Product Complexity and Transaction Structure Selection

Aimao Zhang
Southern Illinois University Carbondale, aimao@siu.edu

Follow this and additional works at: http://aisel.aisnet.org/amcis2000

Recommended Citation
http://aisel.aisnet.org/amcis2000/280

This material is brought to you by the Americas Conference on Information Systems (AMCIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in AMCIS 2000 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.
Product Complexity and Transaction Structure Selection

Aimao Zhang, Department of Management, Southern Illinois University, aimao@siu.edu
Partially funded by Pontikes Center at Southern Illinois University - Carbondale

Abstract

This paper introduces a new construct, product complexity, to the research of transaction structure. Product complexity is a multidimensional construct, which is defined in terms of product transferability, product modularity, and product information intensity. The majority of previous studies on transaction structure are based on the attributes of transactions, i.e., asset specificity, uncertainty, and frequency. This study adds a dimension of product properties to the research and opens up a new perspective.

Introduction

The study of transaction structures has drawn researchers' attention since very early days. Coase first raised the question of why a firm exists (Coase 1937, 1960). Economists have observed how the invisible hand mediates supply and demand in the marketplace (Smith 1776). Organizations have examined how the visible hand manages organizations (Chandler, 1977). Oliver Williamson linked two transaction structures, market and hierarchy, with transaction cost theory. He claims that when market transaction cost increases beyond a certain point, the market will fail and hierarchy will gain advantage due to the relative efficient internal coordination (Williamson 1979, 1981, and 1991).

Malone and others recently studied how information technology affects transaction structure. According to Malone and others, markets are more communication intensive than hierarchies. Therefore, markets benefit more from communication cost reductions that are induced by advances in information technology. The net result is a shift toward market structure as information technology develops (Malone et. al 1987).

Malone and others introduced the concept of complexity of product description. They define the concept as the amount of information needed to specify the attributes of a product in enough detail to allow potential buyers to make purchasing decisions. They believe that products with complex descriptions are more likely to be obtained through hierarchies due to the communication cost (Malone 87). Two problems with Malone’s analysis, first, the domain of coordination is narrowly focused at the point of exchange. A broader view is that the transaction coordination includes coordination in pre-exchange, exchange, and post-exchange stages. Product description cannot sufficiently surrogate the entire domain of transaction coordination. Secondly, beside product description other important aspects of a product contribute significantly to the selection of transaction structure.

The Contribution of This Paper

The motivation of this study is to illuminate aspects of a product which influence and shape transaction structures. Previous transaction cost studies emphasized the attributes of transaction. Little consideration has been given to the properties of products as an influential factor in selecting transaction governance structure. The major exception is Malone’s introduction of the complexity of product description (Williamson 1981, 1991, Malone, Yates and Benjamin 1987, Gurbaxani and Whang 1991). This paper brings a broader perspective into transaction cost analysis by including product complexity.

Figure 1 The Theoretical Model of the Paper

Figure 1 is the theoretical model of this paper. The theoretical model proposes that attributes of transaction and product complexity are the influential factors on transaction cost which, in turn, determine the selection of transaction governance structure.
Traditional transaction theory specifies that the selection of transaction governance structure is based on the three attributes of transaction, i.e., *asset specificity, frequency, and uncertainty.*

- Asset specificity is the degree to which an asset can be redeployed to alternative uses without losing its productive value. Asset specificity is further decomposed into three subcategories, physical asset, human asset, and site asset (Williamson 1981, 1991).
- Uncertainty has two categories: information uncertainty and resources uncertainty.
- Frequency is the rate of transaction recurrence.

The transactions differ in degree of their attributes are aligned with different transaction governance structures (market or hierarchy) that differ in their competencies and costs. Generally, when asset specificity is low, the market transaction structure is more economical. When asset specificity is high, hierarchy gains the advantage of lower governance cost. Internal coordination is more effective than market coordination (Williamson 1981, 1991).

Asset specificity and product complexity are two different constructs, although frequently they are highly correlated with each other empirically. Viewed from a general system perspective at transactions and transaction structures, asset specificity is related to process, and product complexity is related to input and output. Asset specificity is the consequence of capital, human, or location investment in building the process. Product complexity defines the properties of a product as input and output going through the process.

A product with high complexity usually requires a process with high asset specificity. For example, a spaceship has high product complexity in terms of transferability, modularability, and information intensiveness. At the same time, the transaction of the spaceship has high asset specificity, in terms of capital specificity, human specificity, etc. In other examples, the asset specificity is not correlated with product complexity. Iron and steel making requires high asset specificity in blast furnaces and rolling mills, or the locations of iron ore mines. But steel as a product has low product complexity.

**Definitions**

According to Simon, complexity comes in the form of hierarchy, and a complex system consists of a large number of parts that interact in a nonsimple manner (Simon 62). Based on this idea, I define the concept of *Product Complexity* as the degree of intricacy of product hierarchy, and the degree of interactions within a product among its sub-components, and between a product and its external entities. Product complexity is a multidimensional construct. Specifically, three concepts that define product complexity are *product transferability, product modularability, and information intensiveness.*

**Table 1. The Elements of Transferability**

<table>
<thead>
<tr>
<th>Elements of Transferability</th>
<th>Degree of Transferability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Transferability</td>
<td>Low</td>
</tr>
<tr>
<td>Mobility</td>
<td>Fixed</td>
</tr>
<tr>
<td>Quantity</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td>Volume</td>
</tr>
<tr>
<td>Stability</td>
<td>Perishable</td>
</tr>
<tr>
<td></td>
<td>Inflammable</td>
</tr>
<tr>
<td></td>
<td>Toxic</td>
</tr>
<tr>
<td></td>
<td>Fragile</td>
</tr>
<tr>
<td>Logical Transferability</td>
<td>Low</td>
</tr>
<tr>
<td>Level of information</td>
<td>Semantic</td>
</tr>
<tr>
<td>Level of Knowledge</td>
<td>Deep</td>
</tr>
<tr>
<td>Parameter Definability</td>
<td>Undefinable</td>
</tr>
<tr>
<td>Consequence Predictability</td>
<td>Unpredictable</td>
</tr>
<tr>
<td>Consequence Measurability</td>
<td>Unmeasurable</td>
</tr>
<tr>
<td>Transfer Loss (Goodwill)</td>
<td>High</td>
</tr>
</tbody>
</table>

**Product Transferability**

*Product transferability* is the degree of ease of transferring goods and services physically and logically from one entity to another. Physical transfer is defined as the transfer of the ownership of *tangible* part of a product or service. Logical transfer is the transfer of the ownership of *intangible* part of a product or service. For example, a floppy disk with a stored program is tangible, but knowledge of the program is intangible. Table 1 describes the elements of transferability.
Proposition 1: The lower physical and logical transferability of the product, the more favorable of hierarchy.

Product Modularbility

Simon argues that complexity takes the form of hierarchy, which is composed of interrelated subsystems that in turn have their own subsystems, and so on (Simon 1962). Product modularbility is the degree of ease in isolating a component or a group of components by minimizing and standardizing its interaction with other components within subsystems or between subsystems of a product. A product can be decomposed into a hierarchical system of functional components. For example, an automobile has interrelated subsystems, such as cooling system, brake system, steering system and so on. A cooling system in turn has its own subsystems, such as water pump, radiator, temperature control system, and so on. Modular design intentionally creates a loose coupling between components by standardizing component interface to create a high degree of independence. The specifications of the interfaces permit a range of variations in any given component without requiring changes in the overall product design (Orton and Weick 1990, Sanchez and Mahoney 1996).

(Sanchez 1995) suggests that, to a significant extent, product designs constrain feasible choices of organization structure designs. A product design with complex and tightly integrated components requires an organizational structure through which managerial authority can be readily exercised to achieve close coordination of the units making the separate components. Loosely coupled components enable the use of organization designs with loosely coupled structures, such as out sourcing, buying instead of making, or long-term contracts with external producers (Sanchez 1995).

Modular product leads to modular organization design, which can be used to achieve embedded coordination, i.e., they achieve coordination by means other than the overt exercise of managerial authority. For example, the producer of electric motors for washing machines need to discuss the mounting dimensions, speed and torque specification, deliver schedule with the washing machine producer. Other coordination is embedded inside the motor producer structure, such as coordination for production schedule, material purchasing and inventory, personnel schedule, and so on. Each participating entity can operate autonomously and concurrently guided by embedded coordination.

The modular product design increases the flexibility and adaptability of an organization. As a consequence, it has significant influence upon the selection of transaction governance structure and design of organizations.

Proposition 2: The lower modularbility of the product, the more favorable of hierarchy.

Information Intensiveness

The trend of an information society is that information and knowledge replace matter and energy as the primary resource of economy. Information is no longer viewed as an enabler to gain power or an asset to be controlled. Rather, the power comes from turning information into knowledge and from human expertise in managing information. The emergence of information itself as an asset in its own right has the significant marketplace value. Both product and process are becoming more information and knowledge intensive (Naisbitt 1982, Davis and Botkin 1994, Nonaka 1991, Ramaprasad and Rai 1996, Glazer 1991, Melody 1987).

There are two types of information, process and product information. Process information facilitates transaction of products and services. This type of information is exchanged in coordination processes, reduces uncertainty, changes an individual's degree of belief, and facilitates decision making during the transaction process. Malone's complexity of product description fits into this category since the information specifies the attributes of a product that enable potential buyers to make purchasing decisions. When the transaction is finished or coordination is accomplished, the value of information diminishes for this particular transaction. The information is converted into part of organization memory or knowledge. In this study, I refer the information related to the particular transaction as process information, which is different from cumulated processing information or knowledge, indicated by Glazer (Glazer 1991).

Product information has marketable value in itself and is part of product or service offering. The value of information is transferred to a buyer and stays with the buyer. For example, credit card companies sell transaction information to marketing research companies.

Information is given birth by, and lives its entire life within, the perceiver's concerns (Metcalfe and Powell 1995). The concern of this study is transaction cost and transaction structure, so the relevant information is the information that lives in the domain of transaction coordination and communication. The information intensiveness is defined in terms of amount of information and level of richness of information related to transaction
product and process. Uncertainty and equivocality are the two primary concerns for transaction information processing. According to Daft and Lengel, organization structure and internal systems determine both the amount and richness of information provided to members (Daft and Lengel 1986). The reciprocal interpretation would be that the amount and richness of information shapes and influences the choice of organizational structure designs. The four scales measuring the information intensiveness are represented in Table 2.

Table 2. Scales for information intensiveness

<table>
<thead>
<tr>
<th>Process</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Amount</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>• Richness</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

Proposition 3: The higher information intensiveness of the product, the more favorable of hierarchy.

Methodology and Future Studies

Although there are numerous transaction structure studies, we still lack valid measurements, especially measurement of transaction costs. Due to the limited space, methodology and data analysis will not be included. However, for measurements on asset specificity, uncertainty, and frequency, please refer to (Aubert 1996). There will be different measurements for product complexity in different industries and contexts. The measurements on product complexity will be facilitated by the detailed specification of the constructs. Multiple items for each construct will be generated and assessed for reliability and validity. The new constructs are expected to be highly correlated with coordination cost and transaction cost which in turn influence the selection of transaction structure. This paper will provide a foundation for future experimental research in organization transformation. The more consistent experimental results and accurate prediction on structure change are expected by applying the product complexity in the future studies.

References


