



## Value creation in regional innovation systems: The case of Taiwan's machine tool enterprises



Eun-Teak Oh <sup>a</sup>, Kuo-Min Chen <sup>b</sup>, Lu-Mei Wang <sup>b</sup>, Ren-Jye Liu <sup>b,\*</sup>

<sup>a</sup> Department of Applied Japanese of Yu Da University of Science and Technology, Taiwan

<sup>b</sup> Department of Industrial Engineering and Enterprise Information of Tunghai University, Taiwan

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### ABSTRACT

Taiwan's machine tool industry is one of the few industries that do not depend on the support of foreign technologies. Nevertheless, it relies on the development of supplier networks among individual enterprises. This study clarifies the customer value creation mode of Taiwan's machine tool enterprises in a regional innovation system (RIS) by understanding the meaning of the value offered by suppliers to their customers and the dynamic development of value creation models across the boundaries of RIS.

In this study, we use as dimensions the customer's perspective of value, the supplier–customer interaction, and particularly the customer involvement to derive the value creation theory. We propose four models of value creation, including a high degree of product standardization with standard recommendations to the customer; product customization with the customer entering into the supplier's process of achieving the customers' preferences; customers and suppliers co-working in a mutual business process to co-create solutions; and the supplier developing a better understanding of customer needs to provide optional solutions. This study demonstrates that four types of value creation have been evidenced in Taiwan's machine tool industry from the viewpoint of the customer, and each type of value creation has its respective environmental and workable conditions. When accompanied by various RIS factors such as customer value creation, this not only develops dynamic growth but also, to a certain degree, affects the growth in competitiveness of the region and its companies.

In a highly customizing, flexible, and demanding environment, enhancing customers' value creation beyond their functional requirements while reducing the interaction costs associated with customization may be a challenge for a single enterprise; however, it may prove to present an opportunity to shift Taiwan's machine tools industry toward global competitiveness.

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### 1. Introduction

Regional innovation system (RIS) theory began with Cooke (1992). After the Nordic region applied this theory and the development of the cluster concept, which is based on Porter's competitive advantage theory (OECD, 2007), the RIS concept has been expanded and RIS insights have progressed in terms of the theory and also in its empirical applications in policy. Since 2000, studies have been conducted on Taiwan's regional industrial clusters or regional networks (Liu and Brookfield, 2000; Hu et al., 2005).

Taiwan has a successful machine tool industry. It relies on domestic technology and is highly supported by an RIS, which is made possible through the industrial clustering that occurs in the mid-Taiwan region. Gartner research data (Jablonowski and Eigel-Miller, 2014) reveal that the production and export of Taiwan's machine tools totaled \$5.43 billion and \$4.236 billion in 2012, respectively, ranking Taiwan

as the world's sixth largest producer and fourth largest exporter of these products.

Machine tool-related industries are clustered in a 60-km region in mid-Taiwan, including suppliers, integrators, and technological support. Nevertheless, they had weak national institutional support. The industry's strong exporting characteristics and long-term sales, through agents around the world, hint that Taiwan's RIS is lacking in immediate customer participation. The weak understanding of users' needs is considered to be a shortcoming of Taiwan's machine tool industry. Therefore, its value-generation ability largely relies on low production costs than on high user value.

Industrial clusters or RISs have the potential to enhance this industry's prosperity in Taiwan. However, with Taiwan's machine tool enterprises establishing their manufacturing bases in China since 2000, they now face challenges from other rising stars that can provide cheaper and more competitive products. Simultaneously, as Taiwan's machine tool enterprises seize an opportunity to sell products directly to end users in Mainland China, they may create new markets and value creation opportunities. Since the actors in the new RIS differ from those of Taiwan's native RIS, the value creation mode may change

\* Corresponding author at: Department of Industrial Engineering and Enterprise Information, P.O. Box 985, Tunghai University, Taichung 40704, Taiwan, ROC.  
E-mail address: liurj@thu.edu.tw (R.-J. Liu).

at the same time as more focus is being placed on the role of customer value.

Recently, research and empirical studies indicate that industrial marketing has been gradually shifting focus from product to service. The service-dominant logic (SD logic) concept suggests that the supplier's largest value and source of competitiveness results from providing customers with resources to help them create value in the use of the supplier's products. The product's role is to provide customer service and a value exchange. Only customers can define the value created from vendor's supplies (Vargo and Lusch, 2004).

Machine tool builders must provide differentiated machines according to the needs of different customers and apply the results to a customized production mode. Because of a long product life span and regular maintenance needs during the product life cycle, customers and suppliers regularly interact over the long term. The interactive process between both parties affects each other's operational procedures and enterprise development (Grönroos and Helle, 2010; Gruner and Homburg, 2000; Matthysens et al., 2009).

If a supplier in an RIS can determine a customer's needs early and provide solutions that create customer value, the supplier will have a chance of becoming a market leader. Many studies reveal that in the business process, incorporating the customer as the co-creator of customer value is important (Gummesson, 1995; Hauser et al., 2006; Khalifa, 2004; Payne and Holt, 2001; Prahalad and Ramaswamy, 2004; Ramaswamy and Gouillart, 2010; Rowley et al., 2007; Sindhav, 2011). Simultaneously, the importance of cooperating with suppliers and customers outside the region to co-create value and knowledge has also been discussed (Asheim and Coenen, 2006; Bathelt et al., 2004). With the pace of globalization, it is argued that the regional innovation process—which is knowledge creation and application—can lead to regional value creation and competitive advantages through the interactions of actors among the RISs.

Entering into a dialog and involving each other's processes seem to have a value-promoting effect. However, how to understand customers' needs, how they assign value to a product, and how a participation model affects the results of co-creation in an RIS still need to be outlined.

This study clarifies the customer value creation mode of Taiwan's machine tool enterprises in its RISs by understanding the meaning of value offered by the suppliers to the customers and participation within the interaction model across the boundaries of RIS. This implies that we should have a clearer understanding of how Taiwan's machine tool enterprises in the RIS generate value creation and also of the business process of the supplier as a major actor in an RIS.

In particular, this study addresses a system that is shifting from a low production cost, i.e., traditional RIS without direct customer interaction, to a new RIS with a high-value product, in which the customer is an important actor.

First, we reviewed the relevant studies on RIS and Taiwan's machine tool industry and recognized the significance of the RIS boundary and the interaction between supplier and customer within the RIS. Second, in the phase of theory construction, an "RIS-related Value Creation Type Theory" was developed. It is based on the findings of the marketing and knowledge-based RIS literatures, the two dimensions of the customer value creation model and supplier–customer relation, and particularly the degree of customer participation. Finally, a case study on the evolution of product development strategies among Taiwan's main tool builders was used to verify the actual customer value creation model in the RIS. Conclusions and implications have been proposed on the basis of the findings of this study.

## 2. Literature review

Although the history of the development of Taiwan's machine tool industry is novel and exciting, little related research literature exists, both in Taiwan and elsewhere, compared with the literature on other

industries in Taiwan. Nevertheless, studies note the following three features of Taiwan's machine tool industry:

First, few foreign theories accurately describe its development. Harvard professor Amsden visited Taiwan twice, in 1974 and 1981, and published two early papers wherein she described this industry. Her findings on the early stage of Taiwan's machine tool industry were not positive. Rather, she noted that it suffered due to the lack of a scale economy, low investment in equipment, limited technological learning from market demand, and a division of labor that did not match the requirements of the industry's later stages of development.

Meanwhile, we also had difficulties in being convinced by the RIS researches on the following arguments that contribute to dominate Taiwan's machine tool industry development: for example, the developmental state model explaining that industrial policies dominated the means of economic development (Onis, 1991; Stubbs, 2009); the importance of national scientific research institutions in the success of industries in Japan, Taiwan, and South Korea (Mazzoleni and Nelson, 2007); and Taiwan's Industrial Technology Research Institute as effectively leading the country to decide on targeted industry development (Amsden and Chu, 2003; Mathews, 2002).

Second, a special mode is involved in learning technology. Foreign technological cooperation did not significantly contribute to the sector's success (Fransman, 1986). Relative to the codification of technical knowledge, Chen (2009) indicated that the technical knowledge transfer that occurred in Taiwan's machine tool industry tended to be tacit; this implies that it was an evolutionary process based on hands-on experience in the technological learning process.

Third, studies have demonstrated the successful factors for the industrial network and modularity in Taiwan's machine tool industry. In fact, the evolutionary profile of the industry indicates that it progressed from a highly in-house integration system to one that was subcontracting with mature suppliers. The theory of the industrial network is recognized as the most important theory when discussing the competitiveness of Taiwan's machine tool industry (Liu and Brookfield, 2000). In the late 1990s, Taiwan's machine tool industry, led by a combination of modular technology trends (Chen and Liu, 2004) and globalization trends, demonstrated a dramatic change in the management structure in both Taiwan and Mainland China (Brookfield and Liu, 2005).

Although the three abovementioned themes can help us understand the context and characteristics of the development of Taiwan's machine tool industry, we endeavored to examine the delicate relation between these outcomes and the RIS theories.

The RIS is an approach to examine the importance of a region from the aspects of economic and technological structures. In this approach, researchers analyze the impact of interactions and collaborations between key actors on the competitiveness of industries and enterprises in the RIS (Asheim et al., 2011; Autio, 1998; Cooke et al., 1997; Doloreux and Parto, 2005; Tödtling and Trippel, 2005).

Autio (1998) noted that regional innovation includes two key factors. One comprises an enterprise-centered system and subsystems based on knowledge application. The elements in this system are enterprises, customers, partners, competitors, and suppliers. The other comprises a system and subsystems that exist for knowledge generation and diffusion. The main actors comprise technological agents, labor agents, governmental research institutes, and educational institutions.

In terms of the globalization of business operations, the discussion also covered interactions with entities located outside the region to achieve the knowledge creation and acquisition that would contribute to local development and enterprise competitiveness (Asheim and Isaksen, 2002; Bathelt et al., 2004; Grabher et al., 2008; Gertler and Wolfe, 2006).

Based on the concept of local buzz and the global pipeline, Bathelt et al. (2004) described knowledge creation within and across clusters. Buzz is the communication between mutual well-understanding actors in a region who can build new relations that may conduct innovations. A pipeline is a communication channel that serves the enterprise in a

cluster to interact with a distant knowledge provider. Both types of communication are important and complementary (Maskell et al., 2006; Wolfe and Gertler, 2004).

Asheim and Coenen (2005) categorize knowledge into integral knowledge, such as the mutual learning between customers and suppliers, and analyzing knowledge, such as that achieved through co-operation with outside research institutes. The types and characteristics of the European RISs have been clarified by referring to studies on knowledge-based theory. These studies describe the meaning of RIS boundaries and indicate that simultaneously considering both inside and outside of the RIS can promote value creation.

The RIS highlights regional resource utilization through operational-ly interacting actors. In addition, it indicates the importance of locus to support innovative enterprises and technological as well as learning capabilities in promoting economic outcomes. In contrast, previous RIS studies can be divided between the approach that emphasizes institutional theory and that which focuses on a policy perspective (Fiore et al., 2011) or the interaction among the various actors with a focus on companies that create and/or apply knowledge (Bettiol et al., 2013).

Even though Doloreux and Parto (2005) indicate many issues, the two issues that need to be considered are as follows: First, the geographical boundary and the understanding of knowledge flow between scales in the RIS still leave some room to be derived. Second, there is also insufficient detailed positive analysis of the actual knowledge and value creation in the RIS. Most previous studies on RIS have focused on the administrative region or geographical area in terms of understanding the concept of how the RIS area is derived. However, they only emphasize mutual help among administrative agencies, universities, and other auxiliary organs, which is facilitated by strong policy. In fact, this led to a tendency to ignore the main factor of the enterprise in terms of its realizing production in the RIS, which is the innovation process. In short, even where the country lacks institutional and regional policy support, in certain areas in Taiwan center, Taiwan's machine tool industry creates sustainable development through the efforts of the enterprises themselves. The related evidence of this can fill the void in empirical studies on RIS.

Based on the intrinsic and fine relation between Taiwan's machine tool industry and the related RIS arguments, we focused on the issues of how manufacturers refer to the supplier in the RIS and interact with customers as well as on how Taiwan's machine tool manufacturers co-create their value with customers in the RISs. In the following study, we analyze the development of value creation, emphasizing the RIS boundary, the space of the flow of knowledge, and the interactions among the RIS actors.

### 3. Type of customer value creation in the RIS

#### 3.1. Transaction characteristics and value creation of capital asset goods

Machine tools are the typical capital asset goods used in production. They possess the characteristics of high price, small production quantity, low transaction frequency, long life span, and long-term supplier–customer interaction (Takashima and Minami, 2006). The experience of complex interactions between suppliers (Machine Tool Builders) and supply chains and various departments of the customers (Machine Tool users) has direct and indirect effects on value creation (Matthyssens et al., 2009).

In the process of interactions between two parties, the supplier can directly and positively influence the customer's value implementation process and results (Asheim and Coenen, 2005, 2006; Golfetto and Gibbert, 2006; Grönroos, 2010; Grönroos and Helle, 2010).

For customers, the concept of value includes the differences between the customers' actual payment and their perception of value (Edvardsson et al., 2005; Etkar, 2008; Payne and Holt, 2001). Customer value also includes a better experience or an increasing value after the supplier has supplied the customer with the product or service and

the related resources; even the experience in an interactive process has customer value (Esper et al., 2010; Gummesson, 1995; Grönroos and Ravald, 2011; Holbrook, 1999; Khalifa, 2004; Lindgreen and Wynstra, 2005).

In the marketing field, SD logic claims that the activity focus of the enterprises' value creation lies in the application of operational resources and delivery activities. It includes knowledge and skills and not only those established in the goods themselves but also those established in the service (Matthyssens and Vandembemt, 2008; Vargo and Lusch, 2004). The customer is the value creator who creates "value in use" under specific contexts during which the supplier is also one of the participants. The customer's perception and experience are extremely important for measuring the meaning of value (Grönroos, 2011).

Payne et al. (2008) suggested that the customer value creation process is one where the customer performs a series of activities to achieve a particular goal. In the process, the supplier's primary role is to provide the necessary resources for value creation to the customer, and the foundation of value creation is actually derived from the supplier's understanding of his/her customers. In addition, the supplier may influence the customer's value creation process, from the outside to the inside region, through constant contact (Grönroos, 2010; Grönroos and Ravald, 2011).

The above study found that the supplier could provide multiple levels of support and create sustainable customer value based on a "value proposition" and a co-creation process with the customer. This process was proven to have made a significant contribution to business strategy and performance as they relate to customers (Anderson et al., 2006; Khalifa, 2004; Payne and Holt, 2001; Vargo and Lusch, 2004; Ulaga, 2001).

Consequently, suppliers must integrate their own internal and external processes and then enter into the customer's technological and business processes to effectively promote their value in relation to the customer's needs. For the RIS to achieve value creation, supplier–customer interactions are extremely important. Regardless of the RIS boundary, suppliers participate with customers in problem solving and realize customer value creation through the proper application of knowledge.

#### 3.2. Two types of customer value

In this study, customer value from the user's perspective is roughly divided into two categories (Nobeoka, 2011). The first is the functional value inherent in the basic function of the product meeting the customer's needs. The other is the solution-type value that focuses on solving problems for customers by understanding their experience and perception, which is unique and difficult to replace.

##### 3.2.1. Functional-type value

All products and services have their basic function and value in their use. The "functional value" in this study is the value known by both parties in the transaction, which can be clearly defined as the value of the functional items.

Manufacturers can design and plan the machine tool's function and specifications; alternatively, this can be achieved by outsourcing the functional components. The specifications, such as the precision of machining, cutting ability, movement speed, degree of accuracy, control axis capability, among others, can all be described in detail via text and data, which are classified in the functional value of the product.

Another characteristic of functional value is that those who participate in the manufacturing, transaction, and maintenance services process of a product are the creators of a product's functional value. These members include those at the machine tools assembly plant and in its supply chain, components and processes providers, technical services suppliers, and others; however, this system does not include the product's customers.

### 3.2.2. Solution-type value

In contrast, solution-type value is built on the basis of functional value, but it brings the differential advantage of both the product and customer value. Solution-type value is based on an understanding of the implicit and explicit value of the customer's needs that comes from the perspective of the customer rather than that of the supplier.

If the machine tool suppliers had developed and accumulated their technologies and experience in a specific area by continuing constant communication with their customers, they could have made insightful observations during the operational life cycle of their machine tools (Anderson et al., 2006).

Such a solution-type value, derived from the customer's subjective perceptions, is to give proper solutions that correspond to different customers' scenarios. It is difficult to be confined by specifications or text. In addition, value manifests in the value-in-context and the value-in-use, according to the customer's background, when using the products and services (Chandler and Vargo, 2011; Vargo and Lusch, 2011).

Grounded on functional value, solution-type value can offer customers a differentiated problem-solving value. This value is basically judged on the basis of the degree of the customer's potential problem resolving and ultimately decided by the customer's subjective judgment.

### 3.3. Supplier–customer interaction process in customer value creation

Traditionally, the interaction model of supply and demand can be divided into one-way and two-way communication. However, the customer's knowledge and experience are considered to be a potential source of the supplier's competitive advantage. The co-creation of two-way communication in the RIS emphasizes the experience of the interested actors. That is, it accords that these trading parties influence or input in the development of new products, including institutional actors, suppliers, partners, and most importantly, the customer in the RIS and his or her value creation system (Cooke et al., 1997).

Prahalad and Ramaswamy (2004) propose the “value co-creation with customer” concept established under the prerequisite of value co-creation by customers and suppliers. Ramaswamy and Gouillart (2010) propose that co-creation must take place in exchanging, participating, and sharing experiences, so that both sides will have a better understanding of the whole picture of events and situations by means of interacting with each other. The value co-creation process should focus on the experience of the interested parties and then expand its scope to both organizations and processes.

The customer can even act as a funder to support suppliers in quality control, manufacturing, or marketing; that is, he or she can assume the role of co-maker or co-marketer (Auh et al., 2007; Fang, 2008; Lengnick-Hall et al., 2000; O'Hern and Rindfleisch, 2010; Prahalad and Ramaswamy, 2000; Storbacka and Lehtinen, 2001).

Thus, the interaction scope of both the supply and demand sides has been extended from the transaction process to the entire scope of a product's life cycle, including development and services. The exchange of knowledge and skills with customers being partners in jointly establishing a unique service is a process-oriented experience of common value creation that is important in RIS (Rowley et al., 2007; Vargo and Lusch, 2008). In short, they must integrate the individual process into a joint value creation process. Consequently, the supplier can directly and positively influence customer value creation as it occurs (Grönroos and Ravald, 2011; and Sindhav, 2011). A direct influence will exist on each other's process while both the supplier and customer systems are involved in the interaction.

Payne et al. (2008) suggested three broad types of contacts to promote value co-creation: communication contacts, user contacts, and service contacts. These types cover interactions between customer and supplier personnel or the organization, which move from a purely sales contact point to communication with the customer and understanding customer needs in the whole product life cycle.

While the customer moves forward in the supplier's internal processes and becomes involved in new product development, in the process, the supplier is sustainably improving the value he or she offers the customer and both sides benefit (Gruner and Homburg, 2000).

Consequently, customer involvement in the interactive mode will directly impact enhancing customer value.

On the RIS knowledge creation theory (Nonaka et al., 2008; Asheim and Coenen, 2005), innovation and value creation knowledge can be categorized into explicit and tacit knowledge. Tacit knowledge is an integrated knowledge that flows through face-to-face contact. This type of knowledge is embodied in people and can facilitate problem solving among customers and suppliers. In contrast, codified and explicit knowledge can help external research institutions to jointly develop and invent new or better products and services. Certainly, this latter type of knowledge is easier to be transmitted over long distances. This knowledge spreads from regional to global networks, over physical space, through various spatial dimensions formed as a multi-level structure (Gertler and Wolfe, 2006).

Innovative firms are linked outside the RIS by various types of connections, in particular, international linkages with customers and suppliers, as a key requirement for the successful development of the RIS (Doloreux and Parto, 2005). Nevertheless, the value creation of the RIS not only affects the interactions among actors within the RIS but also generates knowledge creation through a knowledge flow among actors outside the RIS.

Based on this study result, the supplier–customer interaction can be measured in terms of its interactive contact point, the supplier and customer involvement range in mutual processes, and a source of competitive advantage and RIS knowledge forms and flow (boundary) as shown in Table 1.

### 3.4. Four types of value creation

This study includes an analysis of value difference based on the two customer perspectives of “the degree of customer involvement” and “type of customer value.” It concludes that value creation influences capital asset goods.

Customer value mainly focuses on the value assigned to a product's use, which is divided into functional value and solution-type value. The supplier provides the functional value directly specified by the customer (customization), whereas the solution-type value surpasses the customer's functional-type needs. This type of value requires that both sides interact in a detailed process and develop an in-depth understanding of the customer's operating process. The idea is to seek the best solution for the customer in a co-created value (Grönroos, 2011).

In this study, value creation activities are summarized into four areas, from the vertical dimension of customer value to the horizontal dimension of customer involvement, as illustrated in Fig. 1.

#### 3.4.1. Standard-type value creation

In this type of value creation, the product is a standard option-type (referred to as “standard-type” in this study) value creation. This type of product uses a highly standardized manufacturing process and has standard specifications and option functions. Its competitiveness arises from mass production and economies of scale. This product type usually has product features that can be measured according to an objective standard, and it does not need a high level of customer participation in product development and manufacturing. In addition, suppliers can presume that the required product characteristics and the interaction between both sides will be limited during the transaction period. While the supplier produces a widely recognized and acceptable resource value, the customers use it to create value in its use.

#### 3.4.2. Customized-type value creation

Its characteristics are the tailor-made product by the supplier according to the customer's needs, and the exchanged professional

**Table 1**  
Comparison of supplier–customer interaction (involvement).

	A High Degree Of Customer Involvement	A Low Degree Of Customer Involvement
Interactive contact point	<ol style="list-style-type: none"> <li>1. The customer's early participation in the supplier's internal processes, such as development, design, manufacturing, and others.</li> <li>2. The supplier also enters the customer's internal processes.</li> </ol>	<ol style="list-style-type: none"> <li>1. Interaction begins from the transaction behaviors during the trading period.</li> <li>2. The supplier contacts or interacts with the customer only when the customer needs the product or the service.</li> </ol>
Supplier and customer's involvement in mutual operating processes	<ol style="list-style-type: none"> <li>1. The supplier becomes part of the process of achieving customer value, covering product use and possible future needs.</li> <li>2. The suppliers may participate in and change the customer's processes.</li> <li>3. The customers become part of the process of product development and production.</li> </ol>	<ol style="list-style-type: none"> <li>1. The suppliers play the role of providing resources (products or services) only.</li> <li>2. The supplier does not enter into the customer's internal processes.</li> <li>3. The customer is only involved in product purchase and use as well as maintenance requirements.</li> </ol>
Source of supplier's competitive advantage	<ol style="list-style-type: none"> <li>1. Incorporate the customer's knowledge and experience as a potential source of competitive advantage.</li> <li>2. Both sides can achieve value-added or upgrading products through the integration of technological application or the business process.</li> </ol>	<ol style="list-style-type: none"> <li>1. Come from supplier's manufacturing process, research and development, or technology.</li> <li>2. Not directly related to the customer's self-generated value-in-use.</li> </ol>
RIS knowledge forms and flow	<ol style="list-style-type: none"> <li>1. Supplier interacts with the customer through tacit knowledge.</li> <li>2. Supplier interacts with the customer through face-to-face contact and trial and error to look for solutions.</li> <li>3. Knowledge and skill can be spatially circulated.</li> </ol>	<ol style="list-style-type: none"> <li>1. Supplier interacts with the customer through explicit knowledge.</li> <li>2. Supplier presents documents to the customer who demonstrates the product innovation.</li> <li>3. Knowledge and skill can hardly be openly spatially circulated.</li> </ol>

Source: Data organized by this study.

knowledge and skills will occur in the supplier's operating process. This type of value creation involves a high level of customer input, meaning that the customer is more involved in the supplier's processes, and the supplier is consequently involved in fewer customer processes.

Customer value creation originates from the supply of products or services that are customized for customers. The value of the supplier's output is in the special resources it provides to meet the customer's needs; the customer achieves value in using the product. For the two sides, these are non-standardized products or services; therefore, the cost is higher than that of the standard-type.

**3.4.3. Solution co-creation-type value creation**

The characteristics of solution co-creation-type value creation are that the supplier regards the customer's professional knowledge and skills as a source of competitive advantage. The supplier needs the customer's high involvement and must gain an in-depth understanding of the customer's internal processes to co-create value in the operating processes.

This value creation type requires that both sides intervene in each other's internal processes through mutual understanding and smooth interaction to co-create a unique solution, which is a cooperative co-creation model that combines the supply of resources and the creation of value in the use of the product. The outcome is neither the existing product nor the original customer demand.

As the result is a distinctively customized product, this means higher interactive and high production costs derived from the expense of

product redesign, development, and production. High-value, high-cost products are generally reflected in this type of a value creation model.

**3.4.4. Solution option-type value creation**

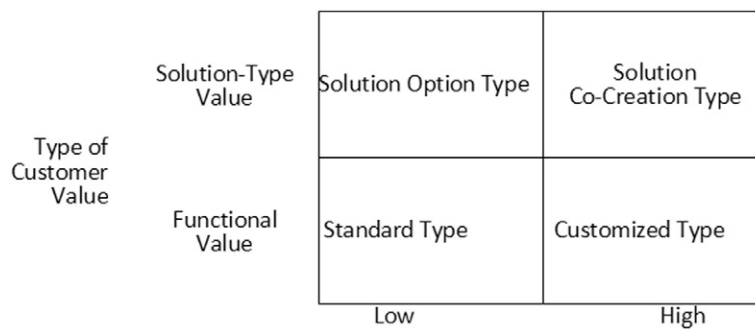
Here, the supplier has continuously accumulated the necessary knowledge and technical experience to meet or go beyond the customer's needs in a long-term operation. The supplier even puts himself or herself in the customer's place to construct an ideal solution. By entering this process, the supplier can provide products with functional options that meet or exceed the customer's needs without the customer's high level of involvement. From the supplier's viewpoint, the output is standardized; however, the solution is specially customized for the customer.

This type of value creation has the low level of customer involvement; yet, the supplier is permitted to intervene in providing the customers with the necessary resources to enhance the customer's ability to offer recommendations for operational improvements and product advantages. The supplier then helps create value beyond the customer's original expectations.

**4. Empirical research**

**4.1. Purpose, object, and method**

Taiwan's machine tool industry has prospered through providing quality products with reasonable prices, supported by a complete



The level of customer involvement and interaction

**Fig. 1.** Four types of value creation from the customer's perspective Source: Data organized by this study.

subcontracting network, modular product design, and strong customization capability. However, a lot of customization that has facilitated product diversification has meant that forecasting demand has become difficult because of high-risk stocks, small lot size with low productivity and long delivery, slow maintenance response, and a low level of customer satisfaction.

Taiwan's machine tool industry has been gradually shifting toward co-creating with customers as it seeks upgrading opportunities and the advantages inherent in direct contact with customers in Mainland China. As it is normally difficult to verify a conceptual theory with a quantitative survey, the case study method that focuses on representative samples is more suitable. Most of Taiwan's machine tool companies are micro to small size compared with their Japanese or German competitors. The use of this model is limited in Taiwan's domestic RIS. In fact, an empirical case study was conducted using Taiwan's top three machine tool companies that had long-term interactions with their customers. We tracked the evolution of transactions to analyze customer value and the nature of value creation in these companies.

Case study interviews were conducted between 2010 and 2013 three to five times for each company at the headquarters of their branches in China. TIMTOS 2011 and TIMTOS 2013 Interviewees include Company A, which comprises a company president, a Shanghai branch general manager, and a China operations assistance manager; Company B, which comprises a company president, a Taiwan branch general manager, and a China operations manager; Company C, which comprises a company corporate CEO, a Taiwan branch general manager, a Hangzhou branch president, and a China operations general manager.

The enterprises investigated in this study are listed among the top five in Taiwan and have specialized in the manufacturing of computer numerical control (CNC) lathes, machining centers, and specialized machining equipment. Two of these companies have a history of more than 50 years and the other is the largest Taiwanese machine tool group in China. The brief profiles of these companies are listed in Table 2.

Their customers cover small-scale job shops to large multinational companies. The machines these companies produce are mainly used for cutting and processing metal parts, including vehicles, ships, aerospace components, energy, sanitary materials, hardware, and others. More than 1000 machine tools are produced annually, and the price range is between NT\$ 1 million and 10 million. Orders customized according to the customer demand accounted for a very high ratio, even more than 50% in some companies.

## 4.2. Customer value creation type of empirical enterprise

### 4.2.1. Standard-type value creation

Standard-type value creation is the most common type in every company. Customers can make a purchase decision and directly choose products from a product catalog, including optional functions and accessories such as different spindle speeds and variant tooling systems. Such customers clearly understand what they need, and they can be fully satisfied with the supplies; they do not need to enter into the supplier's internal processes. Meanwhile, the supplier also finds it unnecessary to become involved in the customer's internal processes. Each company analyzes the trend by investigating its customers and

its competitors to create a standard catalog for product development. These companies also manufacture their products according to the requests and/or feedback of the RIS supplier. These types of customers are those who do not directly use the product, but who mostly work for agencies outside the RIS.

The customer has confidence that he or she will accomplish his or her own value creation; that is, the customer self-creates the product's user value without the supplier's attention and care. Both sides may create their own value in their own individual processes.

The customer's chief purchasing consideration is established in the product's visible functional performance as well as its long-term maintenance ability and some long-term relational knowledge of the supplier. The price is the main but not the only factor.

Supplier–customer interactions to confirm product specifications and feasibility mostly occur at the pre-sale stage in the form of documentation. However, a few customers visit the supplier during the production period so that they can gain an understanding of the production status or check the product quality. Therefore, in this type of value creation model, the customer is not involved in the supplier's process or the customer only wants to understand this process and directly intervene. The customer has no requirements for customization or product modification.

Essentially, there is no value co-creation in this type of model and no obvious effect on organizational learning or an exchange of knowledge and experience between the end customers outside the RIS boundary. However, the supplier's experience is usually transferred to the customer more than the opposite.

### 4.2.2. Customized-type value creation

In this type of product, Company B has the highest percentage, whereas Company C has the lowest percentage because Company C was the first that set up in China and had the opportunity to move to other types of production.

In addition to providing standard and optional functions or features, all three companies have received orders to modify product design according to customer needs. The customer demands are related to mechanical function and performance; even though most of the demands can be quickly fulfilled by re-configuring the components, during development and production, examining the frequent cooperation among the companies that produce components is necessary due to the frequent cooperation among the RIS actors. These cases account for a high proportion of orders, a phenomenon that has been increasing. These modifications include partial changes of the components, modules, or reconfigurations of whole machines.

The supplier may modify the design from existing products and components, according to the customer's needs, to save on cost, to shorten the delivery time, and to accommodate an implied consideration for long-term maintenance. Under this model, the customer also considers a minimum change at the lowest cost when reviewing the supplier's proposed modifications. The supplier's focus is essentially fulfilling the customer's needs; he or she places less emphasis on deliberately exceeding demand.

The typical information customers are willing to provide suppliers include the drawing of machining parts, sample parts, and a manual of

**Table 2**  
Company profiles.

Items	Company A	Company B	Company C
History	>60 Years	>50 Years	>30 Years
Position in the industry	CNC lathe leader	Expert in special purpose machine leader	Largest machining center group
Main products	CNC lathes Machining centers	Machining centers Special purpose machine CNC Lathes	Machining centers CNC lathes
Production-based location	Taiwan and China	Taiwan	Taiwan and China
Direct sale base	Taiwan, China, and other countries	Taiwan, China, and other countries	Taiwan and China

Data sources: Authors interview record with managerial team members.

specifications and standards. In addition to the interaction with suppliers in the pre-sale period and confirming the feasibility of the modifying program, the customer will visit the supplier to check the production status or to inspect the modified product's performance before delivery. Even after delivery, the supplier may again confirm the operational performance of the machine and ask for further modifications, when necessary.

The interaction focuses on upstream suppliers' value creation, yielding a special resource for the customer. The interaction organization extends to the supplier's technical support unit or the customer's product use. In this model, the customer has an opportunity to intervene in the supplier's internal processes involved in the product's development and production and even the supplier's supply system. He or she can also gain an understanding of the supplier's internal processes and technical capabilities.

The supplier's involvement in the customer's process is indirect and partial. This occurs where the customer has a more professional knowledge of a technology than the supplier and can therefore propose specific product needs that differ from the standard product. Here, the supplier may take the opportunity to learn the technology of the application used in the customer's production process and product development. The supplier can also track or confirm the effect of the modifying program to determine possible opportunities for future product development. The customer's experience and technology value may be partially transferred to the supplier's products, thereby realizing a win–win situation. In the process, the internal-organization learning and cross-sectoral learning of both sides are partially observable.

In some cases, where the customer has more professional experience than the supplier or requires specific restrictions and trusts the supplier's ability, the supplier may directly redesign the products according to the solutions selected by the customer; some customers even give design guidance. Because most of the new solutions will not have been verified, the two sides should come to a common consensus on risk sharing in the event of product failure. This type of customer is mostly end user who will (purchase) the machine tool for internal use. In this case, suppliers and customers need to interact to learn through the tacit knowledge that is developed through frequent face-to-face interaction. Only in this way is customization achieved.

Strengthening mutual trust and establishing communication and interaction patterns is necessary. The interactive content necessarily includes providing both sides with the enterprise's internal information and experience, internal processes, and trade secrets.

Key considerations for the customer include prices and the supplier's product-modifying ability; the customer's ability to convey his or her tacit understanding to the supplier and the establishment of a long-term trust relation between both sides are equally important.

The focus of co-creation is on the process of the supplier's product modification. The special resources provided by the supplier have often only reached the customer's functional value. The requirements or the standards associated with the customer's ordered product, which for the supplier is the customized type, have already been clearly defined and regulated by the customer.

#### 4.2.3. *Solution co-creation-type value creation*

As Company C actively entered the Chinese market earlier, Company C benefitted from developing the standard-type of product. Even though Companies A and B did not embrace this type of value creation as early as Company C, they both have been catching up to Company C since 2012.

Under this type of value creation, cases where two suppliers collaborate with the customer in developing new products to fulfill the specific requirements are demonstrated. There has been a constant increase in the number of such cases of value creation among firms having entered the Chinese market. Working face-to-face with the

customer in directly solving his or her problems has proved to be far more effective than the methods used by the agency the customer has trusted for a long time. Often, this latter agency cannot identify the problem. Consequently, customers in China have continuously requested the face-to-face customer–supplier working relation. By resolving this issue, the supplier begins to directly cooperate and communicate with the customer. An example of a metal cutting machine for automotive parts is provided for further explanation. The suppliers have not yet developed the abovementioned machine, although they have the ability, and it is not a standard product. In addition, the customer failed to find a suitable product from among the existing market supply. Both sides agree that it is possible to anticipate the prospects for the product's machine tools market application. Therefore, they interact to discuss the required production process, of the parts and machine functions, by sharing their mutual experience and thoughts on the technology and industrial trends.

Namely, the customer will provide to the supplier the product specifications and the mandatory features. In this manner, the customer becomes involved in the supplier's business process. Hence, more frequent and direct face-to-face cooperation will occur.

As both sides cooperate on the development processes, they usually need to spend considerable time interacting. This gives them an opportunity to understand customer value and the process of value creation from the customer's perspective. The customer as end user is involved in the supplier's internal processes from the confirmation of user requirements to product planning and development. This integrates the process of customer value creation into the supplier's process of resource creation. Interactive organization covers the supplier's product planning, technology and product development, and production departments as well as the upstream supply chain. The customer is seen to be very much involved in the supplier's process.

When both sides have had experience in product development and application and have developed mutual trust and understanding, they benefit in relation to their increased store of information gained from an exchange of knowledge and technology as well as from having experienced each other's internal processes in their two-way exchange of jointly creating value for both sides.

Long-term cumulative experience and mutual trust can be combined into implicit knowledge, which then contributes to an ideal solution, that is, one that is better than before. This is the result of having direct transactions with the customers after entering into China's market. The customer may obtain special competitive resources whereby he or she can use value by integrating the supplier's resources into his or her own internal processes. The customer receives the machine tools with user value as the solution-type value, and the supplier becomes a solution provider with value as a competitive product factor.

The products developed under this close collaboration can be offered not only for a single customer but also for other customers in similar parts processing equipment markets. After a period of time, such a co-creation-type solution exceeds the customer's expectations and becomes the basis of a solution option-type value creation product for the supplier and one that brings a high degree of market approval, while the supplier only pays a small modifying cost.

#### 4.2.4. *Solution option-type value creation*

This type of value creation can be seen in all three companies. As Company B was the last to setup a factory in China, comparing it with Companies A and C indicates the limit to the ratio of this type of product.

Here, after an in-depth approach to specific applications or accumulated relative experience and technology, the supplier has developed equipment for a particular production application or similar applications for a specific customer. Moreover, the supplier can develop new products or reconfigure the whole product or system to make it suitable for a specific application or for other similar requirements. The

customer can directly receive not only the equipment but also the supplier's accumulated experience and wisdom as these become incorporated into their own processes.

In the above example, quoting two suppliers for explaining solution co-creation-type value creation, such a solution option-type value creation is observable. The companies developed three or four production lines for machining automobile parts, such as breaking disks and aluminum wheels for the Chinese customer. This process reduced costly customized interactions, reduced design and production expenses, shortened the delivery lead time, and turned the process into the supplier's standard solution.

The expertise and functionality embedded in the product have already exceeded existing customer demand. Therefore, new customers only need to select from the solutions provided by the supplier, depending on their needs or the supplier's recommendations. After entering into China's market, each company effectively consolidated all the customers' problems from its own distributors and, to a certain extent, understood their demands for their products' technical requirements and features.

This type of machine tool does not require supplier remodification. Because there are no similar products available in the market, this can be considered as the best solution for customers and the most convenient option-type as there is no need for the supplier to customize modifications. Thus, the mode of solution option-type value creation emerged.

As a result of this process development, the interaction between the two sides may be limited to transactions only and not necessitate involvement in each other's internal processes, similar to the standard-type. Under such a circumstance, direct face-to-face contact with the customer has decreased compared with those in the solution co-creation type, while cooperation knowledge has become explicit knowledge. Consequently, cooperation and communication among the national distributors and agencies has become frequent and active. In some cases, the customer accepted the options recommended by the supplier, enabling the supplier to intervene in the customer's internal processes for further recommendations or improvements in enhancing the solution option-type value. The output of this value is not limited to the supplier's products and services but also extends to the supplier's experience, being acceptably transferred to the customer. Certainly, the organizational learning effect is moving from the suppliers to the downstream customers. The outcome of the case study is summarized in Table 3.

## 5. Research findings and discussion

### 5.1. Four value creation types exist for Taiwan's machine tool industry

According to the case analyses of the RIS' business processes and customer orders, it was found that all four types of value creation models have existed in Taiwan's machine tool industry. The value creation mode of the three suppliers (Companies A, B, and C) in this study is plotted in Fig. 2.

### 5.2. Value creation in Taiwan's machine tool industry is a dynamic development based on cooperation with the customer

The solution co-creation-type is a new development type of fulfilling customer demand and resolving customer problems. Moreover, it was observed that in addition to standard-type products constituting a considerable proportion, the percentage of customized-type orders coming from the modification of standard products continuously increased (shown as arrow I in Fig. 2), which confirmed that Taiwan's machine tool industry has evolved from the standard-type to the customized-type value creation, and intense customer co-creating is an important factor.

The rising proportion of the customized type indicates that even though the standard-type product is the foundation of the customized type, it has not been sufficient to meet customers' different needs. In addition, suppliers have paid more for the time and cost of communicating with customers required to modify a product. This, in turn, has been reflected in the higher order price; however, despite this price increase, the product has still not been as profitable as expected. This reveals that the suppliers are facing the synchronous pressure of rising value and cost, which can be considered as the cost of learning paid by the suppliers in the process.

The suppliers who were willing to accept customized-type needs gave themselves an opportunity to gain knowledge and experience from their customers, which they then internalized into their own wisdom, forming a cultural basis for understanding and serving their customers. After strengthening their technical capacity, suppliers are gradually able to offer their customers solution co-creation-type value (shown as arrow II). All managing members in the three companies agreed with this opinion.

Here, the supplier benefits from the mutually accumulated experience as he or she gradually develops some customized achievements into a standard option-type to enrich the product line, while reducing

**Table 3**  
Value creation type result in case study.

Value creation types	Company A	Company B	Company C
Standard-type	Product: Verified, less than 50% of revenue The RIS's main Interaction: Components suppliers, national and international agencies (contractors) The RIS knowledge flow: Explicit Knowledge flow among all actors The RIS boundaries: Existing actors, national and international distributors	Product: Verified, less than 20% of revenue	Product: Verified, less than 60% of revenue
Customized type	Product: Verified, more than 50% of revenue The RIS's main Interaction: Components suppliers, national and regional agencies, research institutes, I customers as end user The RIS knowledge flow: Tacit Knowledge flow among customers The RIS boundaries: National customers(agency, contractor) and new customers as end user(China and global)	Product: Verified, more than 60% of revenue	Product: Verified, more than 30% of revenue
Solution Co-creation type	Verified, Vertical Lathe machining cell for aluminum wheels The RIS's main Interaction: customers as end user (China) The RIS's knowledge flow: Tacit Knowledge flow derived from the face-to-face contact with customers The RIS's boundaries: new Chinese customers	Verified, engine cylinder head machining cell	Verified, car braking disk machining cell
Solution option-type	Verified, three types of aluminum wheel machining solutions The RIS's main Interaction: Distributors (in China) The RIS knowledge flow: Explicit Knowledge flow among the actors that has been standardized The RIS boundaries: International agency and distributors in China	Verified, two types of transmission case machining solutions	Verified, two types of braking disk machining solutions

Data sources: Authors interview record with managerial team members.



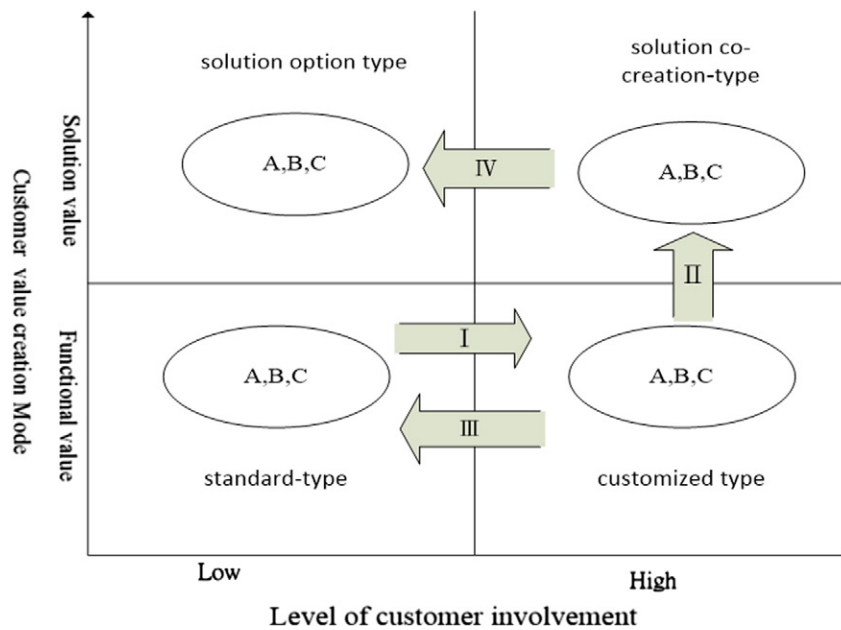


Fig. 2. Development of the value creation type Source: Data organized by this study.

costs and achieving market promotion. In this type of value creation, the supplier can offer more choices by differentiating the products in the market and making them distinct from those of the competitors (shown as arrow III).

The same thinking can be observed that the supplier has developed the solution co-creation-type value creation into the solution option-type as his or her internal standard (shown as arrow IV).

As a differentiated solution in the industry, to provide customers with a suitable choice and one that is beyond their expectations, the processes also deepen mutual trust and reliance and effectively consolidate the supplier's relation with his or her customers. The managerial teams of these companies have confirmed this.

Suppliers using the solution co-creation type are relatively more inclined to create a win-win situation. Under such a system, the customer may receive special resources earlier and thus gain a leading position in the industry. In addition, after precipitating and internalizing the customer's experience and knowledge, suppliers construct a system that leads to a long-term competitive advantage by achieving a solution that becomes the low-cost solution option-type.

Each side's abilities and value differences are also reflected in the transaction's cost-sharing and bargaining power. The supplier's profitability depends on the ability to tailor the customized-type product to meet the customer's requirements. To create solution-type value, at least one entity must have a considerable ability to grasp and improve the overall value creation process. Using the solution option-type as an example, the supplier provides the customer with solutions beyond the customer's needs at a lower cost. This means that the supplier will gain relatively higher profits and the customers' affirming comments on the resource value.

The interaction between both sides will bring a higher value of the solution co-creation type, which is the prime reason why both sides are willing to pay a higher price.

*5.3. The dynamic development of value creation interacts heavily with cooperation, knowledge flow, and boundaries among the RIS actors. The co-evolving customer phenomenon shows that the customer's role in the RIS is important for solution-type value creation*

Compared with the customers outside the RIS, the RIS actors' interactions frequently take place in phases III and IV. This means that the customers outside the RIS seldom interact with the supplier's

production process. Specifically, the most frequent interaction between both sides usually occurs during the trading period and in the after-sales service for product solutions and long-term maintenance. However, for the customized type, it extends back to the stage of product design and production. In the solution co-creation type, customer involvement is advanced to the stage of product planning for solution design or for the establishment of product specification and functions.

In contrast, the RIS actors' interaction with customers outside the RIS frequently occurs in phases I and II. This is especially true under the solution type, where suppliers frequently interact with customers to resolve problems during the design and production phases. The supplier's tacit knowledge and also the exchange of tacit knowledge through suppliers' and customers' interactions enable suppliers to offer significant assistance when trying to resolve customers' problems. That is, suppliers satisfy customers' demands and create customer value in finding solutions to their problems.

During development phases III and IV, suppliers internalize and understand the customer's problems by personally and actively investigating the customer's needs. Such an approach to problem resolution becomes tacit knowledge through documentation. Consequently, the RIS actors are able to exchange tacit knowledge to create functional value for customers and fulfill the customer's demands. For example, in the case study where customers and managers were interviewed, it was shown that a higher frequency interaction can positively enhance satisfaction on both sides. Only in the standard-type or in customized orders that specify the customer's requirements and standards, the influence of the frequency of communication is not obvious, in relative terms, on the satisfaction of both sides.

Such differences may arise from the enterprise's organization capacity or strategy. However, the enterprise's movements and its contacts with customers actively affect the expansion or contraction of the RIS's boundary.

The development of value creation in phases I and II results from the globalization of Taiwan's machine tool industry. In Particular, by entering China's market, a new innovation process occurs as it did in phases I and II. This process is created by companies wanting to actively communicate with customers to resolve their issues. Such a development model arises from the independence of a defined geographical space or a spatial proximity of RIS and the value-creation development caused by expanding the RIS boundary.

In contrast, the development of phases II and phase III mainly aim to reduce the RIS boundary by internalizing issues and creating explicit knowledge through mutual learning, while reducing the extent of the supplier's direct communication with customers. The interactions in the standard-type value creation mostly focus on the sales or transaction-centric touch points. However, other value creation types may include mutual intervention in each other's internal processes that extend forward to upstream, even to an enterprise's business strategy and cooperative supply chain of parts and components and backwards to production, improvements, and long-term after-sales service. It may include an opportunity to discover the customer's future needs. Therefore, the interaction between both sides may be extended to each other's supply chain. All members may have an opportunity to further understand each other's processes and capabilities.

This suggests that the value-creation development of Taiwan's machine tool industry occurs through the active interaction of the RIS actors, using the explicit knowledge that is co-created by the flow of tacit knowledge between the supplier and customer, in close contact, the outcome of which is the co-creation of customer solutions.

## 6. Theoretical contributions and managerial implications

In the last two decades, as Mainland China has become an important market for the Taiwanese machine tool industry, Taiwan's geopolitical and language advantages have helped it transit the boundaries of an enlarged system and achieve direct user involvement. In the past, this has been difficult to do in Taiwan's RIS. The issues of how supplier in the RIS interacts with customers have become a key factor in competitive strategy. Based on the theoretical framework and empirical studies, we have identified theoretical implications and some practical implications.

### 6.1. Theoretical contributions

#### 6.1.1. The construction of a value creation type-based theory is an effective RIS approach to analyze customer value creation

As mentioned by some RIS researchers (Doloreux and Parto, 2005; Asheim et al., 2011; Suorsa, 2014), some ambiguous issues still exist in the concept of the region and the boundaries of RIS, and empirical studies focusing on the knowledge creation of enterprises located within a region are scarce. This study proposes a completely new value innovation model based on the empirical research of Taiwan's machine tool industry. This study is meaningful to RIS development and complements the new mode of interaction between customers and suppliers in enhancing knowledge and value creation.

In its theoretical construction, this study introduces four types of value creation from the perspective of the customer-involvement level and customer value. They include standard-type value creation from the combination of a product's functional value and a low level of customer involvement; customized-type value creation from the combination of function value and a high level of customer involvement; solution option-type value creation from the combination of solution-type value and a low level of customer involvement; and solution co-creation-type value creation from a combination of solution-type value and a high level of customer involvement. Moreover, based on the empirical studies of Taiwan's machine tool industry, this study further demonstrates the practical characteristics of the evolving environment of the four types of value creation. Directly and deeply meeting users over a long-term period is important for understanding customer value creation, particularly with regard to solution co-creation and customized product type.

The theory not only fills the void between the co-creation value of the model type and mode of interaction in the RIS but also serves to explain how the supplier creates and exchanges the knowledge of innovation co-creation in the RIS. The study confirmed that customer value and customer involvement in the RIS are important dimensions of the value creation of capital asset goods. At this moment, most RIS studies

describe the conceptual framework; the empirical research on value creation in RIS development will, nevertheless, bridge the gap between its two dimensions.

#### 6.1.2. The value-creation development patterns of Taiwan's machine tool industry will reinforce some clarification of the RIS boundaries and region in the previous RIS studies

These previous studies offer little explanation on the concept of region and have the tendency to ignore the main behavior of the companies in an RIS (Gertler and Wolfe, 2006).

RIS research was never limited to the specific resources in a single region; it also followed the globalization trend. Utilizing outside resources and constructing a pipeline to the global market is important to create customer value (Bathelt et al., 2004; Gertler and Wolfe, 2006; Wolfe and Gertler, 2004).

Based on the previous argument, this study proposed four customer value creation types based on the interactions between the suppliers inside a region and customers outside a region. Benefiting from direct contact with the end user in the Chinese RIS, the majority of customers interact in the customized type of one-way involvement in the supplier's process, followed by the standard-type value creation and the solution co-creation-type value creation. This study found only a few cases of solution option-type products.

The supplier can produce customized value by meeting customized demand. This occurs when the supplier has gradually increased the frequency and time period of his or her interactions with the customers and has extended the results of these interactions to the internal product development and production process.

Customized-type and solution co-creation-type value creation have a higher cost characteristic, which is expected to be reduced through organizational learning. The results can be found in the outcomes of transforming the customized type to the standard-type and from developing the solution co-creation type to the solution option-type. The frequent interaction of both sides enhances mutual organizational learning and trust.

The type of interaction between suppliers and customers is associated with the RIS boundaries. This boundary is changed by the context and behavior of the suppliers' companies. Thus, the development of RIS value creation appears to be different. In particular, the solution co-creation type value creation is not found within the geographical space of the preceding RIS. In other words, when the RIS boundary expands, a new type of value creation development occurs in Taiwan's machine tool enterprises. In this sense, the RIS boundary concept does not the mean physical space. Rather, the expansion or contraction of the RIS boundary can be decided by company behavior and movements, and the RIS boundary can be interpreted as the semantic or contextual space.

### 6.2. Practical implications

There are various evolutionary features of Taiwan's machine tool industry in the customer value creation model. However, with respect to companies' value creation, more focus should be placed on some of these features.

#### 6.2.1. The use of the standard-type value creation model is gradually being reduced

It is feasible to enrich product lists and successfully achieve profitability goals by focusing on customized-type value creation and the solution co-creation-type value creation. It would be helpful to standardize the use of the customized type outcome in the standard product list. This could reduce the high cost of customization and cultivate potential customers. Furthermore, this effort could enhance the benefits of value creation.

### 6.2.2. Solution co-creation-type value creation has emerged. Customized-type value creation requires a tightly knit interaction with customers

It is possible to enhance each other's technology using the model of solution-type value. However, efforts such as long-term interactions and deep mutual understanding must be based on mutual trust. The interaction point and the communication contents are important. The regional boundary is a physical limit to the interaction activities; this is the critical issue for companies that sell products and provide services to distant markets. The knowledge creation and value creation processes for resolving customer problems in the RIS requires constant and close contact between suppliers and customers.

### 6.2.3. Technological spillover effects and organizational learning are closely related

Regardless of the type of model used for the value creation model, a higher level of involvement and communication between both parties and extensive internal processes in the region, along with the skills and experience of both sides, largely factor in increasing opportunities to achieve the best solutions.

It was observed that in Taiwan's machine tool industry, mutual learning has been considered as a norm among this sector's companies. Recently, the "M-team league" was established. Its task is to formalize this mutual learning, which is helpful in the collective upgrading of the whole industry.

### 6.3. Conclusions and directions for further research

This study established four types of value creation in the RIS from the customer's perspective. Such a value creation is achieved through the influence of many factors that actively develop and create advantages for enterprises and regional competitiveness. Knowledge creation and innovation are part of the value creation development process.

In this study, the development of value creation is a new direction in the RIS framework. Based on the two dimensions of the analytical framework, many issues remain to be investigated and clarified in the future.

Customer value is the source of suppliers' competitiveness. The definition of customer value is based on the customer's subjective judgment. However, the development of products and services is time consuming; therefore, intervening in each other's expected future demand to reduce uncertainty is an important issue for strengthening the interaction and mutual trust between the two sides. High mutual involvement and increased interaction frequency translate into higher costs. Although IT can mitigate part of these costs, the issue of improving the quality of communication required to gain greater value and simultaneously compensating for the associated rising costs requires ongoing research.

Although this study has demonstrated the characteristics of value creation of specialty products in B2B arrangements in the case study of Taiwan's machine tool industry, whether the development of many small and medium enterprises in Taiwan and the development of similar industries of other countries in an RIS framework can be deduced as well as whether the results of this study are applicable to other industries with similar characteristics remains to be academically and practically investigated.

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**Eun-Teak Oh** (DBA, Kobe University) is an Associate Professor in Yu Da University of Science and Technology, Taiwan (R.O.C.). He has published articles on production and operations management and strategic alliances in East Asian company. His interests currently are in research on competition and cooperation between Japanese and Taiwanese company.

**Kuo-Min Chen** received his PhD. for Industrial Engineering management from Taiwan Tonghai University. He also received the Mechanical Engineering master degree from National Taiwan University. He works in the machinery industry for more than 20 years and act still as a high level managerial member in Taiwan.

**Lu-Mei Wang** received her B.S. degree in Industrial Engineering from Tunghai University, Taichung, and her M.S. degree in Mathematics from Ohio University, Ohio, respectively. Now she is the Director of the Center of Technology Transfer and Commercialization at Feng Chia University. She is also working toward the Ph.D. degree at the Department of Industrial Engineering and Enterprise Information, Tunghai University, Taichung. Her research interests include information management, enterprise strategy development and organizational capability development.

**Ren-Jye Liu** is a professor of industrial engineering and enterprise information department in Tunghai University, Taiwan. He received his PhD degree in business administration from Kobe University, Japan in 1991 and his BS in Industrial Engineering from TungHai University, Taiwan in 1980. Dr. Liu's teaching and research activities focus on the areas of strategic alliance of Japanese and Taiwanese enterprise, the shifting of Japanese enterprise in Taiwan and China. He pays a lot of attention on supply chain managerial strategies of automobile and machine tool industries in Asia. Dr. Liu has several publications in academic and practitioner Japan, US and UK journals such as *Journal of Economic and Administration*, *Technovation* and *Long Range Planning*.