

# The Application of the Dimensionality Perspective in Organization Study

## **Abstract**

Previous research suggests that organizations may apply two opposite complexity mechanisms to cope with environmental uncertainty: absorption and reduction. However, except for some anecdotal evidence, there is no theoretical skeleton established to integrate these two opposite mechanisms in one framework and to prescribe the contingent conditions for employing them. This paper deconstructs organizational complexity at the organizational elemental level and establishes framework that incorporates three dimensions – organizational complexity, organizational dynamism, and organizational variability. This paper also discusses the environmental conditions for applying absorption and reduction mechanisms as well as the benefits and costs of applying these mechanisms. This dimensionality perspective provides a new avenue for researchers and practitioners to understand and handle organizational structuration issues.

## **Introduction**

Organizations are often viewed as open and complex adaptive systems that are dependent on their interactions with environmental resources (Wholey & Brittain, 1989). Previously, two complexity mechanisms have been recommended for organizations to produce a better adaptive capability: reduction and absorption (Cohen, 1999). The reduction mechanism suggests that a firm should standardize its internal processes and simplify organizational systems so as to decrease the number of external agents that it has to face (Anderson et al., 1999). The absorption mechanism, in contrast, suggests that when facing external uncertainty, firms should complicate their systems in order to create a variety of compound options and risk-hedging strategies (Boisot & Child, 1999). To date, no theoretical framework has been built to reconcile these two apparently conflicting logics.

We therefore propose a dimensionality perspective to address this issue. The dimensionality perspective focuses on the structuration (i.e., complexity, dynamism, variability) of an organizational system. Applying this approach, the two mechanisms will be deconstructed and analyzed at the organizational elemental level and incorporated in one framework.

We plan, by centering our discussion on the organizational complexity dimension, to illustrate how to apply the new dimensionality perspective in organization studies. We aim to make two contributions to complexity research. First, this is the first project that looks at organizational complexity phenomena from a dimensionality perspective, and this new perspective helps to reconcile some contradictory findings in previous studies. Second, a thorough benefit-and-cost analysis of organizational complexity will be presented. The antecedents (i.e., environmental complexity and environmental dynamism), the interactions of

three organizational dimensions (i.e., complexity, dynamism, variability), and the outcome of these interactions will be systematically discussed to create a theoretical framework to integrate two opposite mechanisms – absorption and reduction.

### **Organizational Complexity**

Ashby (1956) proposed the Law of Variety to set the foundation for studying organizational complexity. In his book *Introduction to Cybernetics*, Ashby stated that in order to cope with environmental variety, firms needed to complicate their organizational structure because only when organizations were more complicated, could they understand, predict, and even “destroy” less-complicated external variety. Following this logic, researchers began to investigate how well a complex organization could cope with environmental uncertainty. Burton and Forsyth (1986) used 14 factors to measure the complexity of organizational structure and processes, including the number of products, the number of product categories, and the number of countries in which operations were conducted, and identified a positive relationship between organizational complexity and firm performance. Damanpour (1996) also found that in general, organizational complexity contributed to organizational innovative capability. Ashmos and his colleagues conducted two studies in the hospital industry in 1996 and 2000 and found that in a turbulent environment, goal complexity, information technology complexity, decision-making complexity, strategy complexity, and network complexity facilitated firms’ adaptation process and yielded better performance. Meanwhile, a few studies using computer simulation also confirmed a positive relationship between organizational complexity and firm performance (Moldoveanu & Bauer, 2004; Morel & Ramanujam, 1999; Siggelkow & Rivkin, 2005). Absorption mechanism, which recognizes the value of a complex organizational structure, has been established.

However, when exploring the benefits of organizational complexity, some researchers also found that organizational complexity did not influence firm performance or, even worse, it produced negative influences. Bourgeois (1985) could not detect any significant relationship between goal complexity and firm performance. Organizational structure complexity was found to impede organizational innovativeness and then jeopardize firm performance (Blau & McKinley, 1979). These findings question the effectiveness of organizational complexity (Anderson, 1999; Simon, 1996); therefore, the reduction mechanism, which recognizes the difficulties in leveraging a complex organizational structure and appreciates the logics of simplicity, has been proposed.

In prior studies, organizational complexity was often conceptualized as the number of factors or elements that were involved in a system, such as the number of hierarchical levels in an organization, the number of tasks, or the number of operations and activities an organization employed (Blau & McKinley, 1979). The same numerical concept was also used to describe the complexity of organizational structures, decision-making processes, goal systems, or relation networks (Ashmos et al., 1996). Since organizational complexity is manifested by the number of different elements within a system, the numerical quantity becomes the essence of the complexity definition (Anderson et al., 1999; Ashmos et al., 1996; Simon, 1996). Along with these studies, we deem *organization complexity* as reflected by the number of elements within an organizational system (Boisot & Child, 1999; Daft, 1992; Morel & Ramanujam, 1999). It is worth emphasizing that, in alignment with prior empirical research, we strictly and narrowly define organizational complexity by the quantity of elements. However, the manner in which these elements connect with each other, i.e., the structure of elements, also affects the complicatedness of an organization and thus can be included in a broader definition of

organizational complexity (Achrol, 1991; Achrol, Reve, & Stern, 1983). In this paper, we use organizational variability to describe the structure among elements. In other words, in order to better explore complexity phenomena, in this paper, we divide the broad definition of complexity into two dimensions: organizational complexity – the number of elements, and organizational variability – the structure of these elements.

### **Environmental Uncertainty**

Environmental uncertainty, viewed as a defining factor for organizations (Atherton, 2003; Pennings, 1975), requires the presence of both environmental complexity and dynamism (Bourgeois, 1985; Boyd & Fulk, 1996; Damanpour, 1996; Gibbs, 1994; Jauch & Kraft, 1986; Prakken, 2004; Siggelkow & Rivkin, 2005; Tung, 1979). *Environmental complexity* is reflected by the “level of complex knowledge that understands what the environment requires” (Sharfman & Dean, 1991). *Environmental dynamism*, as defined by Miller and Friesen (1983), refers to the rate of change and innovation in an industry as well as the uncertainty or predictability of the actions of competitors and customers.

Environmental complexity describes the structure of an environment, including the number of relevant factors and the interactions of these factors. Of these two sub-dimensions, the interaction generates more complexity than the number of environmental factors. A large number of factors will not create much complexity if all factors are isolated from one another. Environmental complexity is mainly produced by the multi-directional interactions among these factors. In addition, as the number of factors increases, the number of interactions among these factors increases exponentially. For instance, when the number of factors increases from 3 to 6, even regardless of the direction, the number of interactions will increase from 4 to 57. Therefore,

environmental complexity is reflected more by the interactions of external factors than by the number of these factors.

Environmental dynamism describes the changes in an environment, including the frequency of changes and the magnitude of each change (Tung, 1979). Among the two sub-dimensions, the magnitude of a change refers to the scale or the significance of a marginal change. Usually radical changes are rarer than incremental changes and we assume that in a regular market, incremental changes are common and can be expected and prepared for by firms. Therefore, environmental dynamism is mainly reflected by the frequency of changes (high frequency means quickly-changing environment, and low frequency means slowly-changing environment).

### **Organizational Complexity Mechanisms**

#### *The Benefit of Organizational Complexity Mechanisms*

With an understanding of environmental complexity and dynamism, we can now explore how to apply organizational complexity mechanisms to cope with environmental uncertainty. As discussed, the advantages of absorption and reduction mechanisms are apparently contradictory. By developing networks or multiplying portfolios, the absorption mechanism complicates organizational structure and expands the organization's boundary. It internalizes environmental factors and incorporates them into the span of an organization's control (Oviatt, 1988; Williamson, 1981). Therefore, the number of uncontrollable external factors is decreased. In addition, a complicated organizational system with a strong network will grant firms more channels to collect information and thus a better picture of the environment will be formed (Cohen, 1999; Siggelkow & Rivkin, 2005). The reduction mechanism, in contrast, codifies and abstracts environmental factors into a few categories, which facilitates the diffusion of

information within the organizational system (Boisot & Child, 1999). It aids information transfer by simplifying internal structures and decreasing the number of nodes or hierarchies that a piece of information has to go through. As such, these two mechanisms can be used differently in managing environmental complexity and dynamism.

When only environmental complexity is concerned, absorption will outperform reduction in reducing the impacts from environmental complexity. Absorption expands organizational boundaries and incorporates part of the environment into the system and therefore, some of the uncontrollable and unpredictable external factors will be turned into manageable and predictable internal factors within the organizational control. By absorbing the externality, both the number of environmental factors and the number of interactions are eliminated. When the number of environmental factors decreases, the number of interactions decreases even faster; environmental complexity is thus effectively reduced by absorption mechanism. Reduction, on the contrary, codifies or abstracts environmental factors into a few categories for a better generalizable understanding of the environment. Therefore, the perception of environmental complexity is decreased while the actual environmental complexity has not been affected. In addition, the reduction mechanism may oversimplify or even misinterpret the environment by abstracting everything into merely a few groups. Therefore, where only environmental complexity is concerned, a complicated organizational system suggested by the absorption mechanism will perform better than a simplified organizational system suggested by the reduction mechanism. Such a proposition can also be verified by prior empirical studies.

It has been found that multiple goals push firms to consider more possibilities for future development and to prepare for a variety of uncertainties in the future market (Bourgeois, 1985); multiple strategies give firms various hedging options in dealing with external changes (Ashmos

et al., 1996); and complicated structures provide firms enough heterogeneity to collect information about different aspects of an environment (Van Maanen & Schein, 1979). All of these make firms more open to various possibilities, and lead them to collect more information and hedge external complexity by creating more potential options. Therefore, we believe that a complex structure helps a firm to cope with a complex environment.

*Proposition 1: As environmental complexity increases, organizational complexity should increase.*

On the contrary, where only environmental dynamism is concerned, the reduction mechanism will outperform the absorption mechanism. Absorption complicates organizational structures and processes and creates more hierarchies and formality within the organization, which typically slows down the dynamics of the system (Siggelkow & Rivkin, 2005). Reduction, however, specifies the roles of different departments according to the requirements of the environment (Boisot & Child, 1999). By defining the function and role of each department, the reduction mechanism and the corresponding simpler organizational structure accelerate information transfer within the organization (Garg, Walters, & Priem, 2003). Previous studies have substantially verified that a complex organizational structure helps to collect more information but slows down information transfer, while simpler structure facilitates information transfer but decreases information richness (Siggelkow & Rivkin, 2005).

The advantage in facilitating information transfer has given simpler organizations a greater chance than complex organizations to survive in a turbulent environment. Luo, Tan, & Shenkar (1998) found that an unstable environment required firms to respond effectively and quickly to market competition. Burns and Stalker (1961) also agreed that a turbulent environment required the ability to process alternatives rapidly. Jaszkievicz (2004) and Rosenthal (1985) found that a clearly hierarchical goal system facilitated strategy execution and

implementation processes. Mintzberg (1973), as well, contended that in order to make decisions quickly, managers must obtain inputs from fewer resources, consider fewer alternatives, and limit themselves to fewer analyses. Summarizing these empirical findings, we conclude that:

*Proposition 2: As environmental dynamism increases, organizational complexity should decrease.*

### *The Cost of Organizational Complexity Mechanisms*

The reduction mechanism implies that the costs of creating and maintaining a certain level of organizational complexity cannot be neglected. Although a complicated organizational form enables firms to collect more information and provide them with better flexibility and more options, keeping such a complex form requires substantial efforts. For example, multiple goals are established at the cost of scanning different environmental segments, searching for right opportunities, and negotiating possible alternatives (Sawyer, 1993). Multiple strategies and complicated structures cause difficulties in coordinating functional departments within the organization as well as in balancing different interest groups outside the organization (Morel & Ramanujam, 1999). The cost concern of organizational complexity suggests that compared with absorption, reduction, with fewer representations of environmental uncertainty and a singular adaptive response mechanism, may reduce frictions and conflicts, and thus lead to a better chance of improved performance (Miller, 1993). For instance, an organization's operating costs decrease as the level of complexity/redundancy within an organization decreases (Lin & Carley, 1997). The cost aspect should thus be taken into consideration whenever the discussion of organizational complexity arises (Tushman & Naddler, 1978). Hereafter, we will elaborate on the interactions between organizational complexity and the other two organizational dimensions,

variability and dynamism, to illustrate the cost consideration of maintaining a certain level of organizational complexity.

*Organizational variability* refers to the compatibilities among the elements within an organizational system. This concept is created to show the difference between the number of elements (i.e., complexity) and the interactions among these elements (i.e., variability).

Variability is not only based on the number of elements (i.e., complexity), but also is affected by the compatibility among these elements, which is reflected by the variance of the importance or priorities of the elements that is imposed by an organization (Achrol, 1991; Achrol, Reve, & Stern, 1983). The greater the organizational variability is, the more difficult for a firm to coordinate and manage multiple elements at the same time (Lin & Carley, 1997).

The concept of organizational variability recognizes the potential difficulty created by the elements' compatibilities. However, different from the complexity reduction view, which believes that the complexity cost is unavoidable, organizational variability shows that the costs of initiating and maintaining organizational complexity do not necessarily increase to an unsustainable level as the number of distinguishable elements increases. When elements are compatible with one another, that is, when a clear priority is established, different functionalities can be coordinated and a low organizational variability can be attained. Theoretically, if multiple elements are clearly prioritized, organizations are able to allocate resources and perform strategies with an unambiguous precedence. Efficiency is thus kept or even improved when organizational complexity increases. In contrast, if an organization assigns the same weight to each goal, or evaluates different types of strategies or different structural components as equally important, the potential difficulty of running the business may be intensified due to the extra time

and energy associated with the increasing communication, coordination, and management work. The benefit of a complex organization may be compromised.

In sum, the cost represented by organizational variability may not always increase as organizational complexity increases. When organizations are clear about the relative importance of elements, the organizational variability cost may be kept at a manageable level; otherwise, the increase of organizational complexity will entrap the organization by trying to accomplish too many things at the same time.

*Proposition 3: As organizational complexity increases, organizational variability may or may not increase depending upon the priority arrangement of elements. Specifically, if there is a priority arrangement of elements, organizational variability may not increase; otherwise, organizational variability will grow.*

The second type of cost that is caused by organizational complexity is related to organizational dynamism. *Organizational dynamism* refers to the time that a firm needs to formulate an effective process to respond to environmental changes and execute strategies, such as the dynamism of reporting systems or decision-making processes (Baum & Wally, 2003; Lin & Carley, 1997; Teece et al., 1997).

Organizational dynamism is driven by organizational complexity (Morel & Ramanujam, 1999) and it should be taken into consideration whenever issues of organizational capability, boundary, and process arise (Cohen, 1999). In organization theory, “dynamic” reflects the organizational capability to renew competences to achieve congruence with the changing business environment and to generate innovative responses when time-to-market is critical. The capability of staying “dynamic” secures a firm’s market position when the nature of future competitions and markets is difficult to predict (Teece et al., 1997). Organizational dynamism thus reflects a firm’s ability to integrate, build, configure, and reconfigure internal and external

competences to address environmental changes rapidly (Teece et al., 1997). However, as organizational complexity grows and as the organization evolves towards separable subsystems, the whole system loses the ability to carry out its activity sets or to implement possible changes reliably and predictably (Moldoveanu & Bauer, 2004). As observed, organizational complexity typically undermines the dynamics of the information-transmitting system (Repenning, 2002) and the decision-making system (Baum & Wally, 2003).

However, the effect of organizational dynamism in improving firms' competitiveness across environments is well documented (Baum & Wally, 2003). A greater level of organizational dynamism leads to an early adoption of new products, business models (Jones, Lanctot, & Teegen, 2000), or efficiency-gaining technologies (Baum, 2000). Therefore, greater organizational dynamism enables firms to catch external opportunities before they disappear (Stevenson & Gumpert, 1985). Nevertheless, as organizational complexity increases, organizational dynamism will be sacrificed. Organizational complexity increases the nodes or levels that a piece of information has to go through and slows down the whole internal process (Hermann, 1963; Lin & Carley, 1997; Staw, Sanderlands, & Dutton, 1981). Therefore, we conclude that:

*Proposition 4: As organizational complexity increases, organizational dynamism tends to decrease.*

As an extension of this argument, we notice that although the increase in the number of elements can slow down the organization, the way that these elements are structured (i.e., organizational variability) may revise the impact of organizational complexity on organizational dynamism. As discussed, when an organization is able to prioritize different elements, it is likely organizational dynamism need not be compromised by an increase in the element number. For instance, Bourgeois (1985) has found that a goal system with different priorities attaching to

different goals (low goal variability) will facilitate the decision-making process, while a system with equally-important goals (high goal variability) will impede the decision-making process by requiring more time for balancing different considerations or interests. Therefore, we propose that:

*Proposition 5: As organizational variability decreases, i.e., organizational elements are prioritized, organizational dynamism tends to decrease.*

#### *The Trade-Off between Benefits and Costs*

We integrate the above benefit-and-cost discussion of organizational complexity in a contingent context, as Figure 1.

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Insert Figure 1 about here

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In Figure 1, the X-axis represents an increasing environmental complexity, the Y-axis represents an increasing environmental dynamism, and the Z-axis represents organizational complexity. Both front and back planes present an increasing level of environmental complexity from left to right; therefore, the pattern of organizational complexity will be the same in these two planes. Also, both right and left planes present an increasing level of environmental dynamism from inside to outside; therefore, the pattern of organizational complexity will be the same in these two planes.

First, in the front plane of Figure 1, when only environmental complexity is concerned, an organization should increase organizational complexity to decrease the number of external factors that are out of the firm's control, as suggested by the absorption mechanism. However, when organizational structure becomes too complicated, the relevant costs (i.e., the increased organizational variability and the decreased organizational dynamism) will offset the benefits

attained by organizational complexity. Therefore, the growth of organizational complexity will be decelerated and the positive growth rate will turn into zero at the point when the marginal benefit provided by organizational complexity is equal to the marginal cost. The shape of the organizational complexity curve, therefore, turns into an inverse L-shape.

When only environmental dynamism is concerned, as the right plane of Figure 1, organizations should pursue a reduction mechanism, which employs comparatively simpler organizational structures in order to facilitate information transfer and to produce quicker responses. However, a lower level of organizational complexity hurts the richness of the information collected (Siggelkow & Rivkiv, 2005). As organizational complexity decreases, the change in marginal costs – the decrease of organizational variability and the increase of organizational dynamism – is also decreasing and therefore, the quest for further simplifying the organizational system is undermined. In addition, no matter how simple an organization is, a certain level of organizational complexity is always needed in order to maintain daily routines and to support basic business operations. Therefore, the organizational complexity curve will eventually be formulated as an L-shape.

The interface of the right plane and the back plane of Figure 1 shows a point where equifinality may occur, which indicates that no one-best-fit organizational complexity level can be found at this point and different levels of complexity may all achieve satisficing performance. This interface signifies a situation where the highest environmental complexity and the highest environmental dynamism co-exist. High environmental complexity requires a great level of organizational complexity, while high environmental dynamism requires a low level of organizational complexity. At this point, firms may form a range of organizational complexity levels, depending on managerial perceptions of the environment and the organizational strategic

orientations. Firms that are threatened more by external complexity than external dynamism will develop a comparatively complicated structure, while firms that view external dynamism as a bigger menace may develop a comparatively simple structure. Firms who can achieve a delicate balance between collecting more information and facilitating quicker information transfer will perform well. In the back plane, as environmental complexity decreases, the requirements for a complex organizational structure were also mitigated. Therefore, the curve extends to the left side plane with a lower level of organizational complexity. The organizational complexity curve in the back plane presents the same inverse L-shape as in the front plane.

The left side plane copies the pattern in the right plane and the organizational complexity curve presents an L-shape. At the interface between the left plane and the front plane, which signifies the lowest levels of both environmental complexity and dynamism, a range of organizational complexity levels will be observed again. A low level of environmental complexity requires a corresponding low level of organizational complexity, while a low level of environmental dynamism allows a high level of organizational complexity. In other words, a range of organizational complexity may be formed once again and equifinality may be observed at this point once more.

Firms always need a certain level of organizational complexity to support their basic daily routines. As organizational complexity increases, more potential options and alternatives are offered, which help firms hedge more risks and capture more opportunities whenever they come up (Ashmos et al., 1996; Ashmos et al., 2000). However, as organizational complexity increases, costs offset the benefits provided by organizational complexity and may outweigh benefits at some point. Specifically, when organizational complexity increases, organizational variability may increase and organizational dynamism decreases. The increased organizational

variability is associated with greater coordination and negotiation costs, and the decreased organizational dynamism leads to slower response system. The benefit of organizational complexity is limited by these constraints. The relationship between organizational complexity and its contribution to firm performance is therefore expected to be in an inverted U-shape: a basic level of organizational complexity is always needed to support firm basic operations; a sufficient level of organizational complexity will benefit organizational performance, while too much complexity will hurt performance.

*Proposition 6: Organizational complexity has an inverse U-shape relationship with firm performance.*

### **Conclusion and Implications**

Scholars have observed that a new perspective is emerging from organization theories but no systematic framework or logic has been established yet (Cohen, 1999). As a consequence, contradictory findings are found in previous studies regarding the application of organizational complexity mechanisms in coping with environmental uncertainty and regarding their benefits to firm performance. The opposite effects of complexity reduction and absorption mechanisms and the resultant difficulty in identifying the main effects of complexity constructs keep researchers suspecting complexity is merely the mask of simplicity (Anderson, 1999; Simon, 1996). This suspicion is also reflected by recent discussions in exploration and exploitation literatures (Benner & Tushman, 2003; Levinthal & March, 1993; March, 1991; Rothaermel & Deeds, 2004). On one hand, complicated organizational forms help firms to collect more information and to explore new opportunities, which serve for the “experiment with new alternatives” (March, 1991, p. 85). On the other hand, the specialization and standardization implied by simpler organizational structures optimizes the efficiency of current operations and exploits present opportunities by refining and extending the “existing competencies, technologies, and

paradigms” (March, 1991, p. 85). Different levels of organizational complexity reflect different organizational capabilities and how to achieve a delicate balance among them becomes essential in attaining a marketable competitiveness.

As such, we propose this organizational dimensionality perspective to reconcile previous contradictory findings and investigate the conventional management themes through a different angle. By formulating three dimensions that highly abstracts organizational systems, a dimensionality perspective analyzes the structuration of the elements that compose an organizational system and examines the contingent conditions for employing different levels of complexity in this system. By doing so, a dimensionality approach complements the traditional elemental content approach, in which the content of organizational elements, such as different types of goals or strategies, is used to explain the fitness between organizational systems and environments. The integration of the dimensionality approach into the traditional content-analysis approach should yield better results for organizational research. When the content approach predicts what type of organizational structure should be used to adapt to a specific environment, the dimensionality approach can be used to prescribe how to arrange relevant organizational elements in this structure in order to function as designed. We hope that by combining the dimensionality perspective into other theories, the effectiveness of this new approach should be fully demonstrated.

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Figure 1  
Organizational Complexity, Environmental Complexity, and Environmental Dynamism

