Developing dynamic transformation capabilities in a high velocity environment: A study of Industrial Internet of Things (IIoT) Companies

Introduction

How firms develop competitive advantage is an important question at the heart of strategic management research. Generating and maintaining competitive advantage potentially creates sustainable performance differences between a firm and its rivals. The Resource Based View (RBV) (Barney, 1991; Penrose, 1959; Wernerfelt, 1984) emerged as one of the key frameworks explaining why one firm might hold a competitive advantage over another. But the RBV struggled to explain how firms develop and subsequently sustain those advantages. This problem gave rise to the dynamic capability view (Teece et al., 1997). Dynamic capability seeks to overcome the static criticism leveled at the RBV by considering how firms develop and renew capabilities, as crucial strategic resources, in situations of high velocity and unpredictable environmental change (Teece, 2007, 2014; Winter, 2003). In recent years, dynamic capability is considered to be a multi-disciplinary framework to explain sustained enterprise performance on a long term basis and is most relevant in ecosystems characterized by hypercompetition (D'Aveni, 1994) or dynamic competition coupled with rapid and unpredictable change (Teece, 2014). Dynamic capability alone is *not* sufficient, however, and should be augmented by valuable, rare, imperfectly imitable, and non-substitutable (VRIN) resources and good organization strategy for a sustained competitive advantage (Teece, 2014).

While much has been learned over the years about dynamic capabilities, the capability transformation condition and process is not well-documented. This remains perhaps the greatest obstacle to advancing our knowledge about dynamic capability and has been described as an 'elusive black box' (Pavlou and El Sawy, 2011). Complicating this matter is precisely what constitutes an operational capability against a dynamic capability. While definitions abound, the problem is more to do with classification. For example, Eisenhardt and Martin (2000) suggest that some of the firm's capabilities, for example new product development (NPD), alliance, marketing, are dynamic capabilities. Yet, Zahra et al. (2006) reveal that dynamic capabilities are context dependent, proposing that a capability that is operational in one firm can be a dynamic in another. Zahra and his colleagues use examples of the same capabilities referred to by Eisenhardt and Martin (2000) to show that in alternate contexts, a NPD capability for example could merely be an operational capability, routine in nature, and necessary for the day-to-day activities of a firm (i.e., 'ordinary').

Capabilities are not tethered to specific purposes or products, defined instead by what they can accomplish as opposed to what they can produce (Teece, 2014). Rather than looking at specific types of capabilities then, a more productive analysis can come from understanding the features and processes that undergirds a dynamic capability against an ordinary one. This allows some reconciliation of context with the functions of, and mechanisms underpinning, a capability.

In light of this discussion, this study seeks to accomplish two tasks. The first is to understand the implications of context for dynamic capabilities. We achieve this by studying a set of large, well-established technology companies being directly affected by the Industrial Internet-of-Things (IIoT). Through a qualitative investigation based on several interviews with senior managers across five large technology companies, we seek to introduce context sensitivity into the body of theory on dynamic capability. In doing so, we reveal the internal and external environment factors that affect the ability of these firms to reconfigure their capabilities and generate new ones. This contributes to insight and help to reconcile and transcend recent meta-analytic findings (Karna et al., 2016) suggesting that dynamic capabilities are not inherently superior to ordinary capabilities and by understanding the organizational circumstances surrounding ordinary and dynamic capabilities. Second, we seek to refine theory to do with the function of, and mechanisms behind, sensing, seizing, and reconfiguring. In doing so, we reveal how managers are explicitly going about these activities and enabling the transformation of capabilities, explaining why some capabilities are prioritized more than others. This contributes to the micro-foundations debate about dynamic capabilities (Teece, 2007; Helfat and Peteraf, 2014).

Theory

This paper adopts Teece's (2007) framework because it presents an unfolding three-stage process of sensing, seizing, and reconfiguring of resources. It is focused on the capability transformation process, and is broadly mirrored in a series of other studies (e.g., Karna et al., 2016; Teece, 2014; Pavlou and El Sawy, 2011). In later work, Teece (2014) appeared to relabel 'reconfiguration' as 'transformation'. For the purposes of this paper, we see reconfiguration as one part of the transformation process.

Capabilities are either 'ordinary' (also termed 'operational') or 'dynamic'. The ordinary capability is also called zero-level capability (Winter, 2003), first order capability (Danneels, 2002) and substantive (Zahra, Sapienza, & Davidsson (2006). The ordinary capability can be classified in one of the three categories: administration, operation, or governance (Teece, 2014). The ordinary capability of a firm is a zero-level routine or collections of routines of the firm, which executes a set of implementation workflows and produces a significant output of a desired type (Winter, 2000). The idea of 'routine' refers to the repetitive activities of the firm to do with this capability. Without that repetition and replication, the capability would unlikely form because a pattern of excellence surrounding the execution of an activity would not emerge. Teece (2014) suggests that ordinary capabilities permit a degree of sufficiency (and sometimes excellence) in the performance of a well-delineated task, but in so doing are vulnerable to a single-minded, relentless pursuit of efficiency, creating inertia at a cost to effectuating change. For this reason, dynamic capabilities are needed to adapt, orchestrate, and innovate change. Dynamic capability builds, integrates or reconfigures ordinary capability (Teece et al., 1997). Like ordinary capability, dynamic capability also has a set of routines, but these impact the ordinary capability, helping managers extend, modify, and reconfigure existing ordinary capabilities into new ones that

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better match the environment (Pavlou and El Sawy, 2011). To a certain extent, a special status is often attached to dynamic capability (Bareto, 2010) and this has largely to do with the assumption that they are of greatest value in turbulent industry environments where the need to renew ordinary capabilities is at its greatest (Teece et al., 1997).

Rather problematically, boundaries between ordinary and dynamic capabilities have been blurred (Helfat and Winter, 2011), and a dynamic capability in one firm may be ordinary to another (Zahra et al., 2006). Indeed, dynamic capabilities may not in fact yield the source of advantages expected of it in turbulent, high-velocity environments (Eisenhardt and Martin, 2000), despite being the very types of environment in which dynamic capabilities are believed to be needed the most (Peteraf, Di Stefano, and Verona, 2013; Teece, 2014; Teece et al., 1997). This matter was empirically supported in the meta-analysis of Karna et al. (2016). This meta-analysis revealed that both can be as important as each other in dynamic environments.[1] The Table 1 explains the differences between ordinary capability and dynamic capability.

Table 1: Differences between operational capability and dynamic capability (adapted from Teece, 2014)

Criteria	Ordinary capability	Dynamic capability
Focus	Tactical with ad-hoc and temporary changes	Strategic and mostly organization wide
Intent	Short term and support current business	Mostly long term and strategic changes in business
Operating Model	Operate, administrate and govern	Sense, seize and reconfigure (transform)
Key Routines	Best practices	Distinguished processes, unique to the firm
Environment	Low to moderate impact	Moderate to high impact
Managerial Emphasis	Cost control and increase efficiency of current businesses	Entrepreneurial, asset orchestration, leadership in the market
Measurement	Technology fitness (efficiency)	Evolutionary fitness (innovation)

There are different schools of thoughts about dynamic capability. The Teece (2007) position claims that dynamic capabilities are necessary for sustaining competitive advantages in a specific boundary condition of 'high velocity environment'. Meanwhile, Eisenhardt and Martin (2000) suggest that dynamic capabilities are best practices (contrary to Teece, 2014) and a specific boundary condition is not necessary and both ordinary and dynamic capabilities should work in both moderate velocity and high velocity environments. Winter (2003) on the other hand presented a capability hierarchy, where 'zero order' (ordinary) capabilities are required for day to day activities of the firm and 'higher order' capabilities are needed for dynamic capabilities. Different scholars have suggested different mechanisms for the development and deployment of dynamic capability. Some suggest that it could be developed and deployed by a structured learning process (Zollo and Winter, 2001). Zahra et al. (2006) suggest that ordinary and dynamic capabilities are context dependent, proposing that a capability can be ordinary in one firm or dynamic in another depending in its design and use. The one constant difference, however, is the idea of *transformation*.

In a high velocity environment, with the introduction of new disruptive technologies, firms should develop dynamic transformative capabilities such that they can readjust their business routines for favorable outcomes. We define dynamic transformation capability *as the ability of a firm, to systematically identify and change core business routines of strategic importance by leveraging collaboration with ecosystem partners, reconfiguring existing resources and capabilities, and developing new knowledge and competence to remain competitive in the marketplace.* The dynamic transformation capability is an extension of dynamic capability and it explains the transformation process. In Teece's (2014) words, "The "transforming" aspect of dynamic capabilities is needed most obviously when radical new opportunities are to be addressed. *But transformative capabilities must also be exercised periodically to soften the rigidities that develop over time from asset accumulation, standard operating procedures, and insider misappropriation of rent streams*" (p.335, emphasis added). In this paper, we seek to explain the capability transformation process and factors responsible for the transformation.

Methods

To understand dynamic transformation capability, we have taken a holistic approach to understand the evolution, formation, continuation and termination of dynamic capability. Using a qualitative methodology, we selected a case study research method to understand the impact of technology disruption on the transformation process and to get more visibility on the formation of dynamic transformation capabilities.

For our qualitative case study, we conducted semi-structured interviews with twelve senior executives from five different organizations to understand the current landscape of the IoT industry. Since IoT is a new and evolving market segment, we interviewed executives to understand the type of strategies and initiatives they use to sense, seize and reconfigure their resources for the industrial IoT business. We chose organizations that are leaders in the industrial

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[1] Although Teece (2014) expressed that ordinary capability may yield competitive advantage even for long periods, ultimately, alone, they are not enough unless competition is weak.

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IoT business and the executives are developing and managing the strategies and initiatives for the industrial IoT business. Nevertheless, despite being leaders, these firms are facing considerable challenges due to the disruptive effects of industrial IoT and particularly since no single standard for IoT has emerged and the uses and pervasiveness of IoT now and into the future are far and wider, having considerable ramifications for the firms if they get their strategy wrong. We selected the study participants based on their knowledge and experience in the IoT industry.

Twelve interviews, each lasting from forty-five minutes to sixty minutes were recorded digitally for transcription. The name of the participants and their company name were kept confidential and forward looking and proprietary information were omitted from the discussion. We have used pseudo names for the participants and for the companies. We used the qualitative analysis methodology of Miles and Huberman (1994), Yin (1994), and Tracy (2013) by coding the interviews and classifying the codes into themes and patterns. Table 2 describes the sample for the study.

Table 2: Study sample

Pseudo Name (Company)	Title/Position	Years of Experience	Firm Size (No. of Employees)	Firm's Industry
Susan (C1)	Senior Director	15+ years	130,000+	Enterprise Software
Kelly (C1)	Senior Director	25+ years	130,000+	Enterprise Software
Carl (C1)	Group Vice President	25+ years	130,000+	Enterprise Software
Jacob (C2)	Director	25+ years	45,000+	Healthcare
Harry (C3)	Senior Director	20+ years	90,000+	Semiconductor
Paul (C3)	Senior Director	20+ years	90,000+	Semiconductor
Henry (C3)	Senior Director	20+ years	90,000+	Semiconductor
Larry (C4)	Senior Director	25+ years	300,000+	Industrial
John (C4)	Director	25+ years	300,000+	Industrial
Cliff (C4)	Director	20+ years	300,000+	Industrial
Laura (C4)	Vice President	25+ years	300,000+	Industrial
Tim (C5)	Senior Director	20+ years	10,000+	Network Equipment

The themes that emerged from this analysis are: technology disruption, modular capability, path dependency, context dependency, strategic focus and intent, ecosystem partnership, and organization structure.

Results and Analysis
Technology disruption
All participants in our interviews highlighted technology disruption as an important factor for capability transformation. IIoT is changing the markets, customers, partners, and products of these firms, and doing so quite dramatically. Our case industrial organizations are trying to transform their businesses from a traditional machine centric business to a digital business. For example, an industrial conglomerate like General Electric (GE) is rebranding itself as a 'digital industrial company'. All participants in our study believe that technology disruption (or a high velocity market) accelerate the capability transformation process because it creates a high state of urgency. So, they are in agreement with Teece's (2007, 2014) argument. What is problematic, however, is that while the recognition of the need to change and transform capabilities is created by this disruption, the severity of the disruption creates its own problems. The organizations in question struggled to understand 'what' capabilities were needed as a result, both for the now and for the future. This problem was exacerbated by trying to ensure short-to-medium term competitiveness in their markets without knowing what the future markets will look like or need of them.

A solution may come from changing the focus of the firm's knowledge base. For example, Larry from company C4 said, "IoT business is a disrupter to existing businesses and disrupting itself. To develop these multi-faced businesses, we need managers who could deal with different industries at the same time. It is not a domain specific knowledge but 'solution centric' knowledge. Though we can learn from existing capabilities, but we need to add 'solution' mindset and modify these capabilities." Larry felt that the existing operational capabilities in his organization should be transformed into new ways of doing business in the digital business. Modifying and transforming current capabilities (operational) for technology disruption is a component of that.

'Technology disruption', then, appears to be an important factor for capability transformation by motivating the dynamic capability process to sense, seize, and reconfigure. IoT created the necessary sense of urgency for these companies to focus on dynamic capabilities and to pursue change but created confusion as to what the transformation was meant to achieve (i.e., what was changed and what were they changed into). The solution may rest in Teece's (2014) notion of untethering capabilities from products and purposes.

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Modularization of Capability
Each firm has some core capabilities. These capabilities are needed for the normal survival of the firm, and typically referred to as or ordinary capabilities. However, due to technology disruption, competitions, and new markets, firms are adding additional layers of capabilities on top of these ordinary capabilities as higher order (dynamic) capabilities, which are adjacent to their current businesses. We term this the modularization of capabilities as this transforms ordinary capabilities into more complex dynamic capabilities.

Cliff from company C4 articulated this idea of modular capability, describing it as, "capabilities are like concentric circles. We have some core capability and then we have multiple concentric circles, consisting of extended capabilities. In this modular capability approach, each organization needs to protect and enhance the core capabilities and add extended capabilities to expand the business." The same narratives were expressed by other participants too. Firms are transforming their ordinary capabilities to dynamic capabilities by modular approaches most likely as part of an untethering process that also hedges the value of those capabilities against the uncertainty of what IoT markets will look like and require of firms. The nature of this modularity, however, seems to be vulnerable to path dependence.

Path Dependency
Capability transformation is path dependent. If a firm is successful in a particular path, that is, in a particular way of doing business, it is difficult to change the business when faced with technology disruption and other changes in business conditions. This view is supported by our interview participants.

Carl, from company C1 stated, "We are very successful in a license based business model and due to severe market pressure we are slowly moving towards a cloud based business model. Still most of our customers are in traditional business models and we will try to extend it as much as we can". Based on Carl's commentary, company C1 is not ready to transform its business models and related capabilities to a service-based business model due to the path dependency of the traditional businesses. This, in part, is due to legacy effects from its customers. There is a contradiction here to Teece (2014) who suggested that path dependence and legacies can provide a foundation and fulcrum of future growth. Because capabilities originate in, and arise from, organizational histories, the narratives and applications for those capabilities are similarly tied. Stated differently, managers may lack foresight to envisage new uses or new forms their capabilities should take precisely because of the histories associated with those capabilities. Thus, while capabilities may be untethered from a purpose or product, they are not untethered from the past.

Jacob, from company C2 expressed a similar view to Carl, stating, "Our medical devices business is high dollar value and low volume and our manufacturing, sales, marketing, and other people are experienced in this business. This business (of selling machines to hospitals) still exist and very profitable. It is difficult for us to switch to a cloud based software business, which is high volume and low margin and we need to transform our existing capabilities or acquire new capabilities from outside". Path dependency, then, becomes an inhibitor of change despite the urgency created by technological disruption and the flexibility sought with modularity.

Context Dependency
Like path dependency, capability transformation is also context dependent. The firm develops new capabilities or transforms its existing capabilities based on the context or the value chain of that firm. A capability may remain as an ordinary capability for a firm and the same capability may be transformed to a dynamic capability based on the context of the firm. Our participants reported this same theme. For example, Kelly in company C1 saw NPD capability for IoT as an ordinary capability, stating, "The IoT product is an extension of our middleware software products. And we do not see any difference of IoT software than other software". However, the same NPD capability for IoT in company C4 is dynamic, calling for a transformation of NPD capability, as explained by Laura, "We are developing an industrial IoT platform, which is a platform-as-a-service (PaaS) product, and our businesses and partners are developing their solutions on top of our platform. This is different than our standard NPD capability as our managers and developers need to take care of multiple businesses with different performance requirements". So, the capabilities depend on the context of an organization, and specifically on its role in the value chain. C1's context is different than C4's context.

For Teece's (2014) refinements to the dynamic capability view, this discussion suggests that context is aligned with the strategy of the firm. Teece (2014) repeatedly emphasized that good strategy determines the value and use of dynamic capability in creating or shoring advantage. The relative distance between the firm's capabilities, its strategy, and the direction of travel in its industries (e.g., resulting from the effects of IoT) might explain why context may on the surface appear similar to two sets of firms but in fact be quite different under the surface, particularly in their response to that context.

Strategic focus and intent
Strategic focus and intent is a pre-requisite for capability transformation. A capability remains as an ordinary capability unless top executives in a firm have strategic focus for capability transformation and they have a strategy for execution. All of our participants highlighted this as a core theme of a transformation process for dynamic capability.

Paul from company C3 said, "In the web or mobile business, the challenges were related to software side of the business or more information technology (IT) centric. Now, we are entering the area of operational technology (OT), which is more complex, for examples, we like to predict the probability of oil spills from offshore platforms and how to

prevent that, we are discussing energy saving using sensors into the street lights etc. These are complex problems and these companies need to have strategic focus and intent to change the existing capabilities and develop new capabilities". On the other hand, Susan from company C1 expressed her frustration, "C1 does not have strategic plans for the IoT business. The managers are not clear how IoT and Cloud could change their businesses. They still think IoT products are extension of their Middleware and Messaging products". C1 does not have strategic focus and intent in the IoT business and till now, it does not have significant presence in the IoT market.

Intentions to change, and actual change, are two very different things. One can have an intention to change but lack the resources to do so (Covin, Slevin, and Schultz, 1994) or seek to make changes but, in fact, scale these back to minor, first-order, strategic changes consistent with the existing strategic archetype (Fox-Wolfgramm, Boal, and Hunt, 1998). This latter problem is expressed by Susan because strategic change needs to occur, and there may be intent, but reinterpretation occurs in line with existing paradigms that then inhibit dynamism.

Ecosystem partnership

All participants voiced a view that ecosystems are integral to a dynamic transformative capability process. In a high velocity market with significant uncertainty in the business, firms tend to form strategic alliances to serve the market and in this process try to hedge the risks in the business. In the IoT business, each and every company is forming alliances with other companies. According to Larry, "Ecosystem partners play an important role in product strategy. For example, for Smart Airport, three internal C4 businesses are involved and C4 businesses are contributing 30% to 40% of the offerings and rest 60% to 70% are offered by the partners". Strategic alliances with ecosystem partners are required to transform the product development, sales, marketing and other capabilities. Though strategic alliance is important for reconfiguration, it carries significant impact in a high velocity market.

Organization structure

An organization structure helps a firm to transform its capabilities and execute its strategy. It is also dependent on the strategy of the firm. Most of the participants in our interviews commented on the organization structure and its impact on the capability transformation process. Our participants expressed the view in their interviews. For example, Larry from company C4 stated, "The traditional business-/domain-based organization structure is changing. Earlier, C4 has businesses in an industry vertical, like Aviation, Oil & Gas, Healthcare etc. but now structure is changing more towards a solution-based organization structure and multiple businesses are participating. So, the IoT managers need to develop new collaborative capability or expand current capabilities to accommodate these changes". Organization structure then appears to define the firm's readiness for change.

Conclusion and Future Directions

In this paper we articulated the difference between ordinary and dynamic capability and drew attention to the elusive nature of the transformational component and process of dynamic capability. Based on our qualitative study, we identify a series of themes that are largely integrated in depicting the challenges and conditions undergirding a dynamic capability transformation process. Technological disruption creates a motivation, if not demand, to change and start a transformation process. But the very nature of such disruption appears to have a double-edged consequence by creating doubt around what future capabilities are needed and what form existing capabilities ought to be transformed into. While firms realize a need to modularize their capabilities, in a way not too dissimilar to Teece's (2014) idea of untethering, path dependency caused by organizational histories and customer legacies cause further disruption to transformation. Context dependency appears to have a bearing on what capabilities are selected for treatment and the ultimate rate of change seems to rely on strategic focus and strategic intent allied with a supportive organization structure (though the content of that structure seems hitherto unknown but perhaps can best be described as 'readiness' for change). The transformation process appears to start at each stage of capability development stage as we saw no apparent start point in our interview data.

Further to this study, we plan to develop hypotheses based on our themes and shape these themes into a theoretical framework of antecedents, mediators and moderators for capability transformation. We will test these hypotheses by conducting a quantitative study with participants from mid-size and large IoT firms. The measurement model for capability transformation is not well-defined and represents one of the most significant on-going challenges to research on dynamic capability.

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