

## **SUSTAINING VALUE CREATION WITH COMPLEMENTARY TECHNOLOGIES ALIGNMENT**

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### **Abstract**

Firm creates value within its value chain (VC) and value systems (VS). As technologies exist in the firm's VC and VS, they have becoming more complementary than replacing each other. Technological change that affects the activities in the firm's VC and/or VS is causing misalignment to the firm's existing complementary technologies, which will affect not just the firm's value creation activities but also the value creation of the members in the systems. It is argued value creation can be sustained if the firm is able to continuously create alignment among the complementary technologies in its VC and/or with the other members' VCs. Guided with the concept of complementary assets alignment from dynamic capability (DC) perspective, the objective of this conceptual paper is to highlight a conceptual framework for sustaining value creation by creating alignment among the complementary technologies within the firm's VC and VS in response of technological change.

### **Keywords**

Complementary assets alignment, Complementary technologies, Dynamic capability, Technological change, Technology management, Value chain, Value creation, Value systems

### **1. Introduction**

Descriptively, a firm's value chain (VC) is consisted of many activities to design, produce, market, deliver, and support its products/services, while a value systems (VS) is consisted of a much larger stream of activities that includes the VCs of the suppliers, distributions, and customers, which are the basis for creating cost advantage, and differentiation strategies (Porter, 1985). As such, both VC and VS are the source for value creation, which 'involves innovation that establishes or increases the consumer's valuation of the benefits of consumption' (Priem, 2007, p. 220). Meanwhile, since most of the activities for value creation is technology-related (White & Bruton, 2007), even if the firm's nature of business is not technology-related, they are somehow reliant on technology. This is because technology has becoming necessity such as in making sure the internal consistency of the business operations or as the enabler in producing products or providing services. As such, it is hard to see any firms that do not possessing any of the technology-related capabilities. With the advancement in technology such as the internet, firm that is smaller in physical size and manpower is now capable of reaching suppliers and customers from all over the world, thus has changed the nature of value creation (e.g., Amit & Zott, 2001).

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As the technologies in the firm's value creation are interrelated or complementary to each other, the effects of technological change have becoming more critical than ever before, such as where the technological change that affects one technology may possibly affects the other technologies in the firm's VC. Similarly, the technological change that occurs in the supplier's VC may as well affect the complementary technologies in the firm's VC. Since changes in one technology may affect the complementarity of all the related technologies (components) in the firm's VC and/or VS, they need to be realigned in order to sustain value creation. Since reliance on technologies may expose the firm to the effects of technological change either directly or indirectly, managing complementary technologies in the firm's VC and VS is very critical for survival. As such, this conceptual paper is focusing on the importance of creating alignment between complementary technologies in the firm's VC and/or VS in response of technological change.

## 2. Issue

The ability to manage specialized and/or co-specialized assets is very crucial in building technological capability to match the rapidly changing environment, but this skills is not always exists in the firm (Teece, 2007). As the result, firm that has no access to the related specialized and/or co-specialized assets will loss the potential profits when the first-mover advantage for the new innovative products are possessed or accessed by the followers or imitators (Teece, 1986). For the reasons, previous study has proposed three modes for successfully commercializing innovation. First, the integration mode that is best to utilize when the appropriability regime is weak (e.g., when the legal protection for innovation is not possible) where innovation is exposes to imitation. With this mode, the owner of the complementary assets will benefits from the commercialization of innovation as it controls all the complementary assets. Thus, by possessing the complementary assets, firm can protect the innovation. This mode is likely to be used in the firm's VC as they have control over their own sets of complementary technologies. Second, the contractual mode that is used by contracting or licensing the innovation to suppliers, manufactures, or distributors where the risks of doing the activities can be reduced and the costs involved in performing the activities can be avoided. This mode is necessary when the firm's innovation is protected with tight appropriability regime (e.g., patent, copyright, and trade secret) that makes imitation by others is not possible (Teece, 1986). This mode is likely to be used in the firm's VS (combination of the firm and other members' VCs) where firm need to accessto the complementary technologies of the other firms. However, in reality it is difficult to have pure integration or pure contractual modes as the numbers of asset to be accessed is quite large even for less complex innovation. Thus, firmmay not necessarily control all of the assets (as in pure integration mode) and even if they do, it is financially unjustified to possessing all of the relevant assets. At the same time, protecting the innovation will be difficult under pure contractual mode as the related assets are controlled by the other firms. Therefore, the third mode that is a mixed mode is used when firm is lacking of technical capabilities. With the mixed mode, collaboration between firms is required where each firm handle only certain parts of the systems. For instance, when computer and telecommunication industries are converged, a mixed mode for commercializing innovation will be appropriate between computer and communication firms (Teece, 1986). As such, for commercialization of innovation, firmneed to utilizethe complementary technologies in both of its own VC and the members' VCs.

As the primary and supporting activities in the firm's VC and VS are mostly technology-related activities (White & Bruton, 2007), they are complementing rather than replacing each other. Under technological change, the affected technology may no longer fit (as it has lost the alignment) with the rest of the complementary technologies for value creation. Since the alignment skills that are

valuable and difficult-to-duplicate by competitors can be the source for sustainable value creation, understanding the concept of complementary technologies alignment with DC perspective is providing potential research area to explain how alignment can be used in managing technology by creating fit between complementary technologies within the firm's VC and/or VS to successfully commercializing innovation under changing technology. As such, the complementary assets alignment that is the critical element in DC's third capacity for managing threats/transformation is crucial in creating fit between complementary technologies in the firm's VC and VS (Teece, 2007). Since its application for managing technology seems to be very promising, further investigation is needed as the complementary assets alignment is receiving lack of empirical evidence in DC literature.

Furthermore, the need to create alignment among complementary technologies within the firm's VC and VS is important since firm need to confront with the turbulent in market and uncertainty of technologies (Kylaheiko, & Sandstrom, 2007) where the interplay between market-driven incentives and technological capability building determine the firm's ability to learn the skills and to gain information in order to deals with the technological change (Lall, 1992). In addition, since firm may find it difficult to build together both of new core and complementary technologies, the organizational linkages between responsible units is critical for adaptation between core and complementary technologies. Meanwhile, as change in technology may has created new channels for distributing new products, firm may needs to change its routines in order to avoid conflicts between new and existing channels (technologies) (Taylor & Helfat, 2009). As such, since 'the expansion of trade has enabled and required both greater global specialization and integration ... there is a need (indeed an enhanced need) for firms to develop and align assets and to combine (integrate) the various elements of the global value chain so as to develop and deliver a 'solution' that customers value' (Katkalo, Pitelis, & Teece, 2010, p. 1178).

### **3. Technologies for Value Creation**

Technology refers to 'all the knowledge, products, processes, tools, methods, and systems employed in the creation of goods or in providing services' (Khalil, 2000, p. 1). It is also refers to 'a process, technique, or methodology – embodied in a product design or in a manufacturing or service process – which transforms inputs of labor, capital, information, material, and energy into outputs of greater value' (Christensen, 1992, p. 336). Since technology is existed in the value-added chain (Khalil, 2000), which is used for creating value in both primary and supporting activities (White & Bruton, 2007), it is shown technology is the basis for value creation that is existed within the firm's VC and VS.

As shown in Figure 1, various complementary technologies are presented in the firm's primary and supporting activities of VC. For instance, the information regarding the materials that is needed for the next manufacturing operations, and the transportation, storing, and handling of the materials involve the use of various technologies in assuring the smooth transition of materials from inbound logistics to operations. The present of technology also can be seen in the processes to transform the materials from one stage of operations to another stage of operations including the quality controls and communication between processes. In the outbound logistics, technologies involve in packaging, materials handling, transportation, communication, and JIT inventory systems. The same thing goes to the other primary activities of VC where marketing, sales, and services apply many technological tools in advertisement and communication with customers, and as mode of transactions. While for the supporting activities of VC, variety of technologies existed within the

firm's infrastructure, HRM, new product development, and in the procurement activity (White & Bruton, 2007).

Meanwhile, Figure 2 is showing the VCs of different members (firms) in the value creation that are interconnected to create one big value systems. This happen because some complementary technologies may be located outside of the firm (Taylor & Helfat, 2009). As 'the sources of technology being widely distributed internationally, there is a requirement to integrate globally distributed assets ...' (Pitelis & Teece, 2010, p. 1255). For the reasons, when the innovation is systemic in nature, the complementary assets of the other parts of the systems will be needed (Teece, 1986). In other words, as the firm is connected to the other parties in the industry such as suppliers, business partners, distributors, and customers that have their own VCs where technologies also playing critical roles, the interactions between different VCs has created VS with more complex sets of complementary technologies. Just like the firm's VC, the well-aligned complementary technologies in VS (that is difficult-to-duplicate by others in different VS) can be the source of sustainable value creation among the members of the systems.

#### **4. Technological Change**

Technological change that is 'a change in one or more of such inputs, processes, techniques, or methodologies that improves [affects] the measured levels of performance of a product or process' (Christensen, 1992, p. 336) will affects the technologies in the firm's VC and VS. There are two types of technological change that may affect the firm's competitive environments; the continuous technological and radical technological change. Continuous technological change refers to the minor progress in technology that is to improve the functionality, quality, cost, and/or performance of the existing technology. This type of change is strengthening the current structure of the industry where competitive advantage can be acquired by improving the technology. For example, the downsizing of personal computer and upsizing of processor speed. Whereas, radical technological change is causing dramatic change to the technology that alters the way things is performed. This type of change established new ways of doing thing through the creation of new functionality of technology that creates the whole new industry or crushes the old one. For example, the introduction of word processing technology has replaced the typewriter technology (White & Bruton, 2007).

Consistent with the continuous and radical technological changes, modular innovation involves fundamental change to the technological approach of component technology while the product architecture remains unchanged. Meanwhile, radical innovations involve change in the component levels that includes new architecture and new fundamental technological approach (Christensen, 1992). Alongside with the above changes, there is another type of technological change called disruptive technology. While this types of change shares many similarities with radical technology change as both of them change the way industry competes, disruptive technology differs from radical technology as it disturbs the market even if the level of change is not radical. For example, the introduction of less radical technology that capable of lowering the cost of production can disrupts the market that is dominated by the incumbent technologies. This technology also differs from continuous technology as the continuous change did not disrupt the market (White, & Bruton, 2007).

Even though the continuous and radical technological changes are affecting the firm's competitiveness, it seems that the radical or disruptive technologies are more critical. This is because when addressing the pace of technological change, it is argued 'the magnitude and speed of

technological change in recent years have been phenomenal. A very rapid rate of technological innovation is making it imperative to consider technology as the primary influencing economic growth and prosperity' (Khalil, 2000, p. 13). Therefore, it is not surprising when scholars have characterizing the dynamic environments as rapid technological change (Teece, Pisano, & Shuen, 1997), unpredictability and strong competition (Chen & Lee, 2009), complex value nets (Kylaheiko & Sandstrom, 2007), radical and new innovation (O'Connor, 2008), emergence of knowledge economy, global competition and technological advance (Lawson & Samson, 2001), new products and processes creation (Helfat, 1997), converging technologies (Bhutto, 2005), global competition (Teece, 2007), rapid development of new products (Deeds, DeCarolis, & Coombs, 2000), and uncertainty of technological knowledge, lack of complementary technologies and developed markets (Marsh & Stock, 2006). This suggests under dynamic environments, the only certain thing is change (Teece, 2000).

Changing of market needs makes the firm's capabilities becomes irrelevant at the time of change and makes it difficult to maintain competitive advantage over long period of time (Biedenbach & Soderholm, 2008). To sustain the competitive advantage, firm need to confront with the turbulent in the high market and the uncertainty of technologies (Kylaheiko & Sandstrom, 2007). Thus, under dynamic environmental conditions firm has to continuously updating their resources and capabilities to meets the changing market preferences by engaging in resources and capabilities developments that is important for the firm's survival (Teece, 2007). As such, since technologies are existed in both primary and supporting activities of VC, changeto any of the technologies will affect the process of value creation. Similarly, as technological innovation is existed in the VS, a changeto the component or architecture of the technologies will affects the whole systems (Christensen, 1992), Therefore, since continuously changing environment will cause early innovation (Zahra, Sapienza, & Davidsson, 2006) that may as well affects the current complementary technologies in the firm's VC and/or VS, to survive firm need to be more 'flexible, innovative and creative' (Biedenbach & Soderholm, 2008, p. 124). Even if the change does not affects the firm's technologies, the same set of technologies that are complementing in one environment may not be complementing in another environments, which is suggesting they need to be continuously aligned under technological change.

## **5. Complementary Technologies Alignment**

The concept of DC that is the extension of resource-based view (RBV) for its ability to respond to rapidly technological change (Teece, 2007) is gaining great attention in strategic management and has becoming an attractive topic among scholars since early 1990s where the discussion about the origin of the concept can be tracked back as early as 1959 by Penrose (Cavusgil, Seggie, & Talay, 2007). It is defined as 'the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments' (Teece, Pisano, & Shuen, 1997, p. 516). As firm is co-evolve with environment, DC is exploring how change in the environment is influencing change in the firm and how firm can improve the capabilities and shapes the environment (Teece, 2009). The concept is to explain the source of sustainable competitive advantage (Teece, 2007) through resources alteration processes (Ambrosini, Bowman, & Collier, 2009) to create value. There are numerous DC frameworks that have been suggested in literature, however, the one that is

receiving attention is proposed by Teece (2007) consisting of three micro-foundations or capacities, namely the opportunity sensing, opportunity seizing, and managing threats/transformations<sup>2</sup>.

According to DC's third micro-foundations, managing threats/transformation involves recombination and reconfiguration of the firm's technological assets and organizational structure based on the technologies and market opportunities that have been identified and selected (with the opportunities sensing and seizing). The process of creating alignment for the firm's assets and structures with the changing environments are to create fitness for the sustainability of profit growth. The redeployment and reconfiguration also involves redesigning of the business model, and realigning the activities and routines of the firm (Teece, 2007).

Scholars have begun to realize the importance of continuous alignment of capabilities to sustain competitive advantage (Harreld, O'Reilly, & Tushman, 2007). This is because the management ability to manage the co-specialized assets based on (technological) opportunities and (market) needs is fundamental to DC (Teece, 2007). 'With co-specialization, value can be added, and potentially appropriated by another party when an asset owner is not cognizant of the value of its assets to other parties with assets whose value will be enhanced through combination' (Pitelis&Teece, 2010, p. 1256). This suggests the continuous or semi-continuous realignment of resources, routines, and structures of the firm are crucial under rapidly changing environments to achieve strategic fit and to become the source of sustainable competitive advantage (Teece, 2007). Moreover, the alignment between investing in resources for efficiency and maintaining the resources to react to the changing environment need to be done (Sirmon, Hitt, & Ireland, 2007) as there is no single resource reconfiguration that can fit into all environment, which makes it as a moving target as different environment need different resources to create fit (McKelvie&Davidsson, 2009).

There are basically six types of alignment: business alignment, strategic alignment, structural alignment, cross-dimensional alignment, information systems (IS) alignment (Sabherwal, Hirschheim, & Goles, 2001), and environmental/contextual alignment (Baker, Cao, Jones, & Song, 2009). As the type of alignment promoted in DC is complementary assets alignment (Teece, 2007), all the six types of alignment can be complementary among themselves. For instance, previous studies have provided an example of technological capability alignment with business strategy, which has suggested even though technology itself may not be the source of competitive advantage but the alignment of IT (technological capability) strategy with business strategy can be the source of competitive advantage (Baker, Cao, Jones, & Song, 2009; Sabherwal, Hirschheim, & Goles, 2001). While in the study of high-tech industries, it is evidenced the organizational processes alignment is the source of organizational performance when mediated by DC (Hung, Chung, & Lien, 2007). As such, managing technological capabilities to achieve sustainable value creation can

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<sup>2</sup> As for the interest of the study, this conceptual paper is focusing on the complementary assets alignment under the managing threats/transformations. This is because 'the capability to orchestrate and leverage co-specialized and complementary assets in order co-create cross-border markets is arguably the grandest of all DCs' (Pitelis&Teece, 2010, p. 1263). For those who interested to read more on the opportunities sensing and seizing, see for example, Harreld, O'Reilly and Tushman (2007) as they have demonstrated the concept with case study.

be done with DC by creating alignments among the complementary technologies in response of technological change.

## **6. Conceptual Framework**

Based on a series of discussion on the issue (Section 2.0), the value creation within the firm's VC and VS that are mostly technology-related activities (Section 3.0), the effects and types of technological change to the firm's complementary technologies (Section 4.0), and the importance of the concept of complementary assets alignment for creating fit among technologies (Section 5.0), the effects of technological change to the firm's VC and VS that require different types of alignment among complementary technologies are summarized in Table 1. As shown in the table, there are basically two levels of alignment for complementary technologies, which are the alignment at VC level, and the alignment at VS level. Furthermore, as the source of technological change can be internal or external to the firm, while the magnitude of the change can be incremental or radical, the levels of complementary technologies alignment (as described in the table) are suggested.

With the information in Table 1, a conceptual framework using a four-by-four matrix for managing technology under technological change with the complementary technologies alignment for sustainable value creation is suggested. As shown in Table 2, the conceptual framework is built based on the levels of value creation (VC and VS) versus levels of technological change (incremental and radical) with four quadrants, each with different types of complementary technologies alignment. For instance, when the change in technology is incremental, which affects the complementary technologies within the firm's VC, a minor alignment to the firm's complementary technologies (that is internal and controlled by the firm) is necessary.

In general, it seems that since firm has more control over its own set of complementary technologies (internal) than the ones possessed by the other members of the VS (external), creating alignment among complementary technologies within the firm's VC is less difficult than creating alignment among complementary technologies in the VS. Similarly, creating alignment will be easier (difficult) if the source of technological change is internal (external) to the firm and incremental (radical) in nature.

## **7. Discussion**

Technology is managed not just for creating value, instead it is also managed to appropriate, protect, and even to destroy value. In managing technology and innovation, value is created when resources are nonreplicable, unique, and rare (White, & Bruton, 2007), which is very consistent with the RBV concept where resources that is valuable, rare, inimitable and non-substitutable (VRIN) is the source of sustainable competitive advantage (Barney, 1991). In the study of DC that is extended from RBV concept, realignment of technologies can be done with the capacity of complementary assets alignment (Teece, 2007), which is relevant as 'DCV [dynamic capability view] focuses on how firms can change their value-creating resources and capabilities over time to achieve congruence with an evolving environment' (Guttel & Konlechner, 2010, p. 2).

In the context of managing technology, alignment is referred to the 'fit among the systems within the firms as they support the firms' strategy. It involves monitoring and adjusting processes and structures to environmental changes and organizational outcomes' (White & Bruton, 2007, p. 393). As such, the alignment promoted in the field of technology management is not contradicted with the alignment practiced in DC to sustain competitive advantage. However, as the alignment discussed in White and Bruton seems to be focusing on the technological fit within the firm (VC) only, using

DC to extend the concept by including the technological fit between firms (VS) will be remarkably important.

Even though the proposed conceptual framework (Section 6.0) is still at the beginning of the work, while the terms used to represent the types of complementary technologies alignment for each of the quadrants is to achieve simplicity, this paper has achieved the objective by proposing a conceptual framework for sustainable value creation with the complementary technologies alignment under technological change. For the reasons, while there is still lots of thing to do in order to prove the proposed conceptual, no further explanation and empirical demonstration is provided. However, this proposed conceptual framework will be the basis for the future case study.

## **8. Suggestion**

This conceptual paper should benefit the field of technology management that is focusing on building technological capability according to the strategic importance of the firm to achieve sustainable competitive advantage. With the concept of DC's alignment capacity to create fits between complementary technologies, the proposed conceptual framework can be seen as a tool for managing technological capability under technological change. This conceptual paper is setting the basis for the future empirical studies where the conceptual framework should be demonstrated through case study.

## **9. Limitation**

The ability to manage various complementary assets (instead of any single asset) that are unique and difficult-to-duplicate by competitors is the most critical elements in DC for sustainable competitive advantage (Teece, 2007). As such, technological capability that is just one asset in the firm is not necessarily the source of competitive advantage. However, as DC is more effective for firm in the industry that is characterized with systemic innovation (Helfat, et al., 2007) where all components of innovation (technology-related) have to be aligned under rapidly technological change in order to create value, managing technology with DC's complementary assets alignment is relevant.

## **10. Conclusion**

In sum, this paper is suggesting a conceptual framework for creating alignment among complementary technologies for sustainable value creation with DC concept. With the information from the types of technological change (i.e., incremental change vs. radical change) and levels of value creation (i.e., value creation in VC vs. value creation in VS), a four-by-four matrix is created where each of the quadrants is suggesting different types of alignment to be used. This conceptual framework will be demonstrated with case study in the future.



**Table**

Table 1

*Technological change and alignments in value chain and value systems*

Levels of Value Creation	Descriptions of Change	Descriptions of Alignment
Firm's Value Chain	<ul style="list-style-type: none"> <li>- internal technological change</li> <li>- change affects the primary and supporting technologies in production systems of the firms</li> <li>- change directly affects the firms' complementary technologies alignment</li> </ul>	<ul style="list-style-type: none"> <li>- incremental change requires minor realignment of the firms' complementary technologies</li> <li>- radical change requires major realignment of the firms' complementary technologies</li> </ul>
Firm's Value Systems	<ul style="list-style-type: none"> <li>- external technological changes</li> <li>- changes affects any of the firms' suppliers, business partners, distributors, and/or customers VCs</li> <li>- change can be directly or indirectly affects the firms' complementary technologies alignment</li> </ul>	<ul style="list-style-type: none"> <li>- incremental change requires minor realignment of the firms' complementary technologies relating to the complementary technologies of the affected members in the VS</li> <li>- radical change requires major realignment of the firms' complementary technologies relating to the complementary technologies of the affected members in the VS</li> </ul>

Table 2

*The proposed conceptual framework for managing technological capability with complementary technologies alignment in the firm's value chain and value systems*

**Levels of Technological Change**

		Incremental	Radical
Levels of Value Creation	Value Chain	Minor Internal Complementary Technologies Alignment	Major Internal Complementary Technologies Alignment
	Value Systems	Minor External Complementary Technologies Alignment	Major External Complementary Technologies Alignment

**Figures**

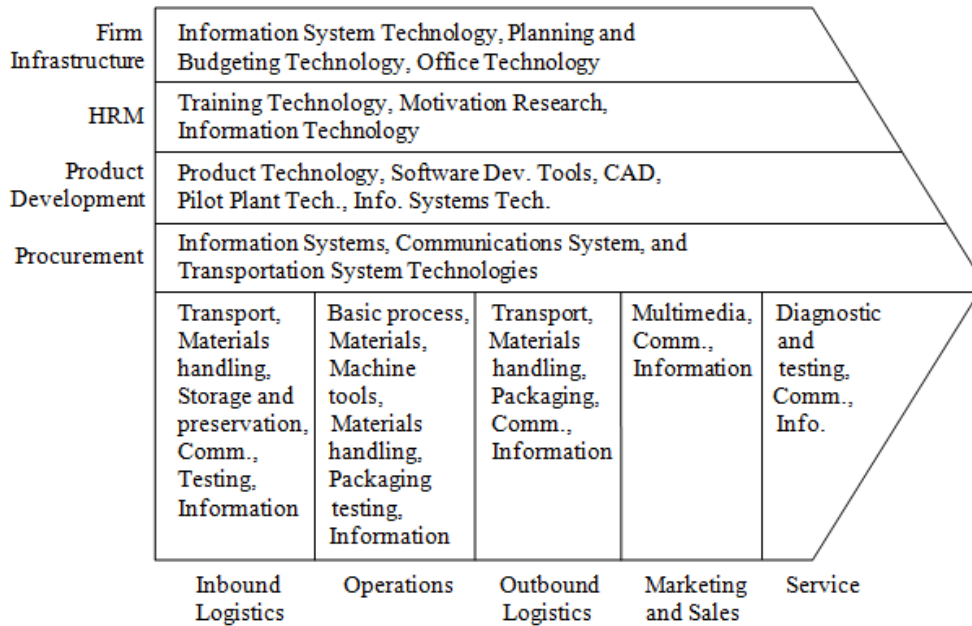


Figure 1  
Technologies in value chain (adapted from White and Bruton, 2007)

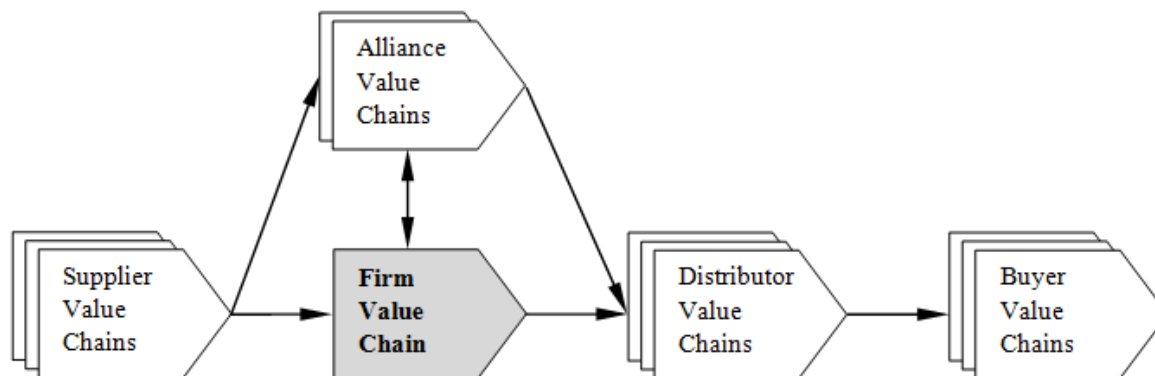


Figure 2  
The firm's value systems (adapted from Porter, 1985)

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