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NAVIGATING TOWARDS A DIGITAL ECOSYSTEM: THE CASE STUDY OF OFFSHORE INFRASTRUCTURE INDUSTRY

Research paper

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Abstract

While Information Systems (IS) researchers have studied the role of digital platform governance mechanisms in digital ecosystems formation, less is known about the dynamics shaping nascent ecosystems formation prior to platfromization. This is particularly important in understanding transitions towards digital ecosystems in established industrial settings. Applying the theoretical lens of ambidexterity, we investigate a case study of establishing a digital ecosystem in the offshore infrastructure industry. Our findings indicate that although firms seek transition towards operating in a digital ecosystem, the uncertainties of the situation ahead make it difficult for them to know just how such a digital form of organizing would look. To this end, we identify three digital ecosystem strategies companies pursue during nascent digital ecosystems formation: data structure control, data flow control and data content control. Based on these, we offer three contributions to existing digital ecosystems literature.

Keywords: Digital ecosystem, Ambidexterity, Transition

1 Introduction

Pervasive digitalization of entire sectors and industries affords a shift in the development and delivery of products and services towards digital ecosystems (de Reuver *et al.*, 2015, Kapoor and Agarwal, 2017, Selander *et al.*, 2013, Sørensen *et al.*, 2015). Understanding digital ecosystem as a "collective of firms that are inter-linked by a common interest in the prosperity of a digital technology for materializing their own product or service innovations" (Selander *et al.*, 2013, p.184), the IS literature has gravitated towards the digital platform around which digital ecosystems organize (e.g. de Reuver *et al.*, 2015, Eaton *et al.*, 2011, Gawer, 2014, Gawer and Cusumano, 2014, Tiwana *et al.*, 2010). As such, emphasis has been on identifying the characteristics of digital platforms (Yoo *et al.*, 2010), understanding the orchestration and governance mechanisms for attracting users and complementors into the digital ecosystem, as well as non-platform owners' strategies for participation in the digital ecosystems (Kapoor and Agarwal, 2017, Selander *et al.*, 2013). Researchers have therefore paid much attention to cases of digital ecosystems such as Apple and Google where the digital platforms exist prior to the ecosystem formation (e.g. Kapoor and Agarwal, 2017).

However, de Reuver *et al.* (2018) in the literature review on digital platforms observe that digital platforms emerge in multi-actor settings where firms and people with divergent interests seek to influence, shape, and redefine what the digital platform is to be. While IS researchers predominantly focused on digital platforms, what requires more attention is the ecosystem around it and getting a better understanding of digital ecosystem formation (de Reuver *et al.*, 2018). Additionally, the literature has provided empirical evidence focusing on the well-known cases such as Facebook, Airbnb, Netflix, Apple and Google where the digital platforms is established so that organizations can benefit the same-side

or cross-side network effects. However, less has been written about the collaboration of networks of businesses that attempt to establish a common digital platform to digitize their ecosystem. The examples of such studies are rare as they have the tendency of focusing on specific industry where the platforms should support the business transactions. Accordingly, as actors in mature industries have fully recognized the transformative impact of such widespread digitalization, the question is no longer whether or not to transition towards such digital forms of organizing, but how to do such transition and accomplish it. To this end, we ask: *how do industry actors transition from their traditional structure towards establishing a digital ecosystem*?

To answer this question, we follow organizations participating in the Open Industry Platform (OIP, a pseudonym for maintaining anonymity), an industry-level collaboration project in the offshore construction industry. Recognizing the need for a shift in the way they collaborate, key actors in the offshore construction industry pursue a shared platform to digitally exchange requirements. As such, we approach OIP as an arena through which these actors pursue the transition towards a digital ecosystem for offshore construction projects. To this end, we apply the theoretical lens of organizational ambidexterity (Tushman and O'Reilly, 1996) to empirically elaborate how organizations not only explore for new opportunities in transitioning towards a digital ecosystem, but also seek to transition strategies to exploit and further strengthen their existing capabilities and position in the existing industrial ecosystem. More specifically, we identify three different strategies organizations pursue to position themselves in the nascent digital ecosystem. In doing so, we contribute to the digital ecosystem literature by investigating a digital ecosystem formation prior to the presence of a digital platform. We empirically elaborate how uncertainties of the situation ahead have led organizations to both sustain their core businesses and seeking for new opportunities. Furthermore, we demonstrate that digital ecosystems do not exist independently, rather they are embedded in a bigger industrial business ecosystem.

The remainder of the paper is organized as follows. In section two we provide a theoretical background, explaining digital ecosystem and ambidexterity. The research method is introduced in section three and following we present our case description. The finding of our analysis is provided in section five in which we empirically elaborate our argument and finally, in section six we present the discussion and the conclusion of the paper.

2 Digital ecosystem and ambidexterity

The emergence of digital technologies has transformed the very nature of products, services and processes which leads organizations to embrace the potential of digitalization and change their business models, structures and their work routines (Urbach and Röglinger, 2019). In the current digital age, the volatile environment also intensifies the need for organizations to find a new way of organizing (Smith *et al.*, 2017). Digital ecosystem, as such, can be considered as a new form of organizing where firms shift towards a network structured around a digital platform to create and sustain value by applying their resource and capabilities (Koch and Windsperger, 2017).

In this article we follow Selander *et al.* (2013) definition of the digital ecosystem as a collection of organizations, with common interest, organize around digital technology to actualize the innovation activities. IS scholars predominantly have investigated the digital ecosystem by emphasizing digital platforms, its architecture, governance and innovation (e.g. Cennamo and Santaló, 2019, Cusumano *et al.*, 2019, de Reuver *et al.*, 2015, Eaton *et al.*, 2011, Gawer, 2014, Gawer and Cusumano, 2014, Ghazawneh and Henfridsson, 2013, Tiwana *et al.*, 2010, Yoo *et al.*, 2010). For instance, Yoo *et al.* (2010) introduced how digital ecosystems are based on platforms layered modular architecture which emerges from third-party developers' activities. Pointing to the governance aspect, Tiwana *et al.* (2010) also proposed how ecosystems' dynamic and platform governance are mutually affected. Focusing on the developers of the platform, they introduced a framework to understand the platform-based ecosystem evolution. More recently, de Reuver *et al.* (2015) also studied the role of platform characteristics on collective action problems in setting up digital payment ecosystem.

Although prior research related to the digital ecosystem has been done in scattered directions and highlighted the role of digital platforms, the fact that digital platforms emerge from a collaboration network of heterogeneous actors should not be neglected (de Reuver *et al.*, 2018). In such networked structured, the characteristics of the ecosystems are associated with partners' choices, their relationships and activities and vice versa (Iansiti and Levien, 2004, Koch and Windsperger, 2017). Thinking of a broader networked structure of business ecosystem and given the complex dynamics among its actors, Iansiti and Levien (2004) identified three different ecosystem strategies - keystone, dominator and niche - based on organizations' operational activities. Their study demonstrated how business ecosystem shapes and being shaped by its participants operational features and behavioural characteristics (ibid.). Such dependencies are even more apparent in digital ecosystems as not only the operational and organizational aspect but also the participants' technological background can also affect how the digital ecosystems are shaped (Koch and Windsperger, 2017).

Reviewing the IS literature on digital ecosystem, we identified two gaps. First, we observed that there are few studies which highlighted the role of organizations around the platforms in shaping the ecosystems (e.g. Kapoor and Agarwal, 2017, Koch and Windsperger, 2017, Selander *et al.*, 2013). As the previous research mostly emphasizes the focal firms' characters and activities, Selander *et al.* (2013) turned their attention towards non focal actors and investigated their participation in the digital ecosystem. They indicated that non-focal actors may also pursue a pluralistic strategy in choosing their digital ecosystems based on their innovation opportunities for value creation. Kapoor and Agarwal (2017) also examined the role of complementor firms in the ecosystem to understand how they can sustain superior performance within the ecosystem. They demonstrated how value appropriation for complementors is dependent on the ecosystem's structural and evolutionary features. To this end, as de Reuver *et al.* (2018) also noted, it is vital to more research on how digital ecosystem formation affect and being affected by its participants organizational and technological structures.

Second, most studied on digital ecosystems have examined cases such as Apple, Netflix, Airbnb, Google and Facebook (de Reuver *et al.*, 2018, Eaton *et al.*, 2011, Ghazawneh and Henfridsson, 2013, Kapoor and Agarwal, 2017) which the digital platforms exists prior the emergence of digital ecosystems and the platform owners attempted to attract the right actors and control the platforms. However, studies that focus on the collaboration of different business actors in developing a shared platform to transition towards digital ecosystem is difficult to find. As Cusumano *et al.* (2019) stated, it is significant for organizations to go through four different steps -choose the market side, solve the chicken or egg problem, design the business models and establish the ecosystem rules- to be successful in their platform businesses. All these steps are crucial and depends on the platform's features and characteristics, yet they become very complicated when the platforms are not present, and uncertainties exist about the situations ahead. Therefore, participation in digital ecosystems is strategically important due to the sensitivity of gaining competitive advantages in the unstable nature of digital ecosystems (Koch and Windsperger, 2017).

Management literature emphasizes gaining and sustaining competitive advantages in an uncertain environment by both exploring new opportunities and exploiting the existing capabilities (O'Reilly and Tushman, 2008, Smith and Tushman, 2005). The simultaneous existence of exploration and exploitation is known as ambidexterity in the literature (O'Reilly and Tushman, 2013). Exploration can be referred to the activities for creating and discovering new future opportunities (March, 1991). It can be seen as 'variance increasing' due to its responsive mode of organizing (Smith and Tushman, 2005). Exploitation, on the other hand, is identified as creating current viability leveraging existing organizational resources (Tushman and O'Reilly, 1996). The use of ambidexterity in IS research mostly emphasized its paradoxical nature and organizational capabilities. Montealegre *et al.* (2019) in their study used the ambidexterity lens to understand the role of organizational capabilities in balancing the tensions arising during digital infrastructure evolution. In another study, Müller *et al.* (2019) investigated startups and how they can manage the exploratory and exploitative efforts in pursuing digital innovation. They emphasized on the role of entrepreneurs and identified the competencies needed for navigating towards ambidexterity. What is common among these studies, is the fact that under environ-

mental and technological uncertainties, ambidexterity is beneficial (O'Reilly and Tushman, 2013). Smith *et al.* (2017) also acknowledged that in facing uncertainties, organizations' direct shift towards new ways of working is not promising without preserving the core aspect of their structure to a certain extent.

Looking closely at the IS literature, ambidexterity may assume to be similar to the notion of duality-presence of change and stability- (Evans and Doz, 1990), however, they are different in some details. For duality to exist, organizations need to seek a unique combination of change (explore) and stability (exploit) happening at the same time, while for ambidexterity, as Smith *et al.* (2017, p.24) stated, organizations "make good now and simultaneously working on what will be good later". Consequently, we believe that ambidexterity as a theoretical lens can allow us to analyze organizations' strategic behavior in transitioning towards a new form of organizing.

3 Method and materials

In this paper, we report from an ongoing industry-level collaborative project named OIP in the offshore construction industry started in June 2018. We have adopted an interpretative approach in following this project as we tried to understand the empirical phenomena through the actor's involvement (Walsham, 1995). To validate our interpretive approach, we followed Klein and Myers's (1999) principles in practice. We applied the first principle, which is the hermeneutic cycle by choosing a case study (Yin, 2017) strategy to collect data. It is appropriate since it opens up the opportunity to explore the phenomena embedded in its real-world context, and it enables the researcher to gain a holistic understanding of it. From the onset of the project, both authors have been indirectly engaged with the activities however from November 2018, the first author embedded with the OIP project team located at HostCo, the responsible company for hosting and coordinating the project. Following this case study gave authors the opportunity to access peoples from different companies throughout the value chain and gain information regarding their business activities and goals.

The other principle refers to the importance of the political and social context of the study. To follow this principle, we gained information about the background and the political situation in the offshore construction industry, mostly through informal discussions with our informants and the available documents. To operationalize the third principle, the interaction between the researcher and the subject of the study, one of our data collection methods -participant observation (Jorgensen, 1989)- helped us to extensively discuss and get the informants' reflections over the materials we gained throughout the study.

The other two principles that we dealt with in practice are dialogical reasoning and having multiple interpretations. To apply the first one, both authors discuss the findings iteratively to reduce the chance of having contradiction and to revise the findings to make it as clear and precise as possible. Finally, for the last principle, as there are multiple organizations involved in our study, we automatically collected different opinions and interpretations. However, we also attempted to include informants from different organizational levels to have a broader overview.

The main data collection methods that were applied in this study are participant observation (Jorgensen, 1989) and interviews, however, to triangulate the data gathering and make sure that we captured different dimensions, we also studied the relevant documents for the project. Participants observation started from the time the first author granted access including office space, access to the IT network and corporate badge. Until April 2019, the first author spent 3,4 days a week at HostCo for a total of 54 days and from May 2019 till now, the amount of the days the first author spent at the company have been 1,2 days approximately every two weeks. In addition to participating in project meetings and having informal discussions with the project team, the first author also helped the project members in planning and arranging two technical workshops and contributed by maintaining the project's document repository. To integrate with the project team, the first author also participated in company-internal workshops and their social events. Doing observations and spending time not only with the key participants of the project but also with the other members of the company generated a

snowballing effect that enabled the first author to identify key external informants for interviews. Writing field notes journal (Fetterman, 2019) was a way data from the observations have been collected.

The second major source of empirical data is both authors' formal interviews with project participants. We have conducted 27 semi-structured interviews (Kvale and Brinkmann, 2009) in which each project team member was interviewed separately. Each interview lasts approximately 60 minutes and was audio-recorded under the participants' consent in order to minimize the distraction and missing important data. All the interviews were also transcribed.

Interviews and the observations' data supplemented by studying the documents available in the project SharePoint, their email exchange and the internet-based public information regarding both the projects and its participants. The documents in the SharePoint were only available for the project's participants and the first author. They constitute their minutes of meetings, technical and non-technical reports and the material required for their activities.

We have conducted qualitative data analysis in parallel with our data collections. Following inductive approach in our data analysis, the first round of analyzing each interview, observation fieldnotes and documents was done by the first author and then the cross interviews comparison was done by both authors. We used NVivo for our structured content analysis to code the data and write conceptual memos. Two authors had multiple discussion sessions, going through the analysis to categorize and provide a logical link between them.

Data collection methods	Sources
Participant observations	• In-office co-located with key project participants (3,4 days a week until April 2019, afterward, 1,2 days) • Meetings (29 project meetings, 5 workshops, 2 different courses) • Events (3 seminars, 1 conference) • Coffee and lunch breaks
Semi-structured interview	• HostCo • Four different operators • Three different EPC companies • Two different interest organizations
Documents	• Project's SharePoint • Internet-based public information • Email exchange

Table 1. Data collection methods and sources

4 Case

Offshore construction industry delivers offshore infrastructures such as production facilities and pipeline through large-scale and complex projects named as Engineering, Procurement and Construction (EPC) projects. In EPC projects, main contractors, which mostly refers to as EPC companies, are responsible for the whole project execution. They organize the activities from the design until the delivery of the facility to the energy companies (usually known as operators) who ordered the construction of the facility for their future operations. EPC companies may also collaborate with their subcontractors, vendors and service companies to outsource a specific part of the project.

Requirements have a very significant role in EPC projects as they constitute governmental regulations, national and international standards along which the construction of the facilities must comply. As of

today, the requirements are formulated using digital technologies, but the exchange of requirements is based on handling a large collection of documents among the project's stakeholders. Therefore, EPC project ecosystem draws upon a wide range of disparate and to some degree overlapping digital systems for storing and managing requirements in offshore infrastructure projects. For instance, most operators and EPC companies have their own internal systems of working with requirements, however, there is no integrated software shared among actors for working with requirements in EPC projects. One of our informants noted:

> *-The amount of companies' specific tools and data are increasing (...) so, if we want to survive, we need to move to the next level and think of new ways for digital collaboration. (Field note excerpt)*

Participating in three industrial seminars, listening to actors' concerns and plans and also the quote above illuminated that the industry actors have recognized the need for a shift in their way of working. To do so, in mid-2018, key companies representing different stakeholders in the industry organized a joint industry project named Open Industry Platform (OIP) to develop a shared system (OIP core) to exchange requirements digitally (by restructuring them into a machine-readable format) and actualize digital collaboration. The project consists of HostCo - a service company responsible for coordinating and managing OIP, four medium to large operators and three EPC contractors. Indeed, OIP was recognized among the project participants as an arena where they can negotiate and perceive how the future and the digital form of collaboration will be. It can create an opportunity for industry actors to be connected around the OIP core and create value. As one of the participants mentioned:

> *-What we are doing is a game-changer, and can make tremendous changes to how we are working on our EPC projects (Fieldnote excerpt)*

While OIP was surrounded by different organizations in the value chain, following this project gave us a good chance to access multiple stakeholders and be able to see the industrial shift from a broader perspective. As we moved on in our data collection, it became evident that what the stakeholders referred to as digital collaboration can be interpreted as a digital ecosystem. What the actors were expecting was a collaboration around digital technology which also enables them to create value for their own businesses. For instance, although HostCo does not have a role in EPC projects, it will benefit from being part of the new digital ecosystem as it provides novel opportunities for their current businesses.

5 Analysis: Ambidextrous ecosystems strategies

Starting the OIP project was recognized as a significant step towards transitioning to a new form of working as it aims to develop a shared digital platform for digital exchanging of requirements. Being able to exchange machine-readable requirements among projects' stakeholders can increase the opportunities of embracing digital technologies' potentials, as one of our informants exemplified:

> *"Digital thread, having the full traceability [of the assets] in all the way from early beginning and until into the operation, is an example of companies' concern. We need to make sure that we don't lose value between each step along that. This project [OIP] is an important driving force towards having that integrated overview." (Interview excerpt)*

As the OIP outcome would be a platform that enables the industry actors to integrate both their technical and non-technical resources, we conceptualize it as an effort to develop a digital ecosystem and a transition towards a new way of organizing. To this end, we identified three different strategies organizations followed in their transition from their current industrial structure towards the digital ecosystem. We approached our analysis by categorizing OIP participants based on their business areas which

enabled us to recognize their strategic behaviors during the project activities and identified their intended role in the future digital ecosystem. Data structure control, data flow control and data content control are the three strategies we identified among stakeholders navigating towards the digital ecosystem. Explaining each strategy, we also attempt to indicate their intended purpose behind following such strategies. Table 2 summarizes our key findings.

Company	Strategies	Key purpose
HostCo	Data structure control	Digital resource provider
Operators	Data flow control	Information integration facilitator
EPC companies	Data content control	Digital service enabler

Table 2. Ambidextrous ecosystems strategies

5.1 Data structure control

One of the strategies we found among the stakeholders for navigating towards a digital ecosystem is to aim for data structure control. HostCo, the quality assurance and risk management service company followed this strategy intending to be a digital resource provider. Henfridsson *et al.* (2018) defined digital resources "entities that serve as building blocks in the creation and capture of value from information". Digital resources in our case can be interpreted as a methodology for structuring the data to a machine-readable format. The company following this strategy believes that providing such building blocks in the data/information-centric industry can be a proper position in an emergent ecosystem.

Aiming for this position and following the strategy of data structure control originates back to one of the company's previous projects in which they introduced a methodology based on Ontology and Semantic technology that enables them to restructure the textual requirements into computer understandable format. That project ended up as an extraordinary innovation project within the company. Accordingly, they started to look for external arenas to cultivate the technology. One of our key informants pointed:

> *"Proof of the pudding is in eating it and we have not eaten it yet. We started by focusing on the technology internally and our plan is to follow it through external projects. (...) We believe in thinking big, acting small." (Interview excerpt)*

Propagating the use of technology in both external and internal projects and getting successful results, led them to consider the technical competencies as one of the key company's competitive advantages. As the project's participants noted:

> *-one of our leverage points is that we have discipline expertise. We know how to build technology and we also know how to provide content to the technology through the discipline. (Fieldnote excerpt)*

> *-I am sure that whatever these companies are thinking about in working with data, like data management, data quality, data integration, etc. They can do it better with our technology. (Fieldnote excerpt)*

Having technology capabilities has created a potential path for the company to capture value and led to a shift in its strategic planning. In doing so, different value proposition workshops were arranged

which became the starting point of thinking about being a digital resource provider. Two of the participants pointed out that:

> *-What we are doing these days with the technology, is building it for the customers, sit with them for a while and help them get started and then they are on their own and independent of us. We should try to extend the scope of our technology. (Fieldnote excerpt)*

> *-We need to improve and maintain the technology to be the one that helps other companies who use digital resources (Fieldnote excerpt)*

From the quotes above, it can be interpreted that based on the technological competencies, the company wants to explore new opportunities by expanding the scope and scale of the technology as a way to stabilizing their position throughout the ecosystem.

> *"Our technology has the capability to be used for anything (...). If we want to deliver services, we have to start thinking about delivering the technology which will open all the way to different uses." (informant, interview excerpt)*

Simultaneously, the company also followed to sustain its core business of requirements/rules validation and verification as part of its risk management activities. Its members believe that using that specific technology internally can also help them to improve their current way of working:

> *"We [HostCo] are working with requirements on a very broad scale and large volume. Much of what we are doing is about creating rules and publishing guidelines. The complexity in understanding set of rules is work intensive. (....) It [OIP Core] will provide computer assistant requirement management by which we can move the burden of knowing and applying complex rules to the computer and then improve quality." (Interview excerpt, software engineer)*

Consequently, the data structure control strategy has two poles of exploration and exploitation at the same time. The company following this strategy wants to both gain advantages by being a digital resource provider throughout the value chain and sustain and continue their current business. In other words, bundling the technology not only in their own activities but also in other companies' businesses can be interpreted as aiming for an ambidextrous strategy while transitioning into a digital ecosystem.

5.2 Data flow control

Operators own and, as their name implies, operate offshore production facilities throughout the facilities' lifecycle. Operators' competitiveness lies in optimizing their oil field's productivity while keeping operating costs to a minimum. A part of this is that operators specialize in activities of optimizing productivity while outsourcing most activities not directly related to production, for instance, maintenance and modification of their equipment and facilities. This means that operators draw upon an ecosystem of subcontractors that provide a myriad of different services through their facilities' lifecycle. Operators contract most of these services through bid-for-tender price competitions to keep operational costs down.

> *"When we operate 50, 60 assets, storing the technical information for the same solution is done differently. On the one hand, we have the information about the asset and the project in the controlling system and on the other hand, we have technical information on the oil and gas production (from the contactors). The naming in the control system is different from the naming in technical information. So, we struggle to compare things in different assets." (Interview excerpt)*

Subcontractors have, historically, delivered technical information about maintenance and modifications in the formats of their own systems. Even though contractors have received information from their subcontractors and archived it, they have struggled to keep their internal systems up to date. The consequence has been escalating costs as subcontractors have received outdated information or by operators themselves spending a lot of time and effort on ensuring that contracting documentation is up to date before sending it to subcontractors. Indeed, operators found themselves practically locked in by subcontractors possessing more information about their facilities than themselves.

Through the data flow control strategy, operators seek on the one hand to strengthen the control of their facilities lifecycle management, while at the same time seeking to effectively position themselves as the focal firm of the digital ecosystem. They do so by assuming control of all technical information flowing to and from its subcontractors. Instead of subcontractors delivering technical information on their own formats, operators require subcontractors to submit all technical information through an open application programming interface (API). This API is a boundary resource (Ghazawneh and Henfridsson, 2013) that specifies the format of technical information, allowing operators to automatically integrate it with their facilities' lifecycle information databases.

By assuming control of the flow of technical information in this way, operators also effectively seek a position in the digital ecosystem where subcontractors are relegated to the position of relying upon the operators to materialize their services.

5.3 Data content control

Data content control is a strategy predominantly pursued by EPC companies. EPC companies have two predominant business areas: they deliver large-scale pieces of equipment or entire facilities (collectively termed 'assets') to ordering customers and they offer maintenance and modification services for assets delivered. Yet, operators (the companies that own and operate offshore installations) hand out maintenance and modification contracts on a bid-for-tender basis. Contractors, therefore, find themselves competing with other companies, both companies specializing in maintenance and other EPC companies, for contracts to maintain and/or modify the equipment they have delivered.

Prior to the OIP project, EPC companies have started different digitalization projects, both internally and externally (in collaboration with other actors in the value chain), to do the engineering work more efficiently. The results of such initiatives are plenty of different systems, applications and platforms used for different aspects of the engineering works. As one of our key informants pointed:

> *"Companies nowadays are investing a lot of money on building different digital tools independently but there is no space for many platforms" (Interview excerpt)*

All offshore assets come instrumented with a wide array of digital sensors generating real-time data about key operating aspects of individual pieces of equipment and the oil and gas flowing through them. Through data content control EPC companies seek to position themselves as the owners of the data content generated by the equipment. EPC companies frequently forward this strategy under the technological solution of 'digital twin'. Digital twins are forwarded as digital representations for real-time monitoring, optimization, and controlling of physical assets (Rasheed et.al, 2020). Digital twins turn physical assets into digital platforms which enables EPC companies to collect all required data for different stages of engineering activities and helps them both in the operation and maintenance phase. One of the EPC companies emphasized that:

> *"Our goal is to integrate all the design data, engineering data, and enterprise data through the whole life cycle of any physical subject into a platform and provide services to our customers" (Interview excerpt)*

Having such strategic decisions, EPC companies believed that the result from OIP is essential for actualizing the integration plan as OIP's technology can feed them with machine-processable information. This also acknowledges by one of our informants:

> *"The goal is to facilitate all the engineering activities along the assets' life cycle, OIP technology is then useful as it gives us verified requirements and it can be used not just in the manufacturing phase but in all other engineering phases. The other strength is that it reduces human intervention and manual work, so OIP can speed up the preparation of the material for us." (Interview excerpt)*

Instead of providing maintenance and modification as services, digital twins enable EPC companies to offer equipment and even entire assets as a service. For instance, instead of selling generators that provide offshore installations with electricity, EPC companies offer operators "energy as a service" by taking full responsibility for the entire lifecycle of offshore generators. In so doing, EPC companies explore for a position in the digital ecosystem as a content provider and enabler of digital service innovation for companies seeking to provide novel digital services on top of the digital sensor data provided through its digital twin. However, at the same time, they exploit their current business by retaining ownership of the asset and effectively shut other companies out of the possibility of competing for maintenance and modification contracts.

6 Discussion and conclusion

Following industry-level project participants, we identified three strategies different classes of organizations in the offshore construction industry pursue in transitioning towards a digital ecosystem: data content control, data structure control, and data flow control. Drawing upon organizational ambidexterity (O'Reilly and Tushman, 2013) as a theoretical lens these strategies show that organizations not only explore for new opportunities in transitioning towards a digital ecosystem. They also seek to transition strategies to exploit and further strengthen their existing capabilities and position in the existing industrial ecosystem, as digital ecosystem formation in established industrial companies constitutes a transition towards digital ecosystems. With basis in this analysis, the paper makes three contributions to information systems theory.

First, through the three identified strategies, we empirically expand and elaborate upon key strategies from the general ecosystem's literature (Iansiti and Levien, 2004) with a sociotechnical perspective. While both operators and EPC companies, for instance, seek to position themselves as focal firms in the nascent digital ecosystem, their reasons for doing so and consequently their strategies vary. Operators, on the one hand, seek to occupy the role of coordinator, or what the general ecosystems literature refers to as keystone company (Iansiti and Levien, 2004), of the digital ecosystem to controlling the data flows. EPC companies, on the other hand, seek to position themselves in a way that excludes other companies intervening in the maintenance activities by taking control of the data content through digital twins. Thinking in terms of the broader ecosystem literature, such a lockout strategy is similar to what Iansiti and Levien (2004) calls the dominator strategy, exemplified by Apple's original strategy of delivering a highly integrated product that excluded other actors from participating in their ecosystem (in contrast to Microsoft who opened up their operating system to both hardware and software providers). Finally, with data structured control, we observed that due to the fact that HostCo has the technology experts, leveraging this unique capability, it aims at making the bulk of the future digital ecosystem by differentiating and propagating their technology. This is a form of niche strategy (Iansiti and Levien, 2004) as for instance AutoCad following the niche role in its ecosystem, focused on their specific expertise by using the platforms provided by other ecosystem participants.

Second, the three identified strategies concretize and elaborate upon de Reuver *et al.* (2018) observation that digital platforms emerge in multi-actor settings where firms and people with divergent interests seek to influence, shape, and redefine what the digital platform is to be. A perspective on digital ecosystems formation that brings forth the divergent interests and concerns of key classes of compa-

nies in existing industrial ecosystems is particularly important. Its significance can be in light of current developments towards a digitalized industrial sector, what is often referred to as the Industrial Internet of Things (Gilchrist, 2016) or Industry 4.0 (Schwab, 2017), where a digital platform is not in place prior to digital ecosystems formation. While IS literature mostly studied digital ecosystems around the cases such as iOS and Android (e.g. Ghazawneh and Henfridsson, 2013, Kapoor and Agarwal, 2017) where the platform exists beforehand, in our study there was no such platform that actors operate around it. As such, existing literature on the orchestration and governance mechanisms for attracting users and complementors into the digital ecosystem (Cusumano *et al.*, 2019, de Reuver *et al.*, 2015, Ghazawneh and Henfridsson, 2013, Tiwana *et al.*, 2010) is less relevant at this early nascent stage of ecosystems formation. Instead, understanding such early stage digital ecosystem formation requires an understanding of the sociotechnical ecosystem strategies employed by companies and their underlying dynamics. We trace these dynamics to companies' attempts at handling environmental uncertainty in transitioning towards a digital ecosystem, which leads us to our third and final contribution.

Third, we show that the organizations find it extremely difficult to have a clear picture of the future digital ecosystem they are transitioning towards. That is, who is to occupy what role and through which technologies. In another words, these can be interpreted as the difficulties over the Cusumano's *el.al* (2019) four steps of successful platform businesses. Our argument is therefore that all companies we have studied have to handle the uncertainties and ambiguities of the situation ahead through ambidextrous strategies. Rather than forgoing their current core capabilities and businesses, they all attempted to concurrently improve their existing business and find novel possibilities to be able to cope with the uncertainties. This observation is in line with Smith *et al.* (2017) and Koch and Windsperger (2017) argument that due to uncertain nature of new forms of organizing, instant shift towards them cannot be promising.

In answering the research question, we show how environmental uncertainties shape companies' ecosystem strategies, especially in cases where a digital platform is still in the development phase. As most of the IS research focuses on somewhat developed digital platforms like iOS, Android, eBay, Uber, etc., our study can give both the practitioners and the scholars new insight on digital ecosystem formation. Furthermore, our study highlighted the fact that digital ecosystems are embedded in a broader industrial ecosystem. In other words, although the digital ecosystem shapes around a specific digital platform, it is not excluded from its industrial ecosystem. However, as we have done our study based on a single case, we believe that there is still a need for more research on different industrial settings to generalize this observation. Doing this can open up future research opportunities for IS researchers focusing on digital ecosystem.

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