

Understanding Dynamic Capability as an Ongoing Concept for Studying Technological Capability

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Abstract

There are numerous conceptual and empirical studies regarding the topics of DCs in the literature. Many literatures have discussing on how to become dynamically capable firms by suggesting the concepts, the antecedents, and the consequences of DCs to achieve performance and sustainable competitive advantage under rapidly changing environment. Meanwhile, the concept of technological management is crucial in studying technological capabilities as it look at the technological capabilities to have important role in deciding the firm success instead of just confined to the study of technology portfolio to create fit with the overall firm objectives. As there is lack of focus of management of technology in this issue and little literature of technology in DCs, the study of technological capabilities as a source of competitive advantage from the concept of DCs is opening for the potential research area.

Keywords: Dynamic capability, technological capability

1.0 Introduction

The strategy has shifted from industry-level of analysis to firm-level of analysis in explaining the source of competitive advantage as the strategic focus is on the capability building since 20 years ago (Davis, 2004). It is difficult for firms to preserve their competitive advantage when the competitive environment of the firms continuously changing because the resources and capabilities systems of firms are dynamics in nature and their relationship is always changing (Grobler, 2007). From the concept of resource-based view (RBV), sustainable competitive advantage is determined by the possession of bundle of resources with valuable, rare, inimitable, and non-substitutable (VRIN) characteristics, but under unpredictable market condition, looking at the relationship of resources and performance alone to achieve sustainable competitive advantage will be insufficient (Wu, 2006). This is because when the environment is not stable, the resources are not strongly favoring the competitive advantage of the firms (Wu, 2009).

To sustain competitive advantage in highly volatile market, firms must continuously reconfigure the resources to create a series of short-term competitive advantage (Eisenhardt, & Martin, 2000). Thus, the strategic focus of firms has changed from the effective ways of managing the unique resources to the effective ways of modifying the resources in rapid changing environment (Kylaheiko, & Sandstrom, 2007). Therefore, to remain competitive in the marketplaces firms have to continuously building new capabilities according to the change to match the changing needs with the processes/skills/routines that are unique and difficult-to-duplicate by competitors. Thus, dynamic capability (DCs) is designed to build new competitive advantage that meets the changing market needs in a timely manner in which the emphasize is laid on two aspects that are not the major focus in the past researches. First, the 'dynamic' aspect of DCs which is refers to the firms' capacity to renew the competences such as innovation. Second, the 'capabilities' aspect of DCs which is refers to the firms' ability to create change through the process of integration, building, and reconfiguration of competences to match the changing environments.

At the same time, technological capabilities have identified as one of the firm's assets (Teece, Pisano, & Shuen, 1997). Technological capabilities are argued to have important roles in influencing the firm success especially for the technology-intensive industries and under the environment of rapidly technological change. It is argue that under globalization and open market, the role of technological capabilities is becoming more critical than ever before. Thus, the management of technological capabilities and change is important in assuring the technology will be managed for achieving competitive advantage. However, Chanaron and Jolly (1999) argue the management of technology (MOT) has neglected the consequences issue and focusing more on the unprecedented issues of technological innovation and less on the impacts of technology on the practices, methods, and management science. In this case, Chanaron and Jolly (1999) stressing that technological management (1) is not mainly focusing on the allocation of resources, (2) is not confined to the technical functions, (3) firm need not has R&D department to manage technical issues, and (4) managers should be educated and trained in managing the co-evolution of technology and management.

Therefore, the technological management suggested by Chanaron and Jolly (1999) is looking at the role of technology as more critical than ever, not just the responsibility of technical personnel and confined to the technical areas only. Because of that, it is argue that through the concept of DCs, technological capabilities can be managed as critical resource that has role in create competitive advantage instead of functioning just within the technical areas of the firms that need to be managed to create fit with the overall operational and strategic objectives of the firms. This article is designed to create awareness of the importance of managing the technological capabilities with the promising concept of DCs as critical factor that influences the firm decision making and affecting the competitive advantage. In order to understand how technological capabilities can be studied under DCs, the article will first review DCs at glance from the concept of DCs in section 2.0 to the focus of DCs in section 6.0. The importance of technological capabilities within DCs perspective will be discussed in section 7.0 while the discussion and suggestion for the potential research area for technological capabilities with the DCs perspective will be discussed in section 8.0.

2.0 The Concepts of Dynamic Capability

Even though DCs and RBV are both resource focused as DCs is sharing the same assumptions with RBV (Ambrosini, & Bowman, 2009), DCs is different from RBV for two main reasons; first, RBV is static in nature which mean it is insensitive to the environmental change while DCs is addressing the changing environment, and second, RBV theory is focusing on the best way of utilizing the firm's resources bundle while DCs is focusing on the best way of integrating, renewing, reconfiguring, and recreating the resources bundle. According to Teece, Pisano and Shuen (1997), from RBV perspective, firms create wealth through the selection of rational alternative among the potential set of investments (in resource bundle). In this aspect, the focus of RBV is exploiting firms' specific resources or assets to create wealth. In contrast, DCs is designed to create wealth for the firms operating under environments of rapid technological change with the objective of sustaining competitive advantage by changing the resource base.

DCs is not an ordinary resource as its impacts is to the resource base. Because of that, the meaning of capability under DCs is different from capability understood under RBV (Ambrosini, & Bowman, 2009) as DCs is high-order capability. Moreover, DCs is not only focusing on the resource aspect (as RBV does) but also the environmental aspect of the firms which suggest that DCs is focusing on creating competitive advantage by renewing and modifying resources. The concept of DCs exists because of dynamic interactions between environments and the firms' capabilities, and the needs to sustain competitive advantage through capability building. This is because DCs assess the environments and realign the resource base to gain future performance (Arthurs, & Busenitz, 2006). In highly volatile market, sustaining competitive advantage is difficult to do since firms are continuously dealing with unstable structures. In moderately dynamic market, competitive advantage is easier to sustain since the established routines are capable of maintaining the resources in linear processes.

DCs is effective under volatile environment where the effectiveness of RBV to competitive advantage is reducing. This is evidenced by Wu (2010) where DC is capable of renewing resource base according to market change to create competitive advantage. This empirical result is supporting Teece's DCs concept as he differentiates DCs and RBV in term of the effective environment. In other words, DCs is superior to RBV under highly volatile market where the accumulation of resources with VRIN is not effective for competitive advantage (Wu, 2010). However, firms still can makes profit with resources even without DCs, but for short and temporary time only (Teece, 2007). Therefore, in order to deals with changing market needs that affects the firms' competitive advantage, the concept of DCs is suggested as the theory of RBV is not relevant in the situation of rapidly changing environment. Thus, without DCs, resources alone will not be able to be translated into performance (Wu, 2006).

There are many definitions in literature that stressing on resources as important aspect of DCs such as definitions by Kaminska-Labbe, Thomas and Sachs (2005), Zahra, Sapienza and Davidsson (2006), and Helfat, et al., (2007). Thus, the ability of firms to compete in the market is reflected by capability they possess (O'Reilly, & Tushman, 2008) as it affects the way firms use their assets such as resources and knowledge (Forbes, & Wield, 2008). Capability is nontransferable (Makadok, 2001) but does not last very long as it changing over time through the process of accumulation and depletion (Bayer, & Gann, 2007). Know-how, learning process, business secret, and reputation are examples of capabilities that create advantage to the firms as these capabilities are difficult to be acquired from external business environments (Chen, & Lee, 2009) and is intangible in nature (Ayuso, Rodriguez, & Ricart, 2006). The organizational capabilities create competitive advantage (Bayer, & Gann, 2007) with the frequency introduction of the new product and/or service to the market (Yalcinkaya, Calantone, & Griffith, 2007) that will create a series of short-term competitive advantage, hence creating a sustainable competitive advantage.

The firms' continuity of competitive advantage under the condition of dynamic environments can be assured when firms consistently develop and renew capabilities over time (Hou, 2008) as new goal appears (Canibano, Encinar, & Munoz, 2006) to respond to opportunities or threats. However, not all firms will success in pursuing for higher level performance (Majumdar, 1999) because of differences that exists between firms. In addition, organizational capabilities are different from DCs (Lee, & Kelley, 2008) because DCs is meta capability (Collis, 1994) or higher level capability (Wang, & Ahmed, 2007) that is needed to become higher performers (Cetindamar, Phaal, & Probert, 2009). This is because DCs building processes is explained by the idiosyncrasy of the firm which create causal ambiguity that makes it hard to understand the link between DCs and performance, hence difficult to tell the source of competitive advantage. Anyway, it is argue that DCs is not directly impacts the competitive advantage as the effect is through the reconfiguration of resources and capabilities.

3.0 The Alignments

DCs are to achieve innovative form of competitive advantage. It is to explain the sources of competitive advantage at firm-level of analysis. DCs are building capabilities which is to achieve evolutionary fitness that enables firms to make a living. To makes a living firm has to be successfully commercializing the new innovative product in line with the opportunities (Teece, 2007). Commercialization of new innovative product will only success if the related complementary assets are utilized together which means firm have to access to the complementary assets, otherwise the benefits of the new product will be harvested by the followers, imitators or the owners of complementary assets. Complementary assets are disaggregated into generic, specialized, and co-specialized assets. However, the possession of specialized and/or co-specialized will decides who will make the most profits when the new innovative product is commercialized (Teece, 1986). The alignment between firm's resources and market demand is crucial to assure the firm survival and to create competitive advantage (Liao, Kickul, & Ma, 2009).

The firm strategy and the capability building alignment will create DCs that are better able to achieve performance and sustaining the firm competitive advantage (Wang, & Ahmed, 2007). This is because the concept of DCs is to respond to the environmental change and to achieve performance (Wang, Klein, & Jiang, 2007). Moreover, well-integrated bundle of resources is a source of performance (Helfat, et. al., 2007). Therefore, the organizational alignment needs to be done every time the strategy is changing because the success of strategy execution is depending on the alignment (Harreld, O'Reilly, & Tushman, 2007). In addition, the success of firm responding to the market demand and to create differentiation is achieved with the alignment of information, knowledge and resources (Liao, Kickul, & Ma, 2009). Moreover, the value creating innovation is created through the knowledge resources alignment (Lee, & Kelley, 2008).

Thus, the alignment of the knowledge is a must to achieve market performance (Pelaez, Hofmann, Melo, & Aquino, 2009). The DCs performance is depending on the performance of all processes relating to DCs in the firms. DCs performance is not increasing if only one or two of the related processes having high fitness while the rest of the processes are not. Firms' ability to create fit between processes under changes is important parts of co-specialized assets orchestration (Helfat, et al., 2007). Therefore, the alignment of internal processes with demands in an effective and efficient ways will increase the value of strategic assets (Oliver, & Holzinger, 2008) as the knowledge stored in the intangible assets is non-tradable and non-transferable which make DCs become difficult-to-duplicate (O'Reilly, & Tushman, 2008).

4.0 The Resources Base and Level of Capabilities

Resource management is comprehensive process of structuring firm's resource portfolio, bundling the resources to build capabilities, and leveraging those capabilities with the purpose of creating and maintaining the value for customers and owners, in which, the firms' success is affected by the managerial skills at resources selection and development (Sirmon, Hitt, & Ireland, 2007). Resource base is referred to the firm's resources or assets consisting of technological assets, complementary assets, financial assets, reputational assets, structural assets, institutional assets, and market assets (Teece, Pisano, & Shuen, 1997) and divided into tangible and intangible assets (Hitt, Ireland, & Hoskisson, 2005) that are controlled or assessed by firms (Grobler, 2007; Helfat, & Peteraf, 2003).

In DCs study, processes are also treated as resources (Helfat, et al., 2007). There are various tangible and intangible assets such as specialized know-how, management capability, alliance experience and financial capital (tangible asset) as suggested by Wu (2010) when investigating the resources relationship with competitive advantage under environmental volatility. In addition, resources coordination and firms' routines are the elements of DCs (Hong, Kianto, & Kylaheiko, 2008) where DCs is focusing on modifying the firms' resources to match the changing environment (Bowman, & Ambrosini, 2003).

As the changing of resources positions at various time will cause differences in firms' performance (Zott, 2003), the new or improved resources are always needed whenever major change happen in the market to respond to the new demands. However, it is difficult to assure the resources possessed by the firms have a potential to create value in the future when the environment is hard to be predicted (Sirmon, Hitt, & Ireland, 2007). Moreover, strategic capabilities are built from resources but possessing of resources does not guarantee capability building for firms. This is because resources and capabilities systems of the firms are dynamic in nature and their relationships are always changing (Grobler, 2007). With the VRIN characteristics of the firms' assets, the internal processes and efforts are crucial in building DCs than the external efforts. Thus, DCs is an internal resource orientation rather than external orientation (Zhou, & Li, 2009) where the internal resources and capabilities are the crucial factors to the success of firms in competition (Grobler, 2007). However, even though DCs is internal resource oriented, the resource base for DCs can be both internal and external to the firms as long as they have access to the resources even if the resources are outside the firms' boundaries such as alliance-based DCs and acquisition-based DCs in which both are related to the relational capability of DCs (Helfat, et al., 2007).

Among examples of resources that have been used in empirical researches of DCs are technological, alliance, human resources, and planning (Liao, Kickul, & Ma, 2009), specialized know-how, capital, operational management capability, reputation, and cooperative alliance experience (Wu, 2009, 2006; Wu, & Wang, 2007), resource know-how, capital, and managerial capacity (Wu, 2007), and asset specificity, relationship predictability, market knowledge gap, and type of market (Griffith, & Harvey, 2001). As suggested by literature, DCs is not an ordinary resource because it is a resource that is capable of renewing resources. This means resource base can be identified in hierarchical order. For example, the empirical analyses of various categories of resources to firm success is demonstrated by Galbreath (2005) where he has identified three categories of resources that are; (1) the tangible resources such as financial assets, (2) the assets related to intangible resources such as intellectual property, and (3) the skills related to intangible resources such as capabilities. However, he does not classify capabilities further into core capabilities even though they are different in their effects to the firm success.

In addition, it is argued that core capabilities are better than capabilities, and capabilities are better than resources as the sources of competitive advantage in the hierarchy. Nevertheless, more detailed categories of resources have been suggested by Wang and Ahmed (2007). Wang and Ahmed (2007) posited that firm's resources and capabilities are in hierarchy order when addressing competitive advantage, which Ambrosini and Bowman (2009) called as DCs typologies. Wang, and Ahmed (2007) identified resources as the zero-order, while capabilities as first-order, core capabilities as second-order, and DCs as third-order in the hierarchy. They claim DCs is the ultimate organizational capabilities and therefore is the source of sustainable competitive advantage instead of simply a subgroup (Lopez, 2005) or subset of capabilities (Teece, Pisano, & Shuen, 1997). However, the categorization of resources and capabilities in hierarchy order is not the first of kind as Collis (1994) has defined organizational capabilities in three categories after he claims there were so many versions of organizational capabilities definitions in literature.

For this reasons, he categorized the organizational capabilities in first category, second category, and third category of capability. It is agreed that Wang and Ahmed's hierarchy order and Collis's categorization of capability is referred to the ranking in organizational capabilities where DCs is the third-order (ultimate) or third category of organizational capabilities. As DCs is the ultimate of organizational capabilities, it is different from the rest of organizational capabilities because it enables the firm to innovate outside the routines (Lee, & Kelley, 2008). Thus, DCs is the higher level capability that is capable of renewing the lower level capabilities including itself (Ambrosini, Bowman, & Collier, 2009). Base on the literature, the second- and third-order capabilities are DCs in nature. However, the physical border between the hierarchies is hard to be explicitly determined (Collis, 1994). Thus, the discussion of capability hierarchy is to create clear understanding of the level of capabilities and to shows differentiation of DCs from the rest of resources and capabilities.

5.0 Dynamic Capability and Competitive Advantage

DCs is gaining great attention in strategic management and have becoming an important topic since early 1990s where the discussion about the origin of the concept can be tracked back as early as 1959 by Penrose. The concept of DCs is designed to achieve sustainable competitive advantage (Teece, Pisano, & Shuen, 1997; Lopez, 2005; Bhutto, 2005; Kylaheiko, & Sandstrom, 2007; Teece, 2007), rent creation (Makadok, 2001; Blyler, & Coff, 2003), and performance (Majumdar, 1999; Zott, 2003; Jantunen, Puumalainen, Saarenketo, & Kylaheiko, 2005; Arthurs, & Busenitz, 2006; Marsh, & Stock, 2006; Wu, 2006, 2007; Grobler, 2007; Wu, & Wang, 2007; Hung, Chung, & Lien, 2007; Pablo, Reay, Dewald, & Casebeer, 2007).

The firm resources are positively affecting the competitive advantage but the effect becomes weak under volatile environment which suggesting the use of DCs (Wu, 2010). The threats to competitive advantage is coming from outside the firms when the market dynamism is moderate while in highly volatile market the threats is coming from both inside and outside of the firms (Eisenhardt, & Martin, 2000). Firms can create new set of VRIN resources by renewing or modifying the resource base whenever change happen. Thus, DCs is basically the capabilities to renew capabilities including renewing itself which is called as regenerative DCs (Ambrosini, Bowman, & Collier, 2009) where the renewal of resources is not just for expansion but also for exit decisions (Helfat, et al., 2007). As mentioned before, the objective of DCs is to explain the source of sustainable competitive advantage. However, firm is not necessarily creating competitive advantage by simply possessing DCs, moreover possessing of capabilities involve sunk cost (Helfat, et al., 2007). Hence the question is how DCs enable firm to achieve competitive advantage? To become the source of competitive advantage, these intangible resources have to meet three criteria; (1) it has to be technically fitness, (2) it must meets the need of the change, and (3) it has to be rare (Helfat, et al., 2007).

DC is entrepreneurial in nature where the innovative outcome of the renewed resource base is to create and/or response to the opportunities and threats of the market and technological change. The firm's ability to renew the resource base is in form of the intangible resources of learning process and knowledge management. DCs is referred to the operating routines rather than competencies (Zollo, & Winter, 2002). These intangible resources (such as processes, skills, routines) when unique and difficult-to-duplicate will become the source of sustainable competitive advantage. At the same time, DCs has many forms and types where its use is depending on the context. Therefore, it is clear that some DCs is to achieve efficiency (such as technological capability) while other is to achieve effectiveness (marketing capability). These efficiency and effectiveness can be identified as technical and evolutionary fitness (Helfat, et al., 2007). As the resource base is defined in term of efficiency and effectiveness, the measurement for DCs performance is the renewal of the resource base that is technically (efficiency) and evolutionarily (effectiveness) fit.

6.0 The Focus of Dynamic Capability

The literature has contributed to the understanding and development of the concept of DCs, promoting DCs as an important tool to sustain competitive advantage under dynamic environments, drawing guidelines for firms to build DCs, analyzing and/or examining the use of DCs in various industries, and showing the evidences of successful implementations of DCs through case studies. The literature both in empirical and conceptual offers valuable knowledge as they identify, develop, demonstrate, examine, or explain DCs under various setting. The research has taken place in various industries such as manufacturing (Kylaheiko, & Sandstrom, 2007), high-tech (Helfat, 1997; Deeds, DeCarolis, & Coombs, 1999; Hung, Chung, & Lien, 2007; Wu, 2007, 2009), consumer products (Zhou, & Li, 2009), public sector (Pablo, Reay, Dewald, & Casebeer, 2007) and telecommunications, information technology, and mobility industry (Majumdar, 1999; Bhutto, 2005; Wu, 2006; Wu, & Wang, 2007; Cepeda, & Vera, 2007; Liao, Kickul, & Ma, 2009). The themes that normally studied under DCs other than strategic management (Teece, Pisano, & Shuen, 1997; Eisenhardt, & Martin, 2000; Bowman, & Ambrosini, 2003; Helfat, & Peteraf, 2003; Winter, 2003; Bhutto, 2005; Lopez, 2005; Menon, 2008; Zhou, & Li, 2009) are strategic alliances (Chen, & Lee, 2009; Chen, Lee, & Lay, 2009), entrepreneurship (Jantunen, Puumalainen, Saarenketo, & Kylaheiko, 2005; Wu, 2007), knowledge management and organizational learning (Zollo, & Winter, 2002; Marsh, & Stock, 2006; Cepeda, & Vera, 2007; Pablo, Reay, Dewald, & Casebeer, 2007; Chen, & Lee, 2009; Chen, Lee, & Lay, 2009), new product development (Deeds, DeCarolis, & Coombs, 1999), R&D (Helfat, 1997), and innovation (Lawson, & Samson, 2001; Miguel, Franklin, & Popadiuk, 2008; O'Connor, 2008; Liao, Kickul, & Ma, 2009).

The concept of DCs that are commonly discussed in literature are environment (Newbert, 2005; Eisenhardt, & Martin, 2000; Teece, Pisano, & Shuen, 1997), assets and resources (Cavusgil, Seggie, & Talay, 2007; Bowman, & Ambrosini, 2003; Teece, Pisano, & Shuen, 1997), processes and activities (Menon, 2008; O'Connor, 2008; Bowman, & Ambrosini, 2003; Eisenhardt, & Martin, 2000; Teece, Pisano, & Shuen, 1997), learning processes (Hou, 2008; Cavusgil, Seggie, & Talay, 2007; Bowman, & Ambrosini, 2003), and specificity and commonality of DCs (Menon, 2008; O'Connor, 2008; Cavusgil, Seggie, & Talay, 2007; Newbert, 2005; Eisenhardt, & Martin, 2000; Teece, Pisano, & Shuen, 1997). The interest of scholars in DCs have moving around the development and understanding of theory (Teece, Pisano, & Shuen, 1997; Eisenhardt, & Martin, 2000; Winter, 2003; Helfat, & Peteraf, 2003; Lopez, 2005; Teece, 2007; Schreyogg, & Kliesch-Eberl, 2007; Teece, 2007; Menon, 2008), the drivers of DCs (Chen, & Lee, 2009; Chen, Lee, & Lay, 2009), the critical elements of DCs (Kylaheiko, & Sandstrom, 2007), the key determinants of DCs (Deeds, DeCarolis, & Coombs, 1999), the mechanisms for DCs (Zollo, & Winter, 2002), the effects/impacts of DCs (Jantunen, Puumalainen, Saarenketo, & Kylaheiko, 2005; Bhutto, 2005), to examine/analyze DCs (Wu, 2006, 2009), and to promote/demonstrate the use of DCs (Lopez, 2005; Grobler, 2007; Wu, 2007).

In addition, the influential factors of DCs are also various according to the context under studied. Among the examples of factors studied in literature such as network, partnership, external linkage (Chen, & Lee, 2009; Chen, Lee, & Lay, 2009; Desai, Sahu, & Sinha, 2007; Wu, 2007, 2006; Wu, & Wang, 2007; Ayuso, Rodriguez, & Ricart, 2006; Ho, & Tsai, 2006), resource base (Desai, Sahu, & Sinha, 2007; Wu, 2007, 2006; Wu, & Wang, 2007; Zott, 2003), environmental changes and opportunities (Liao, Kickul, & Ma, 2009; Boccardelli, & Magnusson, 2006), and firm orientations (Zhou, & Li, 2009; Desai, Sahu, & Sinha, 2007), the drivers of DCs, such as resource reconfigurability, social networking capability, and market orientation for CRM capabilities (Desai, Sahu, & Sinha, 2007), and the critical elements of DCs, such as customer orientation, competitor orientation, and technology orientation for adaptive capabilities (Zhou, & Li, 2009).

7.0 The Importance of Technological Capability in Dynamic Capability

To sustain the competitive advantage, firms need to confront with the turbulent in the high market and the uncertainty of technologies (Kylaheiko, & Sandstrom, 2007). The dynamic of technological capabilities together with the scientific capabilities of the firms determine the firms' ability to constantly build new product as the environment continuously change (Deeds, DeCarolis, & Coombs, 1999). This allows the transformation of the resources into performance and generating profits for the firms (Wu, & Wang, 2007). Building the link between new product development activities and the firms' strategy is crucial for the managers (Marsh, & Stock, 2006). This is because firms see the worthiness of certain technologies in a different way than the others because of the different technology base and strategy they have (Teece, 2007). Changing of technological resources will bring new challenge to the firms' competitiveness (Chen, & Lee, 2009). As the change will bring new challenge to the firms, DCs is able to turn resources into performance hence capable of generating profit (Wu, & Wang, 2007).

Thus, firms must evaluate how technologies evolve and create response to the customers, suppliers, competitors, and policies makers, and change the nature of opportunities and competitions. One of the determinants of the firms' success is the efficient and effective transfer of technology in both inside and outside of the firms (Teece, 2007). Therefore, DCs is very important in order to assure the survival of technology-based firms (Wu, 2007) and for the continuity of the firms' businesses when the environment they dealing with are developing very fast (Wu, & Wang, 2007) with rapid introduction of new technology and a shorter technology lifecycle (Wu, 2007). In a rapid changing environments, the introduction of new technology is very fast while the lifecycle becoming shorter (Wu, 2007) where globalization and digitized mode of operations were identified as drivers of rapid changing environments which is known as 'the third revolution' (Kylaheiko, & Sandstrom, 2007).

In addition, uncertainties are significant challenges to the firms in developing new products (Marsh, & Stock, 2006), hence, the ability to build new products rapidly is a key to the success of entrepreneurial firms in environments that is characterized by continuously technological change and fierce competition of global markets (Deeds, DeCarolis, & Coombs, 1999) with rapid changing of consumer needs and technological uncertainty (Wu, 2006). In order to reduce the gap or to create the balance between the firms' capabilities and the market needs, firms need to build new products/processes that can match the changing market needs. Technology resource and product are like two faces of the same coin (Wernerfelt, 1984). Thus, firms have to develop the right technological capabilities as these are the capabilities to build new products/processes. Therefore, to build the right products/processes that can address the changing market needs means to build the right technological capabilities as the technology itself can be the products/processes (Khalil, 2000).

8.0 Discussion and Suggestion

In the world of businesses, technology is presented in the ways it is being used to produce goods, as goods itself, or in proving services to customers. In order to become competent and gaining competitive advantage especially in industries that are depending largely on technology, managing the technology is very critical. Like the rest of things in our life, technology needs to be managed to harness the benefits out of it. It can be disastrous if not properly managed because the impact of technology is broader not simply on individual firms but also on the society at large either positively or negatively (White & Bruton, 2007). The management of technological capability is highly important and the insufficient reaction of the established firms to technological change can lead to their demise. In order to reduce the probability of failure in the face of technological discontinuities and to increase the effectiveness of technological decision-making, many researchers called for a more systematic observation of technological trends (Lichtenthaler, 2004). Furthermore, Lichtenthaler (2004) has identified the level of technology and the maturity of technology as the most crucial factors in technology intelligence in the context of technological change. The rate of technological innovation is significant at sustaining competitive advantage (Ray, Ida, Chung-Sok, & Rhaman, 2004). This means the technology and the competency has a correlation and therefore managing the technological change will improve the competency level of the firms.

However, to sustain competitive advantage, firms need to confront with the turbulent in high market and uncertainty of technologies (Kylaheiko, & Sandstrom, 2007). Managing technology is critical in order to create competency to the firms. MOT was defined by Tarek Khalil (2000) as an interdisciplinary field that integrates science, engineering, and management knowledge and practice. Thus, managing technology is very crucial in any disciplines and businesses and not only applicable to the product-based industries, as it is equally important to the service-based industries. Technology is use in product and service industries as tool for competitiveness. Hence, a proper management of technology (MOT) will bring competitive advantage to the firms where the firms have an edge over rivals in attracting customers and defending against competitive forces (Thompson & Strickland, 2003). According to well cited MOT definition by the Task Force on Management of Technology (1987), MOT is defined as:

a process, which includes planning, directing, control and coordination of the development and implementation of technological capabilities to shape and accomplish the strategic and operational objectives of an organization.

It is obvious from the definition MOT is to manage the technological capabilities to achieve the operational and strategic objectives of the firm. In this case, technology is treated as resource (Cetindamar, Can, & Pala, 2006) in which one of the firm assets is technological asset (Teece, Pisano, & Shuen, 2007), but it is argue that 'technology (has) becomes more than an idiosyncratic set of resources' (Chanaron, & Jolly, 1999: 613). Base on the definition given above, the role of technology is not very critical for the firm in which MOT is designed to make sure the technology portfolio of the firms is in line with the firm objectives (Chanaron, & Jolly, 1999). Chanaron and Jolly (1999) argue that technology has critical role in firm in which they have introduced the extension of the concept of MOT in which they called as technological management (TM). They argue TM is different from the current concept of MOT because in MOT 'there was clearly no interest in dealing with the impacts of technology on managerial practices, methods and finally management sciences' (Chanaron, & Jolly, 1999: 614). They argue that the reasons for the existence of TM because of:

1. An increasing acceptance that technology is not an issue which should be confined to researchers and engineers involved in creating and optimizing a portfolio but is a key variable that has an impact on everyone within the organization, and
2. An increasing recognition that management efficiency, and obviously business success, is associated with breaking down barriers and spanning bridges between disciplines and functions, leading to a transversal and integrated vision (Chanaron, & Jolly, 1999: 615).

As discussed before, DCs is crucial for firms to create and sustain the competitive advantage under rapidly technological change. It is designed for management level that is focusing at firm level of analysis. Because of TM is looking at technology not at the confined issue of technology portfolio to create fit with the firm overall objective (as in reason # 1 above), instead as major element that influencing the firm decisions, it seem to be that DCs suits the concept of TM, that is the technological management can be demonstrated with the concept of DCs. Moreover, the detail of the TM concept is not explained in Chanaron and Jolly (1999). Thus, DCs might be used as an ongoing concept to explain TM. Figure 1 shows the relationships between R&D management, MOT, and TM in which the role of TM is not confined to technical areas but its effects is expanding to all functions in the firms. Because TM is to control the impacts of technology over management functions, thus, TM is also to maintain the internal alignment of the firms through its processes.

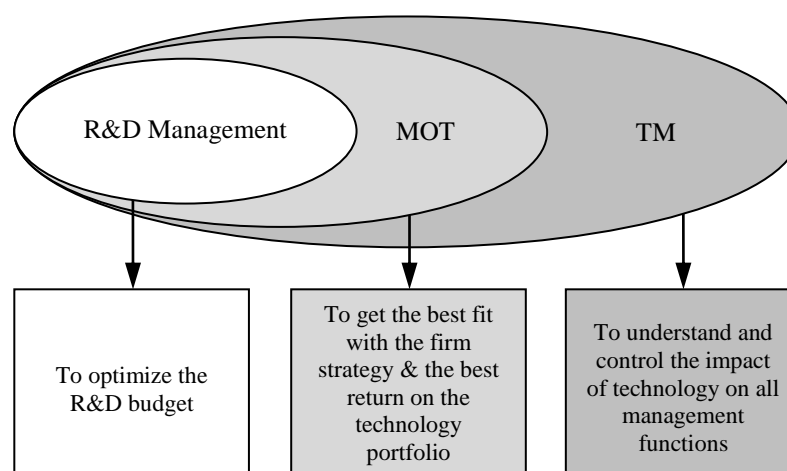


Figure 1: The relationships between R&D, MOT, and TM (Chanaron, & Joll , 1999)

But there is limitation that needs to be carefully handled when studying technological capability under DCs perspective as technological capability is just one asset in the firms and it alone cannot create competitive advantage as the concept of DCs is stressing on the need to create alignments between the complementarity and the co-specialization of various assets. The complementarity and co-specialization of the assets that is unique and more difficult-to-duplicate by competitors are the most critical elements in DCs compared to any single asset (Teece, 2007). However, as DCs is more effective for firms in the industry that is characterized with systemic innovation (Helfat, et al., 2007) in which all the components of innovation have to be aligned in order to realize the potential of technology especially for technology-intensive industry under rapidly technological change, the technological management is very crucial and its studies under the concept of DCs will be benefiting. However, the concept of DCs for studying technological capabilities is still new in which many related literature for technological capabilities are published after year 2000. Table 1 shows some examples of technological capabilities topics in the recent DCs and TM related literature. Thus, it is argue that the room for studying technological capabilities with the concept of DCs to understand TM is very promising. Hence, looking at TM with the concept of DCs will be benefiting at pushing the level of importance of technology in determining the firm success.

Table 1: Examples of technology related research in dynamic capability

Authors	Titles	Publications
Bhutto (2005)	Managing Interindustry Differences Through Dynamic Capabilities: The Case Study of Nokia	International Journal of Innovation and Technology Management
Bhutto (2008)	A Dynamic Technological Capability (DTC) Model for the Next Generation of Technology Evolution	Unpublished Doctor of Philosophy, Nottingham University
Bianchi, Chiesa, & Frattini (2009)	Exploring the Microfoundations of External Technology Commercialization: A Dynamic Capabilities Perspective	European Journal of Innovation Management
Cetindamar, Phaal, & Probert (2009)	Understanding Technology Management as a Dynamic Capability: A Framework for Technology Management Activities	Technovation
Chen, Sun, Helms, & Jih (2008)	Aligning Information Technology and Business Strategy with a Dynamic Capabilities Perspective: A Longitudinal Study of a Taiwanese Semiconductor Company	International Journal of Information Management
Deeds, DeCarolis, & Coombs (1999)	Dynamic capabilities and New Product Development in High Technology Ventures: An Empirical Analysis of New Biotechnology Firms	Journal of Business Venturing
Desai, Sahu, & Sinha (2007)	Role of Dynamic Capability and Information Technology in Customer Relationship Management: A Study of Indian Companies	Vikalpa: The Journal for Decision Makers
Hacklin, Marxt, & Ingnas (2005)	Technology Acquisition through Convergence: The Role of Dynamic Capabilities	Paper presented at the 14th International Conference on Management of Technology, Vienna
Salomo, Gemunden, & Leifer (2007)	Research on Corporate Radical Innovation Systems - A Dynamic Capabilities Perspective: An Introduction	Journal of Engineering and Technology Management

9.0 Conclusion

Firm will respond to the change whenever their performance is at risk. But, there are lots of stories where incumbents are no longer remain competitive in the new market settings and their positions were overtaken by much newer and more innovative firms because the way they responding to the market is insufficient and not matching the needs of the change and their strategy is easily duplicated by competitors. Thus, the concept of DCs is suggested as DCs is focusing on the firm's ability to renew the resource base as a source of competitive advantage under dynamic environment. One of the important resources of the firm resource base is technological capability that is crucial to be managed as this asset is critical in determining the firm success especially for firm in the technology-intensive industries under continuously technological change characterized with systemic innovation. The technological capability is the main focus of the management of technology (MOT), but it is argue that the MOT concept is less focusing on the impacts of technological capabilities. Thus, the extension concepts of MOT that is called as technological management (TM) has been suggested in which technological capability is treated to have an important role in deciding the firm success instead of just confined to the study of technology portfolio to create fit with the overall firm objectives.

As TM concept is not discussing the details of how technological capabilities can be managed and renewed to affect the competitive advantage, using DCs as working concept for TM to manage and renew the technological capabilities will be crucial. Because there is lacking of focus of MOT in this issue (the effects of technological capabilities to firm success) and little literature of technological capabilities in DCs, the study of technological capabilities from the concept of DCs is very promising for future research.

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