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VALUE CO-CREATION IN MULTI-TIER SUPPLY CHAINS: A STUDY OF CUSTOMIZED-PRODUCTS

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ABSTRACT

Multi-tier supply chain actors interact to co-create value and support customer use, yet the value co-creation (VCC) environment and interactions that enable customers' value-in-use (VIU) in customized-product supply chains remain underexplored. This study examines value interactions in multi-tier supply chains for customized products, focusing on VCC and actors' facilitating activities for customers' VIU. Semi-structured interviews were conducted with fifteen experts, who were selected from multiple tiers of industrial automation (IA) supply chains providing customized-products. The interview data was evaluated through content analysis. The findings reveal high customer involvement in value creation within customized-product supply chains, driven by intense direct interactions among multiple provider tiers and customers through five VCC activities: co-design, co-trial, co-production, co-procurement, and coopetition. These value interactions assign different roles across two phases: during product supply, all actors, including customers, act as value co-creators; while during product use, providers serve as value facilitators and customers as value creators. This study contributes by examining value interactions in multi-tier supply chains for customized products, highlighting the intense direct interactions and distinct actor roles that support customers' VIU.

Keywords: *customized-product, value co-creation, value-in-use, multi-tier supply chain*

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ÇOK KADEMELİ TEDARİK ZİNCİRLERİNDE ORTAK DEĞER YARATIMI: ÖZELLEŞTİRİLMİŞ ÜRÜNLER ÜZERİNE BIR ÇALIŞMA

ÖZ

Çok kademeli tedarik zinciri aktörleri, ortak değer yaratımı yoluyla müşterilerin ürün kullanımını desteklemek amacıyla etkileşim içindedir. Ancak özelleştirilmiş ürün tedarik zincirlerinde, müşterilerin kullanım sürecinde değer yaratımını mümkün kılan ortak değer yaratımı ortamı ve bu süreci destekleyen etkileşimler literatürde yeterince incelenmemiştir. Bu çalışmanın amacı, özelleştirilmiş ürünler sunan çok kademeli tedarik zincirlerinde değer etkileşimlerini, ortak değer yaratımı ve aktörlerin müşterilerin kullanım sürecinde değer yaratımını kolaylaştıran faaliyetleri odağında incelemektir. Bu doğrultuda, endüstriyel otomasyon tedarik zincirlerinin farklı kademelerinden seçilen on beş uzmanla yarı yapılandırılmış görüşmeler gerçekleştirilmiş ve veriler içerik analizi yöntemiyle analiz edilmiştir. Bulgular, özelleştirilmiş ürün tedarik zincirlerinde müşteri katılımının yüksek olduğunu ve bunun, sağlayıcıların birden fazla kademesi ile müşteriler arasındaki yoğun doğrudan etkileşimlerden kaynaklandığını göstermektedir. Bu etkileşimler, ortak tasarım, ortak deneme, ortak üretim, ortak tedarik ve rekabetçi iş birliği olmak üzere beş temel ortak değer yaratımı faaliyetiyle gerçekleşmektedir. Ürün tedarik aşamasında tüm aktörler ortak değer yaratıcıları olarak rol alırken, kullanım aşamasında sağlayıcılar değer yaratımını kolaylaştıran, müşteriler ise değeri yaratan aktörler olarak konumlanmaktadır. Bu çalışma, çok kademeli tedarik zincirlerinde aktör rollerini ve değer etkileşimlerini bütüncül biçimde ortaya koyarak literatüre özgün bir katkı sunmaktadır.

Anahtar Kelimeler: *özelleştirilmiş ürün, ortak değer yaratımı, kullanım sürecinde değer, çok kademeli tedarik zinciri*

1. INTRODUCTION

Value refers to an interactive and relativistic experience (Morris and Holbrook, 1996) that is defined by customers' experience of a product or service (Pinho et al., 2014). The service logic (SL) framework defines value as value-in-use (VIU) (Grönroos, 2008), which customers perceive and evaluate uniquely, experientially, and contextually (Grönroos and Gummerus, 2014). Therefore, rather than providing value directly to customers, firms develop and provide potential VIU for customers as value facilitators (Grönroos and Voima, 2013; Grönroos and Gummerus, 2014). Firms may also co-create value through direct interactions among actors in the value generation process. These actors are forming the multi-dyad collaboration nodes (Nejma and Cherkaoui, 2020) of highly complex

supply chains composed of multiple interconnected tiers (Mena et al., 2013). Within this complex setting, providers can engage with customers' value creation process, which raises opportunities of value co-creation (VCC) among supply chain actors at multiple tiers (Grönroos and Gummerus, 2014). Through interactions with customers, the provider can actively and directly take part in and influence their value creation (Grönroos, 2009). Here, different actors at multiple tiers may take different roles: customers may create value alongside other actors who facilitate VIU (Grönroos and Voima, 2013; Koç et al., 2020); customers, providers and other actors in the supply chain may co-create value in product design, development, manufacturing, and delivery (Grönroos and Voima, 2013).

Customization, which is intertwined with VCC (Merle et al., 2008) has become increasingly popular among firms. Customization occurs when customers proactively specify elements in their marketing mix (Arora et al., 2008). For instance, through co-design and co-production, VCC enables personalization through customers' active involvement to create desired value based on specific requirements (Zine et al., 2014).

VCC and customization has been studied in several sectors such as electronics, telecommunications, transportation and vehicle manufacturing, chemicals (Zhang and Chen, 2008), real estate (Kaur et al., 2017) and tourism (Oyner and Korelina, 2016). These studies all examined customization as dyadic, provider-customer VCCs since customization is a way to meet each customer's demands. However, because customers co-create value via several actors at multiple tiers, value chains go beyond these dyadic interactions (Choi and Wu, 2009; Pinho et al., 2014; Nejma and Cherkaoui, 2020). For example, Grafmüller et al. (2018) adapted a multi-actor network perspective to show that VCC and customization created both challenges and benefits in the textile industry. However, the characteristics of the textile industry may not be relevant in other sectors (Grafmüller et al., 2018) and it is essential to test their approach in other sectors. The research about VCC should be progressed with addressing more industry-specific issues to facilitate organizations to implement VCC as a resource-integration process (Saha et al., 2022). Therefore, VCC activities, the facilitators of value interactions for customer's VIU and the roles of actors in customer's value creation process in multi-tier supply chain setting providing customization need further examination. Furthermore, additional research is required to gain a deeper understanding of multi-tier supply chains in specific industries with more complex supply chains (Mena et al., 2013; Thomé et al., 2014).

Accordingly, this study examined the value interactions of actors in multi-tier supply chains providing customized-products from a SL perspective with a focus on VCC and facilitating activities for customer's VIU. Two key research questions are addressed as: (1) How is value co-created for the customer's creation of VIU in multi-tier supply chains providing customized-products? (2) What are the facilitators of customer's creation of VIU in multi-tier supply chains providing customized-products?

The research is conducted in industrial automation (IA) sector, where the products and services are highly customized requiring intense interaction between actors at multiple tiers. Given technological advances, IA is a developing sector with a distinct and growing market (Industrial Automation Market, 2022). These technological trends encouraging innovation and improving product design forms the customized nature of IA products and bring together many different actors (firms), making the IA industry appropriate for research on customized settings.

The study first outlined the key actors and their connections within the multi-tier IA supply chain to identify the sample base for the research process. Then, semi-structured interviews were conducted with key respondents from each actor category positioned at different tiers of IA supply chains. The interview data were then examined using content analysis to reveal the VCC activities and facilitators of value interactions for customer's VIU and to outline the roles of actors in the value creation process in customized-product networks.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

2.1. SL and Value Creation Process

The SL asserts service as a multifaceted phenomenon, emanated by the use of resources to support customer's value creation (Grönroos and Gummerus, 2014). Service is also referred as the 'value-supporting processes' that is generated by the interaction of the firms' new and existing resources with, both each other and the customers, to facilitate the value creation at the customer's processes (Grönroos, 2006).

Defining value is difficult because value is an elusive concept (Woodall, 2003). Customer's value-creating process emerges the 'value' in the form of 'VIU', and value creation is defined as the customer's creation of VIU (Grönroos, 2008). The VIU emerges over time and

accumulates throughout the customer's value-creating process (Grönroos and Voima, 2013). In that process, the potential VIU is created, and the real value is facilitated by the service provider (Grönroos and Gummerus, 2014). Potential value is the expected VIU, that is, the value that is not actualized, but facilitated for customers that will be transformed into real value, which is the value that is actualized and referred as VIU (Grönroos and Voima, 2013).

The difference of value facilitation from value co-creation is that value facilitation *is not a part of* the customer's value creation in relation to VIU; rather, customers *use the output of* provider's value facilitation activities in their value creation for VIU. In other words, when the providers develop, design, manufacture and deliver the resources for the customers without direct interaction with the customers, value is generated through value facilitation (Grönroos, 2011). Different from value creation and VCC, value facilitation is only a part of the total process that advances value for customers, where the provider facilitates value creation of the customer creating value. Customer is the user and the driver of the value creation process (Grönroos and Gummerus, 2014), that is, the customer creates value, and the provider facilitates value creation (Grönroos, 2011). Differently, VCC is a joint value sphere of direct interactions in value creation process (Grönroos and Voima, 2013). In direct interactions, multiple parties' processes occur simultaneously, that form a one merged interactive process of coordinated actions' and influence the value creation process (Grönroos, 2011). Joint value creation takes place by the customers and providers where the customer and the provider are in direct interaction and co-create value together.

The expansion of the networked economy has made VCC a prominent theme in the literature (Kohtamäki and Rajala, 2016). SL framework advocates a service-oriented logic and assume that VCC occurs through actors' direct interactions and is evaluated as VIU by customers (Grönroos 2008). Therefore, VCC is driven by VIU (Grönroos and Voima, 2013).

In summary, SL has two major implications for the value creation process. First, in some cases, providers find opportunities to engage with their customers and co-create value together (Grönroos and Gummerus, 2014). Co-creation of value emerges when there are direct interactions between the provider and the customer, that is the VCC, that results with VIU which is the value that the customer derives from using the product or service to meet their needs (Grönroos and Voima, 2013). Second, the provider facilitates processes that support customers' value creation. In other words, at some point the customer may be a sole creator of value

(Grönroos, 2006) while the provider facilitates the customer's value creation by producing and delivering resources and processes that represent potential value, or expected VIU, for the customer (Grönroos and Voima, 2013). Hereby, SL argues that there are cases where actors jointly co-create the value as well as the customer solely create value while the provider facilitates it. These activities should not be assumed separately because instead, they support each other for the formation of VIU through the value creation process.

Despite the importance of this complexity for understanding the VCC, few studies approach the value process holistically from both the customer and provider perspective (Holmqvist et al., 2020). Consequently, studies are needed that analyze VCC in complex networks to expand our understanding of this phenomenon (Pinho et al., 2014).

2.2. Roles of Multi-Tier Supply Chain Actors in the Value Creation Process

The strategic positioning of actors within multi-tier supply chains determines their unique contributions. Each actor possesses distinct resources and plays a specialized role in the system (Mena et al., 2013). Value is co-created by a network of actors (Vargo et al., 2020), who engage in multi-dyad collaborations (Nejma and Cherkaoui, 2020) within highly complex multi-tier supply chains (Mena et al., 2013; Thomé et al., 2014). From SL perspective, the accumulation of value by the customer's value-creating process is provided by the interactive processes between the service provider and the customer, where the service provider engages or facilitates the processes related to the customers' value creation (Grönroos, 2006). Both the customer and the service provider are involved in the value-creating process, but through different service interactions as mutual or reciprocal actions of two or more actors. The reciprocal value creation among actors is facilitated by the service (Grönroos and Gummerus, 2014). SL argues that any action may not be a VCC and there are cases where value is created by the customer only. As a result of the interaction, customers can continue the value creation independently as the user and integrator of resources (Holmqvist et al., 2020; Grönroos, 2011). In such cases, the provider is the value facilitator since the customer creates value as VIU, while the provider facilitates this value creation (Grönroos, 2008; Grönroos, 2011).

In that respect, Grönroos and Voima (2013) defined the roles of the provider and the customer in value creation and co-creation activities. They argue that the role of the provider starts with the design of the product

and continues with the development, manufacturing, and delivery activities. VIU begins when customers *use* the product. Their research defines providers as value facilitators during the usage phase, while customers are independent value creators outside direct interaction. On the other hand, customers co-create value with providers by inviting the provider into this phase in a merged dialogical process, which is the VCC. Therefore, it is obvious that, while VCC mostly involves providers and customers (Tax et al., 2013; Yoon and Lee, 2019), there can be multiple actors (Ostrom et al., 2015) beyond the activities of single exchanges or actor dyads (Vargo et al., 2008; Choi and Wu, 2009) in multi-tier supply chain settings (Mena et al., 2013). Relationships are not limited to dyads, contrary, they are nested within and occur between networks of relationships (Vargo, 2009; Nejma and Cherkaoui, 2020). This no longer occurs solely within firms' boundaries; instead, VCC involves various actors within a network (Pinho et al., 2014) of highly complex interconnected tiers (Mena et al., 2013; Thomé et al., 2014). Thus, a holistic network view is required since each actor interacts with others within a service network to co-create value (Jaakkola and Hakanen, 2013). Therefore, the roles of the involved actors have a dynamic structure and change over time and context (Edvardsson et al., 2011). Consequently, it is important to comprehend the changeable roles of the actors because "*generic actors assume several roles simultaneously and may perceive multiple forms of co-created value*" (Ekman et al., 2016). Research should be conducted on larger networks to understand how actor roles evolve in such multi-tier settings (Ekman et al., 2016).

2.3. VCC and Customization

Customization adds complexity to multi-tier supply chains and involves various actors in VCC activities. Assuming that customers are rational decision-makers aiming to gain maximum benefit from products and services (Etgar, 2008), *"customization is a reliable way to deliver superior customer value"* (Scholl-Grissemann et al., 2020). Customized-products and services involve customers in co-production to maximize positive VIU. Customization is conceptualized as an offer enabling customers to personally modify certain elements of products through engaging co-design activities to create a more personal experience (Merle et al., 2008). Thus, multi-tier supply chains, providing customized offerings, are shaped by co-creation activities. Actors create mutual benefits by intensely combining and exchanging resources for innovation of products and services (Patrucco et al., 2022). Customization is directly related to customers' expectations and require customer and supplier collaboration. Customer involvement in VCC is thus important for firms

seeking competitive advantage in satisfying personalized demands in several industries (Zhang and Chen, 2008; Koç et al., 2020).

The degree of customization depends on the stage that the customer's involvement occurs (Duray et al., 2000). Early involvement in design, for example, increases product customization whereas involvement during final assembly would reduce customization. Customization requires customer involvement in co-creation activities, yet achieving customization is the major motivation to engage in co-production (Etgar, 2008). Since co-creation requires personal information, time, mental and physical effort, the greater the customization, the greater customers' willingness to engage in co-creation (Heidenreich and Handrich, 2015). Thus, customization is important in VCC; and customized-product networks are also considered as complex systems due to their status as high-value, high-technology and engineering-intensive products, systems, and services (Appio and Lacoste, 2019).

Various studies have examined VCC in customized contexts (Zhang and Chen, 2008; Zine et al., 2014; Kaur Sahi et al., 2017). However, the complexity of multi-tier supply chains from a service-oriented perspective needs further attention to expand our understanding of VCC (Pinho et al., 2014, Widjojo et al., 2020). Ranjan and Read (2016) associated these VIU dimensions with experience, personalization, and relationship. Medberg and Grönroos (2020) enhanced the work of Ranjan and Read (2016) to reveal empirical dimensions of experience, personalization, and relations. Medberg and Grönroos (2020) identified seven dimensions of positive and negative VIU: attitude and convenience (experience); flexibility (personalization); expertise, solution-oriented and speed of service (relationship). They also mentioned monetary costs as the empirical dimension of VIU based on the sacrifice given to be evaluated in form of positive or negative VIU. Additionally, to these studies, Porter and Donthu's (2008) demonstrates that trust motivates customers. There is a need for further research to focus on whether these factors are different for customized-products (Franke et al., 2009).

Therefore, in order to add to the literature, research is needed to analyse VCC in complex multi-tiered networks and to address the customer experience of VIU as a result of interaction with multiple service providers (Medberg and Grönroos, 2020).

3. METHODOLOGY

Qualitative research is a widely accepted and applied methodology in VCC research stream (Saha et al., 2022). In qualitative studies, semi-structured interviews allow participants to freely express their ideas and feelings, while the interviewer can introduce topics and questions as needed. Hence, researchers commonly prefer to implement this method when participants have substantial experience with and knowledge of the subject to enable in-depth exploration of research topics (Matthews and Ross, 2010). Therefore, to examine the value interactions of actors in multi-tier supply chains providing customized-products, a qualitative approach was implemented through conducting fifteen semi-structured interviews with various actors from different tiers of IA supply chain, operating in Türkiye. This approach was adopted to gain a deeper understanding of the diverse perspectives of interrelationships among different actor groups (Bodendorf et al., 2022). This sector was selected due to its multi-tier structure and customized-product offerings. The interview data is interpreted through content analysis inductively (Krippendorff, 2004).

3.1. Description of the Context: IA Sector and Customized IA Product

Over the centuries, progress in industrialization, marked by four industrial revolutions, has introduced highly mechanized and automized production in almost all industries (Lasi et al., 2014). The IA sector has also implemented technological revolutions that provide customers with various automation solutions. IA sector is significant economically, with a global market size of USD 191.89 billion in 2021 and projected to grow from USD 205.86 billion in 2022 to USD 395.09 billion by 2029 (Industrial Automation Market, 2022). IA mainly serves two industry groups: discrete and process. Therefore, IA companies' portfolios include both customized and standard products, but the major focus of the sector is the customized-products as automation products require customized system integration. The present study examines VCC in multi-tier IA supply chains operating in Türkiye, as they are mainly focused on providing customized-products and are constantly evolving through technological advances. Türkiye is chosen as the research context as it provides an important setting for examining how VCC in the industrial automation industry enables firms and their stakeholders to collaboratively enhance innovation, competitiveness, and sustainable industrial development in an emerging market context. Turkey's role as a manufacturing and distribution hub connecting Europe and Asia, alongside

its industrial base, makes it a relevant context for competitiveness-oriented industrial studies (Department of Commerce, 2026).

A customized-product is tailor-made to meet the unique preferences and requirements of the customer. Customized-products are designed and manufactured according to customers' specific requirements, while standard products are manufactured to meet the general needs of a broad customer base. In general, IA products have pre-existing designs, and the product configurators are used to model the products in accordance with customer preferences (Hvam, et al., 2008). IA products are customized, designed and produced based on the end customer's requirements. Therefore, it is expected that the VCC activities between the IA firm and the customer will be higher than the other actors.

3.2. Sampling and Data Collection

This research is conducted to analyze the value interactions within the customized-product development in the multi-tier IA supply chain and data is obtained through semi-structured interviews (Matthews and Ross, 2010) with IA sector professionals. Respondents are selected from each tier in the IA supply chain to enable a comprehensive analysis of the value interactions and gain rich insight on the diverse perspectives of the relationship complexities (Bodendorf et al., 2022). The participants shared their experience and knowledge according to customized-products.

Identification of the key informants is important (Gugiu and Rodríguez-Campos, 2007). Therefore, we decided to focus on interviewees' experiences to understand how they are involved in customer's value creation process for the supply of the customized-products specifically. The participants were carefully selected according to their resumes through purposeful sampling (Eisenhardt, 1989) and were all familiar with and technically knowledgeable about automation in relation to customized IA products.

In total, fifteen participants from thirteen companies were selected from different actor categories. First, an initial sample of three key respondents were selected through purposeful sampling from IA firms (Charmaz, 2006) to provide an overview of the IA sector and outline its multi-tier network structure. After a preliminary data analysis, purposeful sampling was complemented by snowball sampling (Noy, 2008) (Table 1). Snowball sampling complemented purposeful sampling by extending access to additional actor categories and enriching the data. Through participant referrals, the researchers reached interconnected actors across multiple supply chain stages that may not have been identifiable through

purposeful sampling alone, such as technology providers and actors from different end-user industries.

Table 1: Participant Profiles

Abrv.	Role	IA Work Experience	Company Name	Company Information	Interview Duration
IA1	SE	3 years	Industrial Automation Company A	13 production facilities +10.000 employees International scope	60 mins
IA2	MSM	16 years	Industrial Automation Company B Industrial Automation Company C	10 production facilities +10.000 employees International scope 10 production facilities +10.000 employees International scope	58 mins
IA3	MSM	4 years	Industrial Automation Company A	13 production facilities +10.000 employees International scope	70 mins
IA4	MSM	5 years	Industrial Automation Company A	13 production facilities +10.000 employees International scope	71 min
IA5	SM	25 years	Industrial Automation Company D	10 production facilities +10.000 employees International scope	48 min
IA6	MSM	16 years	Industrial Automation Company A	13 production facilities +10.000 employees International scope	56 min
TP1	MSM	22 years	Technology Provider Company A	1000-5000 employees International scope	60 min
E1	ME	7 years	End user - Chemical Industry	+2 production facilities 1000-5000 employees International scope	60 min
E2	PAE	7 years	End user - Petrochemical Industry	+2 production facilities 1000-5000 employees International scope	68 min
E3	ADE	7 years	End user - Iron and Steel Industry	1 production facility 50-200 employees International scope	65 min

OEM1	CPL	5 years	Original Equipment Manufacturer A	1 production facility 50-200 employees International scope	52 min
OEM2	SM	22 years	Original Equipment Manufacturer B	1 production facility 10-50 employees International scope	75 min
EPC1	IS	7 years	Engineering Procurement & Construction Company A	5000-10.000 employees International scope	58 min
SME1	CO	15 years	SME - Engineering Company A	5-15 employees International scope	46 min
SME2	CO	14 years	SME - Engineering Company B	5-15 employees International scope	52 min

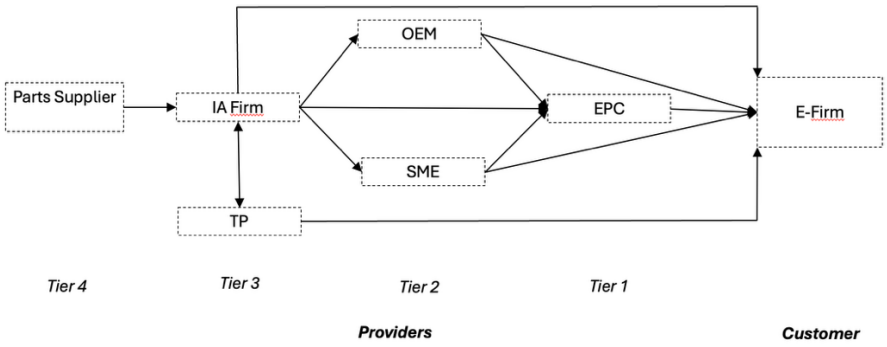
Abbreviations: SE, *Sales Engineer*; MSM, *Middle Level Sales Manager*; SM, *Sales Manager;* ME, *Maintenance Engineer*; PAE, *Process Automation Engineer*; ADE, *Automation Development Engineer*; CPL, *Customized-Product Lead*; IS, *Instrument Supervisor*; CO, *Company Owner*

An interview questionnaire with twenty-one open-ended questions was prepared to probe the value interaction environment in multi-tier IA supply chains providing customization to end users (E firms). Each interviewee was first given consent and information explaining the academically technical terms 'customization, value facilitation, VCC and VIU'. The semi-structured interviews were conducted in three months period in 2021. The interviews lasted an hour on average, with added questions to follow up on participants' contributions to gain more detailed insights by encouraging them to speak. Many participants became more aware of value-creating activities in their work and were eager to provide further examples. The semi-structured interviews continued until data saturation was reached (Corbin and Strauss 2008; Fusch and Ness, 2015). Researchers generally agree on several key indicators of data saturation, including the absence of new data, the emergence of no additional themes, the lack of new codes, and the ability to replicate the study (Guest et al., 2006). In this study, saturation was determined when ongoing data collection yielded no new information, no new themes, and no additional codes, indicating that further sampling was unlikely to generate novel insights. Reaching this point suggests that data saturation had been achieved, thereby enhancing the dependability of the qualitative findings.

3.3. Describing Multi-Tier Structure of IA Supply Chain

To understand the network structure of IA supply chain, the first three interviewees were selected from IA firms. These interviews enabled us to understand and visualize the IA supply chain (Figure 1) and confirm

that the sector has a multi-tier, multi-actor, complex supply chain structure. To analyze the value interactions in the multi-tier supply network, interviewees were selected from actor categories at different tiers in IA supply chain.



Source: Author's own work.

Figure 1: Multi-Tier Structure of IA Supply Chain

During the interviews, each participant was asked to describe IA supply chain structure and to identify and elaborate on the key actors involved based on their professional experience. The preliminary supply chain model and actor map were iteratively developed by comparing and integrating the interviewees' accounts. When discrepancies, uncertainties, or new actors emerged in subsequent interviews, earlier participants were re-contacted to clarify, validate, and confirm the evolving structure and actor roles within the supply chain. This iterative validation process ensured that Figure 1 reflects a consolidated, empirically grounded representation of the IA supply chain. Accordingly, Table 2, which provides explanations of the actors in the IA supply chain, was developed and refined in parallel based on this iterative process. As Figure 1 shows, the IA supply chain has a multi-tier structure comprising of IA firms and their part suppliers, small-medium sized enterprise (SME) engineering, technology providers (TP), engineering, procurement and constructions (EPC), original equipment manufacturers (OEMs) and E firms. The explanations of actor categories are as follows (Table 2):

Table 2: Explanation of Actors in IA Supply Chain

Actor Category	**Explanation**
Parts Supplier	Provide product to IA firm as components
IA Firm	Provide the main automation product and appropriate automation solutions to customers
TP	Design advanced software solutions integrated with customers' production and enterprise resource planning systems
EPC	Provide engineering studies based on customer demands to design and construct their production facilities
SME–engineering	Provide engineering solutions for E firms' production operations
OEM	Make production machines for E firms, which incorporate IA products as component
E firms	Use IA products in their production operations

Here, E firms are the customers that use IA products in their own production operations, provided through operational interactions among the other actors in Figure 1. In IA supply chain, IA firms, SME-engineering, TPs, EPCs and OEMs are the *providers* working to supply the IA product to the *customers*, the E firms.

3.4. Content Analysis

Content analysis transforms textual data into meaningful categories (Weber, 1990; Krippendorff, 2004). Qualitative analysis specifically aims to understand a phenomenon by examining data in depth rather than generalizing from samples to populations through measurement and statistical inference (Krippendorff, 2004; Forman and Damschroder, 2007). As the meaning of value is subjective and contingent upon individual, particularly seller and buyer, value systems (Neap and Celik, 1999), content analysis was employed to investigate the VCC process and activities fostering customer value in complex, multi-tier supply chains dedicated to customized-products. Given that the participants' positions were at different tiers in the IA supply chain, their assessments and perspectives for value interactions were analysed using latent content analysis to reveal their common but potentially hidden meanings under different words or phrases (Krippendorff, 2004).

Content analysis methodology employ systematic procedures to derive replicable and valid inferences regarding the contextual utilization of textual data (Krippendorff, 2004). Following this methodological process, first, all interviews were recorded in high audio quality and transcribed verbatim for subsequent analysis (Fawcett et al., 2014). These transcripts were then coded iteratively through a hierarchical coding process through forming categories, themes or sub-themes (Eisenhardt,

1989; Corbin and Strauss 2008). First, open codes were assigned to individual statements or paragraphs for developing the first-order codes simultaneously and iteratively during the sampling and data collection process (Eisenhardt, 1989; Krippendorf, 2004; Pratt, 2009; Flick, 2014). This approach enabled us to streamline the qualitative data by identifying core consistencies and underlying meanings, thereby facilitated the exploration and categorization of data patterns (Patton, 2002). Through careful comparison, these first-order codes were then grouped into thematic categories, which were then categorized into theoretical codes (Eisenhardt, 1989; Corbin and Strauss 2008). Consequently, the value interactions of multi-tier supply chains for customized-products were outlined.

3.5. Reliability of the Research

Consistency and reliability of the content classification are crucial in content analysis. Therefore, the research quality in this study is ensured through Halldórsson and Aastrup (2003) and Shenton (2004)' four criteria: credibility, transferability, dependability, and confirmability.

The preliminary descriptive data collected through three key respondents from IA firms validated that the products supplied through multi-tier IA supply chains require rigorous customization, confirming that the sample was appropriate for the research context.

All interviews conducted through direct online interactions by a researcher, who has a professional experience and extensive knowledge in the multi-tier IA supply chains. After the first coding phase, each interview was coded by linking similar expressions to improve the data quality. In the second phase, the codes from actors playing similar supply chain roles were compared to identify similarities and differences. The process was then repeated for contrasting actors. This multi-step coding enhanced the reliability of the qualitative content analysis. Following Suddaby's (2006) recommendation to classify data based on previous proven research, earlier studies were consulted.

The interviewees were selected for their IA expertise and experience for the customized-products. The interviewees' diversity from different actor categories enabled to receive different perspectives from multiple tiers on VCC activities, which enhanced the analysis of the value patterns.

4. FINDINGS

The analysis in this study illustrates the complex nature of supply chains for customized-products, which are characterized by multiple interconnected tiers. It has been demonstrated that the value interactions within these systems are not limited to simple dyads, but rather form complex networks. The findings revealed that value interactions in multi-tier supply chains of customized-products occur differently with high involvement of the customer to value creation process and through intense direct interactions among the providers and the customers during the product supply phase. Besides, actors at multiple tiers contribute to the value creation process through nested actions and take different roles in relation to VCC and value facilitation activities to support the customer's VIU.

The four key findings are as follows: (1) The value is co-created in the product supply phase through five activities: co-design, co-trial, co-production, co-procurement, and coopetition. (2) The value interactions of multiple actors assign different roles in the product supply and product use phases. In the product supply phase, all actors at multiple tiers contribute as value co-creators, whereas during customer's use of the product, providers contribute as value facilitators and customers contribute as value creators. (3) The co-created potential value is used to create real value by the customer as VIU, which is facilitated by the providers through four activities in the product use phase: pre-collaboration, training to product usage, product maintenance and after-sales support activities. (4) The accumulation of value by the customer's value-creating process through VCC and facilitating activities for E firm's VIU is affected by eight factors: monetary cost, quality, speed/time management, expertise, solution-oriented, convenience, flexibility, and trust.

4.1. VCC Activities and Actors' Roles in Multi-Tier Supply Chains of Customized-Products

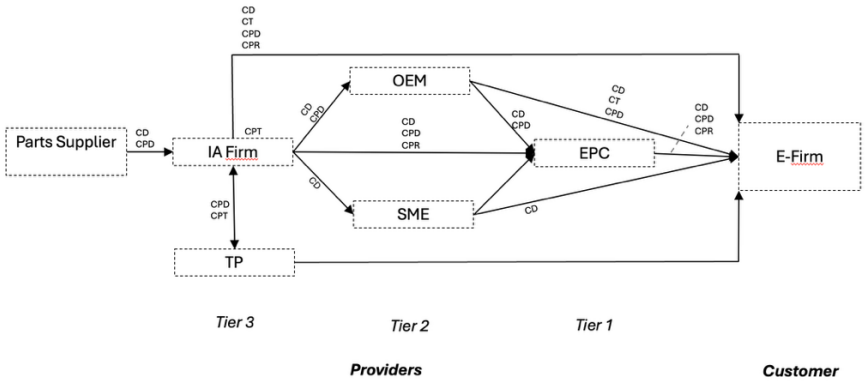
Coding identified five VCC activities generated through the value co-created by two or more actors positioned at different tiers: co-design, co-trial, co-production, co-procurement, and coopetition. Table 3 presents the VCC activities and actors' involvement as value co-creators through intense direct interactions by the customer.

Table 3: VCC Activities and Actor Connections of Customized-Products

Co-design	**Co-trial**	**Co-production**	**Co-procurement**	**Coopetition**
IA ➔ E IA ➔ EPC IA ➔ OEM IA ➔ SME OEM ➔ E SME ➔ E PS ➔ IA IA ➔ EPC ➔ E IA ➔ SME ➔ E OEM ➔ EPC ➔ E	IA ➔ E OEM ➔ E	IA ➔ E IA ➔ EPC IA ➔ OEM IA ➔ TP OEM ➔ EPC IA ➔ EPC ➔ E IA ➔ OEM ➔ E PS ➔ IA ➔ E	IA ➔ E IA ➔ EPC ➔ E	IA ➔ IA IA ➔ IA ➔ E IA ➔ TP ➔ E IA ➔ IA➔ EPC ➔ E

As shown in Table 3, the VCC in multi-tier supply chains for customized-products include both mutual and reciprocal interactions among two or more actors.

The interview data further revealed the value interactions within and among the supply chain actors, which helped to improve Figure 1 to Figure 2 with a clearer representation of co-creation paths. As seen in Figure 2, value is generated through multiple VCC activities in the multi-tier supply chain with direct, intense E firm involvement, highlighting the distinctive effect of customization on value generation patterns.



Source: Author's own work.

Figure 2: VCC Activities in Multi-Tier IA Supply Chain for Customized-Products

As demonstrated in Figure 2, actors from multiple tiers of IA supply chain co-create value by actively contributing to the customized-product's supply process. The details of the VCC activities along the multi-tier IA supply chains are explained in the following sub-sections.

4.1.1. Co-design

Co-design refers to collective creativity throughout the design process (Steen et al., 2011) by bringing together various experts (researchers, designers, product developers) and (potential) customers (Steen et al., 2011). While our analysis revealed three co-design sub-activities, the interviewees emphasized that customized-products require continuous operant resource transfer, such as experience and feedback, to shape the design to E firm expectations and highlighted the need for feedback and transparent information sharing. The sub-activities for co-design is brainstorming for design, site visits for design verification and design testing (Table 4).

Table 4: Co-design Activities in Customized-Product Supply Chains

Sub-Activities of **Co-design**	Within/among Actors	Sample Quotes
Brainstorming for Design	IA-E	*"The customer explains the problems faced while using the product. We evaluate these issues together and plan for actions to not to repeat the same in other designs." (IA6).*
	IA-EPC	*"EPC companies that provide quality engineering services can guide us very well and enable us to make better choices. The EPC company gives the necessary information such as the status of the customer's production site, the way the works are carried out. Thus, the EPC can manage what the end user wants and how to go about the solution." (IA4)*
	IA-OEM	*"We do not make the control cards of PLC devices; it comes with ready-made software from the automation company. We tell the automation company how this software should be made. For example, recently the control card in the device had to be changed, we told the automation company all the features of the card and what they should do. Here, our share was 70%, the automation company's 30%." (OEM1)*
	IA-SME	*"We need to be in constant contact with the IA firm to select appropriate product. If a wrong product design is made it's too late to fix it when we go to the customer's site and make product installation." (SME1)*

	OEM-E	*"Some of our customers provide us process and technology know-how. These customers can direct us on what they want. These types of customers are world giants that have factories all around the world. There may be cases where they show us the machines used in their factories abroad and ask us to do the same. They force us by giving feedback that the product should be like this, or an instrument should have the following features. This motivates us to produce better and do better." (OEM2)*
	SME-E	*"For customized production, we usually expect specifications from our customers, or we discuss the product requirements through contact or in writing. While presenting a customized-product, we tell our customers what the product does. Of course, know-how is important here. If we do not have process experience, the customer should guide us, if there is, we can guide the customer ourselves." (SME1)*
	PS-IA	*"The supplier also offers me alternatives, as I do to the customer, and offers suggestions that it might be more appropriate if we proceed in this way. And I share that suggestion to the customer. Thanks to the supplier, I am in a position that offers new alternatives and creates solutions in the eyes of the customer." (IA1)*
	OEM-EPC-E	*"Customer's consulting firm (EPC) sometimes required outdated things. We were trying to explain to the customer that this is a solution from the 1980s and we were talking about the automated system with today's technology to be used, but the customer preferred to trust the EPC and we could not convince them. So, there are cases that customer and EPC attends the design phase with us but with bad ideas." (OEM1)*
	IA-SME-E	*"We feel lucky when the customer directs us what they need, the feedback and information from the customer is crucial and facilitates the product design. Then we ask help from the IA firm (we sell their products to the customer) for the product design because when the customer needs customization or extra things in product, the solution is IA firm's support." (SME2)*
Site Visits for Design Verification	IA-EPC-E	*"EPC actually understands the customer's needs. They go to the field, talk with the customer, complete the engineering work there. What I mean by engineering work is to determine how the customer's process can work most efficiently. In other words, EPC engineering determines the measuring instruments and control mechanisms that should be used in the customer's field. And then it becomes a bridge between the customer and the*

		automation company by supplying products from automation companies." (IA1)
	IA-E	*Sometimes we can't get full information about the details for design requirements. So, we go to the field, observe, examine, and discuss with the customer on site. (IA6).*
Design Testing	IA-E	*"In some cases, functional tests are carried out to ensure that the product is designed properly. Our engineer, with a representative of the customer, go to the field, check, and confirm whether the product is appropriately designed." (IA1).*

Brainstorming for design refers to VCC when actors consult each other and generate ideas to create qualified customized-products that meet customer requirements. Actors contribute, mainly through feedback and consequently brainstorming. For example, IA firms occasionally need E firm feedback during product design. Since the product is customized, the customer helps the provider by giving information about the previously used products. This is very important for the provider because in this way, provider can detect previous design mistakes and improve the design of the product by providing the exact required customization. This feedback may also influence future design corrections.

Alternatively, because OEM manufactures machines that use IA products as sub-assembly, it may take over the role of the customer while working with the IA firm during the design phase. Thus, OEM can also provide feedback at the customized-product design phase.

Site visits for design verification involve site visits to assess challenges in E firm processes to ensure design accuracy of the customized-product. For example, if the E firm provides insufficient information to define the product specifications, the IA firm can verify the exact design required by observing the E firm's production process on-site.

EPC plays a supervisor role to the E firm in re-designing existing production lines or designing a new production facility by using IA products. Therefore, EPC collaborates with IA firm in product selection and design phase. Consequently, EPC and IA firms may conduct site visits together to check the design requirements. Thus, multi-actor co-design activity creates potential high value by designing the exact product required by the E firms.

Design testing generates value by testing products with E firms to verify product design accuracy. E firms may also contribute to this process.

4.1.2. Co-trial

Product trial activities are also important in multi-tier supply chains of customized-product. In this research, the term refers to the activity of 'collaborative trial' in businesses implemented for demonstrating the product's accuracy and suitability. Co-trial is one step ahead of design testing, where the design process is completed and the demonstration and confirmation of whether the customized-product will integrate and operationalize with the E firm's processes appropriately or not, is made. In that respect, two co-trial sub-activities were identified (Table 5).

Table 5: Co-trial Activities in Customized-Product Supply Chains

Sub-Activities of **Co-trial**	Within/among Actors	Sample Quotes
Confirmation of Product Suitability	IA-E	*"Product trials are made with the customer in the field" (IA3)*
	OEM-E	*"Apart from this, another cooperation can be R&D, and we can realize this in our pilot facilities. In these pilot plants, some of our customers make new product studies or new process trials, and we provide technological and financial support to them. In other words, we do not demand the rental costs of the products. We follow up the business in engineering and technology and we do work together." (OEM2)*
Inter-functional Involvement to Product Trials	IA-E	*"The customer contributes to the product trial phase and allocates resources, for example by creating a team to deal with the product trials" (IA3)*

Confirmation of product suitability is the activity when IA firms, OEMs and E firms cooperate to the confirm the suitability of customized-products to ensure the product works as designed.

Inter-functional involvement to product trials goes beyond confirming product suitability. It involves E firm departments harmoniously conducting trials with the IA firm and taking increased responsibility the more customized the product is.

4.1.3. Co-production

Generally, co-production comprises all cooperative activities between customers and production partners (Etgar, 2008). However, in this study, it refers specifically to direct collaborative production activity between all providers and E firms. In multi-tier IA supply chains, all actor groups perform co-production through four sub-activities: interactive production, production control, product installation and product monitoring (Table 6).

Table 6: Co-production Activities in Customized-Product Supply Chains

Sub-Activities of **Co-production**	Within/among Actors	Sample Quotes
Interactive Production	IA-TP	*"Our software is complemented by IA product. So, we develop our software by IA firm involvement." (TP1).*
	IA-OEM	*"We use automation products inside of our machines, like spare part. So, automation products are a part of our machines." (OEM2)*
	PS-IA-E	*"One of our customers does not want the X brand valve that we have assembled on our product. Because once there was a problem with the valve, our supplier assembled the valve on our product incorrectly. We know that this mistake will not happen again, but our customer never wants the product of that supplier. While designing the product, I never give the product of that supplier. The customer still continues to work with us, as I solved the customer's problem by using a product from an alternative supplier and arranging the assembly of the product." (IA1)*
Production Control	IA-E	*"Factory acceptance tests are made by the customer in the IA firm's factory to check the production of the customized-product for detecting any issues earlier." (IA4).*
Product Installation	IA-EPC	*"The IA engineer makes system commissioning. The EPC engineer ensures that the automation product works together with the devices it communicates within the field. In other words, it controls the installation and wiring of input-output devices." (EPC1)*
	IA-EPC-E	*"I worked on a big project when I was an IA firm engineer. We were working with an EPC that the customer selected for this project. The product and system installation on the customer site is the final stage, you have to make communication between the IA systems. EPC was very experienced and for the jobs that we couldn't solve, they instantly solved them with their equipment. As a result, the customer wasn't waiting long for system installation." (E3)*

	OEM-EPC	*"Some EPCs are very knowledgeable about communication systems, and when I prepare the communication system and send it under the software, the EPC can install it." (OEM1)*
Product Monitoring	IA-OEM-E	*"IA had developed a system for the OEM. IA could remotely control machine malfunctions and downtime via the web. (These machines were sold by OEMs to customers and used at the customer site.) In this way, IA could receive feedback, make corrections, and intervene in the machine." (IA2)*

Interactive production is the active involvement of various actors from multiple tiers in the production because OEMs need IA products while producing their own machines. Hence, they sometimes collaborate with IA firms during production. TP may also collaborate in production if they use IA products as hardware to complement their own software.

Production control is E firm involvement in production, especially for customized-products.

Product installation is another collaborative activity as IA products and systems needs communication with other products or machines. IA firms, OEMs and EPCs collaborate for the system commissioning, installation and communication.

Product monitoring is when IA firm remotely monitors the OEM's machine downtime and malfunctions to make corrections.

4.1.4. Co-procurement

This refers to the groups rather than individual buyers make procurement decisions collectively (Rezaei et al., 2020). The analysis revealed two sub-activities for co-procurement (Table 7).

Table 7: Co-procurement Activities in Customized-Product Supply Chains

Sub-Activities of **Co-procurement**	Within/among Actors	Sample Quotes
Joint decision-making for procurement	IA-E	*"In fact, the first thing you need to do is to get immediately involved in that business after the idea of investment comes to the mind of the customer. If IA can convince the customer to put even a word in the purchasing specification at the beginning of the project, our chances of getting that job increase.*

		Because we only put a word, a product feature, no one can bid there." (IA4)
	IA-EPC-E	*"It's good that EPC would intervene to our decision-making process and offer different solutions. We could have the opportunity to benefit from the EPC's experience and perspective." (E2).*
One-stop procurement	IA-EPC-E	*"Depending on the size of the project, procurement from a single supplier can be made more convenient by joint contribution of us and EPC companies" (E2).*

Joint decision-making for procurement is jointly deciding on the most appropriate automation product to procure. This shows that the providers' involvement from the beginning of procurement can affect E firms' preferences regarding product requirements.

EPC involvement during procurement may also help E firms evaluate from different perspectives. For instance, one E firm interviewee commented that EPC can select more appropriate automation products using their know-how.

One-stop procurement refers to sourcing from a single supplier to simplify the E firm's task. EPCs can play a key role in consolidating products from several IA firms and delivering them to E firms from one supply point.

4.1.5. Coopetition

Due to product range variety and customized demands, IA firms may cooperate horizontally, whether willingly or not. Our analysis revealed three sub-activities of coopetition (Table 8).

Table 8: Coopetition Activities in Customized-Product Supply Chains

Sub-Activities of **Coopetition**	Within/among Actors	Sample Quotes
Coopetition for determining design requirements	IA-IA	*"Competitor automation companies can co-work together to capture the technological advancements. Sometimes, co-working groups with our customers are also established." (IA5).*
Coopetition for supply	IA-IA-EPC-E	*"IA product suppliers don't have every item in their product portfolio, but customers do not want to be in contact with more than one automation company in the purchasing process. That's why the customer goes to one automation company and that company makes an agreement with other automation companies and makes the offer to the customer from one source" (IA6).*

	IA-IA-E	*"The customer wants to work with a single provider without making the job complicated. That's why collaboration among competitors has such value for the customer" (IA3).*
Coopetition through service intermediaries	IA-TP-E	*"IA firms are globally more accessible. The number of people working in the TP company is low compared to IA firms. Therefore, we could better market our TP firm to customers by using the global power and accessibility of the IA firm. In the end, because the customer values our competitor company [IA firm], we could create a win-win situation by moving forward together with IA company" (TP1).*

Coopetition for determining design requirements refers to information sharing among competitors during product design, usually between two IA firms. Continuously developing technology may require more IA firms to cooperate in new product designs to maximize the value from resources. By involving E firms, they can agree on the product specifications for the required customization.

Coopetition for supply occurs when competitors collaborate to supply convenient products for E firm, for example by creating a single supply channel. By reducing their responsibility for supply, E firms may force IA firms to cooperate during product design/selection and offers.

Multi-actor coopetition can also facilitate supply. For example, early EPC involvement in product supply from different IA firms may increase future cooperation among competitors. When E firms want to upgrade their automation products, IA competitors must cooperate to meet their demands.

Coopetition through service intermediaries refers to competitors aiming to improve their relationships and trust with E firms through some intermediaries. Depending on the situation, TPs can compete and cooperate with IA firms. During coopetition, relations between IA firms and E firms enable TP to gain E firm trust. In this way, these companies can co-create value by working together for the E firm. Thus, mutual trust can enhance value for coopetition.

4.2. Providers' Facilitation of E firms' VIU

Findings show that, E-firms' VIU is influenced by providers' activities within the context of highly complex and interdependent tiers of customized-product supply chains and providers facilitate E firm's product use and their evaluation of VIU through four activities: pre-collaboration, training for product usage, product maintenance and after-sales support. It is outlined that IA firms are the key value facilitators in E firms' VIU

evaluation, supported by all provider actors. For example, frequent breakdowns caused by a faulty supplier component in an IA firm's automation system demonstrate the negative consequences of poor initial product selection on E firm VIU.

Through *pre-collaboration* activities, IA firms can affect E firms' product evaluations and facilitate their value creation. Given constant technological evolution, E firm's interviewees emphasized that they could improve their processes more deliberately with guidance from IA firms regarding the latest automation product groups, particularly for customization. Such pre-collaborations also encourage customers to use IA products.

Because IA products are customized, IA firms must provide *training* to explain product usage to E firms. These sessions can enhance E firms' knowledge about products and help them intervene in urgent cases.

Our findings revealed that learning through training plays an important role on VIU. E firms also create value on their own by improving their knowledge through training.

IA firm maintains the product at certain intervals while the E firm is using that product. The aim is to reduce unexpected shutdowns. Thus, IA firms facilitate product usage through providing periodic or long-term *maintenance* services that help E firms fix system errors. IA firms can also improve product design using maintenance data.

IA firms facilitate E firm's VIU creation by increasing efficiency through periodic maintenance operations.

When E firms choose not to get periodic or long-term maintenance from IA firms, a quick intervention is required to fix the problem. In these cases, E firm may solve the problem with the *after-sales support* of the IA firm. The IA firm should be accessible to direct the E firm remotely in solving the problem. Here, E firms create value by fixing the problem, which is facilitated by the IA firm.

Our study further showed that eight factors affect the accumulation of value by customer's value-creating process: monetary cost, quality, speed/time management, expertise, solution-oriented, convenience, flexibility, and trust. Table 9 presents the factors and sub-factors affecting VIU.

Table 9: Factors Affecting Customer's Value Creation

Factors	Sub-factors	Criteria
Monetary Cost	Initial Investment Cost	low-cost
		no extra charge for the changes in the project
		preserve initial investment cost
		discount privilege
		no volatile prices
		production cost of by-products
	Total Cost of Ownership	return on investment
		quality tendency
		effect on customized end-product
Quality		effect on the quality end-product
		effect on productivity / efficiency
		effect on safety
		effect on environment
		aligned with government regulations
		effect on risk minimization
Speed / Time Management		quick action / solution
		project completion time
		product delivery time
Expertise	Provider Expertise	employee expertise
		risky process expertise
		directing end user for the product sustainability
		expertise in new automation technologies
		process expertise
		expertise to fix customer mistakes
	Customer Expertise	ability to provide accurate data/documentation
		ability to understand customization requirements
Solution-oriented		solution-oriented
		solution capability
		quick solution
Convenience		procurement convenience
		one-stop shopping
		co-design enhancing convenience
Flexibility		flexibility of payment
		flexibility of procedures
		flexibility of doing extra jobs
		flexibility to meet all the demand
		flexible product to extend
Trust		bilateral relations
		transparency
		trust to the person
		trust to the company
		brand awareness and loyalty

For the *monetary cost*, one IA interviewee mentioned the importance of *initial investment cost* and an E firm interviewee indicated that the discount offerings strengthen the customer loyalty. On the other hand, E firm interviewee noted that the total cost of ownership may also affect value perceptions as customers tend to select higher quality, hence more expensive IA products if they have productivity concerns and end-product quality is critical.

For the *quality*, since the exact customization brings quality product, the quality has an effect on value evaluation.

On the other hand, interviewees highlighted the importance of *speed/time management* as customers want products and services supplied faster.

One E firm interviewee preferred receiving services from IA firm employees with more *expertise* in automation and risky processes and noted that customers want IA firms to direct them regarding sustainable production processes. Customers are also attracted by the providers with prior experience.

The value accumulation is also shaped by problem-solving as acting *solution-oriented*. The provider firm's ability to solve problems and quick-acting, solution-oriented attitude affects the customer's value judgement.

Value accumulation is also enhanced by *convenience*. Rival IA firms and EPCs must cooperate, which affects the value process through convenience. The co-design activity can be more convenient and reduce product selection time for OEMs that possess technical knowledge.

Flexibility is also needed because automation products have extendable system structures. This is because automation products are shaped by technological developments that introduce new product and customization offerings.

Lastly, value process is directly advanced by *trust* in companies. As one E firm interviewee explained, trust is more important than quality. Customers may also show brand loyalty to IA firms due to their trustworthy brand image.

5. DISCUSSION AND RESEARCH IMPLICATIONS

This article investigates value creation process in the context of a multi-tier supply chain that offers customized-products. The analysis confirms that supply chains of customized-products are highly complex systems comprising multiple interconnected tiers (Mena et al., 2013; Thomé et al., 2014) with relationships extending beyond dyadic interactions and occurring within and between networks (Choi and Wu, 2009; Vargo, 2009; Nejma and Cherkaoui, 2020). Expanding on the literature that highlights value co-creation within complex, multi-tier supply chain networks (Vargo et al., 2020; Nejma and Cherkaoui, 2020; Mena et al., 2013; Thomé et al., 2014), this research underscores the pivotal role of customers in value creation, particularly in customized-product contexts characterized by extensive direct interactions between providers and customers. These direct interactions are generated through five VCC activities through value interactions of actors amongst multiple tiers, which are co-design, co-trial, co-production, co-procurement, and coopetition. The study of Grönroos and Voima (2013) suggests that the provider's role starts with the design of the product and continues with the development, manufacturing, and delivery activities and if the provider does not directly interact with the customer, its role becomes the value facilitator. Besides, when the provider finds opportunities to engage with the customer through direct interactions, they can co-create the value. This research contributes to Grönroos and Voima's (2013) work by demonstrating that the customer and the providers have direct interactions in various activities from product trial, development and production to delivery. Therefore, the provider is not the value facilitator but the value co-creator when performing these activities. On the other hand, while co-production, co-design, and coopetition are well documented in VCC literature (Ertimur and Venkatesh, 2010; Terblanche, 2014; Grindell et al., 2022; Garri, 2021; Rusko, 2013), prior studies have largely not conceptualized co-procurement and co-trial as separate phases of VCC. This study advances the literature by conceptualizing these two activities as integral phases of VCC in customized-product supply chain settings. Our findings show that co-procurement and co-trial play an important role in practice and extend existing VCC frameworks that have not previously accounted for these phases. The findings show that in multi-tier supply chain settings, the new and advanced customized-products require the active involvement of the customer to the trial phase to enable the providers to improve the design of the customized-products. This approach enables actors to co-create innovative offerings by intensively sharing and integrating resources, resulting in mutual gains (Patrucco et al., 2022). On the other hand, even in the procurement phase, customers can engage with

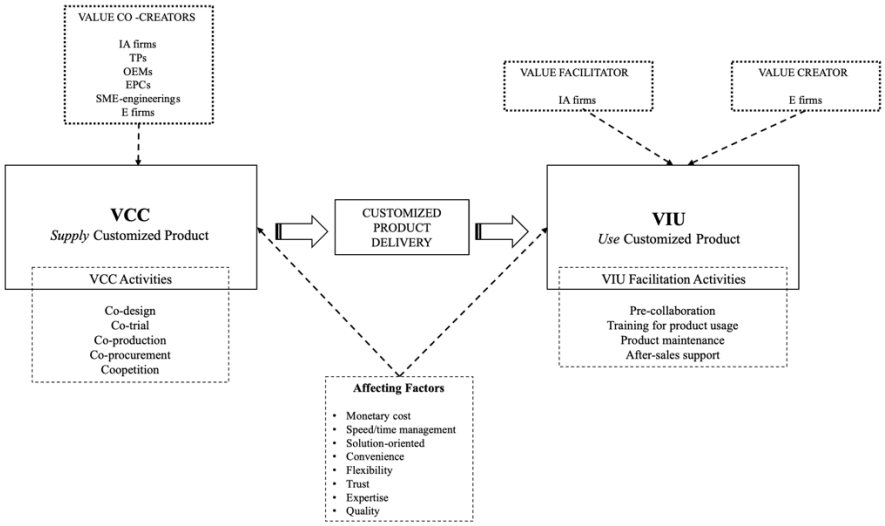
the IA firm and EPC because the customized structure of the product generates a need for the help of the automation professionals.

Furthermore, the findings show that the co-created value is perceived by the customer as VIU, which is facilitated by the providers during the customer's evaluation of VIU through pre-collaboration, training to product usage, product maintenance and after-sales support activities. Since these facilitating activities are determined in relation to the customized-products developed along multi-tier supply chains, it contributes to the literature by demonstrating how value facilitation occurs for customized-product settings. The main difference of pre-collaboration from the other three facilitating activities is that it occurs even before the decision of the procurement of the product while the potential value is generated (Grönroos and Voima, 2013; Grönroos and Gummerus, 2014). The findings also revealed actors at multiple tiers, such as IA firms, Technology Providers, OEMs, EPCs, SME-Engineerings and E firms (end-users), have roles in VCC, but the value facilitating activities are performed only between the main provider's (IA firm) facilitating activities to the customer's (E firm) value creation. Thus, the findings are in line with the previous research of Grönroos (2011), Grönroos and Voima (2013) and Grönroos and Gummerus (2014).

Besides, the analysis confirmed that monetary cost, quality, speed/time management, expertise, solution-oriented, convenience, flexibility, and trust affects the creation of the value by the customer in forms of VIU also in multi-tier supply chains providing customized-products. However, our findings indicate two other factors affecting the value process: expertise and quality. While expertise is already a known factor (Medberg and Grönroos 2020), our analysis indicated that it has two dimensions for customized-product development, such as customer expertise and provider expertise, rather than just the provider (Medberg and Grönroos 2020). This is directly related to the high customer involvement and interaction in customized-product development. Furthermore, the current literature suggests that VIU represents service quality, which results from VIU (Medberg and Grönroos 2020) rather than causes it. However, our analysis suggests that quality affects VIU in customized-product supply chains. The reason is that high-quality customized automation products affect customer's value creation process, thereby generating value in relation to productivity, risk minimization, environmentally friendly production, etc. Furthermore, our study is introducing trust as the new factor affecting the value process. Compared to Ranjan and Read's (2016) and Medberg and Grönroos's (2020), trust may be accepted as a factor effecting the customer's value creation process under "relationship" dimension. Another trust subtheme was brand

awareness and loyalty in that E firm interviewees frequently mentioned their loyalty to IA brands. This supports Porter and Donthu's (2008) conclusion that "*trust motivates customers to behave relationally toward the sponsoring firm by sharing information with, co-producing new products with and granting loyalty to, the sponsoring firm*." Our findings also supported that E firm often remain loyal to IA brands introduced to them through OEM equipment. Consequently, the OEM's initial brand selection significantly influences subsequent purchasing decisions. This highlights the OEM's influence on long-term brand loyalty.

In conclusion, the value interactions in multi-tiered customized-product settings assign different roles to actors in two phases. During product delivery phase, all actors (including the customer) contribute as value co-creators and during customer's use of the product, providers contribute as value facilitators and customers contribute by evaluating VIU as value creators. Therefore, this study demonstrated that actor roles have a dynamic structure and change over time (Edvardsson et al., 2011) and showed roles of multiple actors at different tiers in the customer's value creation process as value creator, value co-creator and value facilitator. Figure 3 presents these value interactions and actor roles for different phases.



Source: Author's own work.

Figure 3: Value Creation in Multi-Tier Supply Chains of Customized-Products

Our study has several managerial implications for multi-tier supply chains providing customized-products. First, actors at multiple tiers, including the E firms, co-create value and influence E firm's VIU through nested value interactions. Therefore, managers should consider that in customized-product supply chains, VCC is not only generated through dyadic interactions between provider and customer; rather, it is co-created through multi-tier collaborative contributions of actors through nested actions.

Second, effective customization critically depends on customer involvement in all processes. Customized-products depend on establishing a collaborative work environment reinforced by customer experience and know-how and direct information sharing. Furthermore, as product complexity and customization increase, it becomes even more important to test and trial products collaboratively with customers. Therefore, managers of customized-product supply chain actors should prepare an interactive and active business environment that meets and involves the actors at multiple tiers with the customers, from the initial phases of the product development until even further the use phase.

Besides, providers can add high value by using their expertise to translate customer feedback about past failures into improved design, assembly, and supplier choices. Customers' preferences are often shaped by earlier mistakes (e.g., misassembly by suppliers), and provider expertise helps distinguish true product issues from execution errors, prevent their recurrence, and restore trust. By doing so, providers not only resolve immediate customer concerns but also embed learning into future customized designs.

Lastly, managers should recognize that even after product delivery to the customer, value interactions continue, but transformed into value facilitation activities during product use to maximize customer's VIU. Providers should continue supporting E firms by informing them about technological developments and new products through seminars and training and providing maintenance services and after-sales support to establish more sustainable long-term relationships.

This study also has limitations, which offer opportunities for further research. First, the study can be extended to different industrial settings in relation to customization to advance knowledge on value interactions. Second, further focus can be given to the VCC activities in multi-tier supply chain settings resulting in negative value on the customer's side, in relation to the misuse of resources and resulting in value

co-destruction. Lastly, future research can specifically examine how customer expertise affects customization.

AUTHOR CONTRIBUTION

CONTRIBUTION RATE	EXPLANATION	CONTRIBUTORS
Idea	Pointing out the research idea or forming hypotheses	Author 1 and 2
Review of Literature	Conducting the literature review for the study	Author 1
Research Design	Forming the research design, including research methodology, deciding on scales and samples	Author 1 and 2
Data Collection and Editing	Data collection, editing, and analyzing	Author 1 and 2
Findings and Discussion	Reporting and discussing the findings	Author 1 and 2

Conflict of Interest

No potential conflict of interest was reported by the authors.

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