actions to tame uncertainties. SC uncertainty is addressed with managerial and collaborative actions, while network uncertainty is addressed through integration and network initiatives. Thus, informal interaction bring forward rules and ways of conduct that enhance a common network picture. Operations uncertainty is reduced when the OSB is given higher managerial responsibility.

Particularities regarding OSB/O&G when viewed as a service network include that there is no defined network manager. Everyone takes care of their own supply chain. This entails that supply chain integration still is limited. This also entails that SCM efficiencies may be enhanced through improved collaboration leading top better coordination of logistics processes at the supply base. Also the supply chain focus on material flow and information leads to that information does not reach or is given too late for efficient network operations/flows. This implies that in addition to integrating the flow of goods and services, the flow of information that supports these production processes also needs to be enhanced. This includes two aspects: (1) coordinating different information processes with each other, and (2) improving interaction between the flow of information and the production-related flow of goods and services. The latter involves enhanced goods identification techniques as well as providing documents that better manage the production at the supply base.

Limitations and further research

Limitations may be that other OSBs differ from descriptions given in this paper. Interviews were also conducted with managers – further interviews with other employees may give another picture, and would have given a broader picture of the situation. This also forms the basis for further research. This paper also calls for a more throughout study of network interdependencies, uncertainties and integration. This entails probing further into the details regarding operations and how inter organizational networking supports these operations. Further research can also be about how networking through information exchange supports logistics processes, which cut through company borderlines.

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