Service Offering, Perceived Value and Value Driver in Semiconductor Foundry Industry: An Exploratory Study

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Abstract – **Semiconductor manufacturing service providers, or foundries, have been playing a more and more important role in the industrial value network. However, little research has focused on service content and value. Based on service-dominant logic thinking, this study identifies major service offerings by focus group research and conducts a large-scale survey to explore the value and value drivers perceived by customers. Research results reveal that perceived value and key value drivers are quite different among service offerings. Results also suggest that foundry companies tailor value propositions for customers in different region when designing their service-offering portfolio.**

Keywords - **Perceived value, foundry service, value driver**

I. INTRODUCTION

After several decades' evolution, the semiconductor industry has been appearing a complex value network structure that comprises of a variety of integrated and specialized firms. Originally, the semiconductor firms take integrated organizational form to design, produce, and market its products by themselves, due to the necessary technologies and resources for developing an integrated circuit product are rare and with strategic importance to competition. By taking the organizational hierarchy mechanism to coordinate the whole value chain activities, the firms are able to accumulate intellectual assets learned from the integral knowledge and reduce the transactional cost mainly caused by inter-organizational "technical dialogue" [7][9]. With the advancement of information and communication technologies, the relative small and specialized firms can leverage collaborative systems to conquer the technical dialogue problem [2][10] and focus on developing their specialty expertise and knowledge to compete with the integrated rivals by taking advantages of market mechanism to find the most efficient combination of the specialty assets to forge a "virtually integrated firm" for gaining the strategic flexibility. Since the "fabless-foundry" business model [1] largely lowers the entry barrier to semiconductor industry, the industrial network now consists of firms with various value propositions to their targeted customers.

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In this new industrial dynamics, the sources of cost effectiveness or strategic flexibility are most likely come from the management of value network rather than from specific organizational form. For instance, Intel, as a largest integrated device manufacturer (IDM) in the world, usually manufactures its most advanced microprocessor product in its own factory for intellectual property protection and time-to-market consideration; meanwhile, it outsources manufacturing activities to the foundry as well for maintaining the strategic flexibility in product mix optimization by leveraging external production capacity to serve those phasing-out product markets. Comparatively, Qualcomm, the global largest fabless company, while enjoys the strategic flexibility of multiple manufacturing resources provided by different foundries, still needs to deliberately select a main manufacturing partner to make sure the cost effectiveness of advanced process technology can remain. Since both the fabless and IDM are eager to partner with the foundry to serve the market and the foundry does not produce its own product, it actually plays a role of manufacturing service provider in the industrial value network. In another word, the appropriate business strategy of the foundry should be service-oriented rather than product-oriented.

Traditionally, the dominant logic of marketing is based on the thoughts of exchange of "goods" which focused on tangible resources, embedded value, and transaction. Vargo and Lusch [14] argue that the dominant logic should be revised to deal with the more and more important issues such as intangible resources, the co-creation of value, and relationship in current business environment. In other words, they advocate evolving a new dominant logic of marketing to treat service provision, instead of goods, as fundamental to economic exchange. From the service-centered view, more and more firms exchange to acquire the benefits of core competences or services in the value network [5]. In the exchange process, customers are active participants in co-production and value co-creation [12][16]. The service/product value is perceived and determined by the consumer on the basis of "value in use," firms can only make value propositions to satisfy customers [8][15]. To foundry, it might imply that the conventional goods-dominant logic that deliver "services" in such ways: developing a set of standard process technology, promoting the new offerings from the perspective of technical performance features, packaging the design kits

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to support customer new product development, taking the customer tooling mask set for mass production, shipping tested semiconductor wafers to customer or subcontracting assembly houses, billing customer for generating revenue; could not be competitively enough any more for managing current industrial value network.

Following the service-dominant logic, the firm should identify and establish its core competences and find potential customers that could benefit from these core competences at first, and then cultivate relationships with customers to develop customized and compelling value propositions to meet specific customer needs for gaining competitive advantage. Finally, the firm ought to carefully collect and analyze marketplace feedback to learn how to improve its offerings and value propositions [15]. In other words, if the efficient manufacturing process and superior technology capability are a foundry's core competences, then the firm should well define its service offerings with right value propositions so that the service contents can render customers the irreplaceable utilities in the value network. The service offerings should not be a loose collection of independent elements. They need to be properly designed as re-configurable and re-composable modules of an integral solution for maintaining the strategic flexibility [11][13]. Hence, the first research question of this study is to understand the appropriate design of foundry service offerings in the perspective of service-dominant logic of marketing.

As we stated above, although firms can propose value propositions for its services, only customers can perceive and determine the value of the offerings. Therefore, the second research question of this study is to explore the perceived value of each service offering and find the key drivers behind them in the foundry business context.

II. RESEARCH DESIGN AND METHODOLOGY

To address the research questions, this study was conducted to identify what kind of service offerings that foundry can provide to its customers in the value network relationship and to measure the associated perceived value and the drivers behind the customer's perceptions. Given the situation that the foundry industry seems to face a challenge that the competition logic is moving from goods-centric to service-centric, and almost all the leading companies are still struggling with finding new competitive strategy, we conceive that it is more possible to generate meaningful information from interviewing very experienced experts and top management with regarding to the strategic nature of these innovative services. When the service offerings are properly identified, an instrument can be developed for large scale survey for understand the perceived value and drivers. Cooper and Schindler [4] suggest a useful way, called a two-stage design, to handle such kind of research situation. With this approach, qualitative exploration becomes a separate first stage to clarify some unclear contextual research situations and then to refine later research topic at the second stage.

At the first stage, we conducted a focus group study for addressing the first research question. Dozens of semiconductor industry experts and managerial executives were invited to a focus group meeting to provide in-depth information about what kind of foundry service offerings that they do think are important to its company's success. Although focus group study is usually used to generate valuable information or insights [3], this methodology is also frequently challenged by researchers on its external validity due to its research conclusion is only drawn from a small sample of selected people. Therefore, the quality of data that is collected from the research procedure must be ensured to earn the credibility [6].

Following the focus group research flow suggested in [6], we invite thirty semiconductor industrial experts and executives to participate in the discussion and nineteen of them agree to join the study. All of the participants hold manager and above position in manufacturing, marketing, design engineering and supply chain management field respectively. At the beginning of the focus group session, the moderator explains the objectives of this research and briefs the procedure and rules to the participants. In the discussion, the participants are guided to describe their ideal service offerings and the most important value should be provided by foundry partner. All the three focus group sessions are recorded by video camera and the discussion scripts are reserved for later content analysis.

This study further conducts a large-scale survey to explore how valuable these service offerings perceived by customers and the impact of the drivers on the perceived value of service offerings respectively. After two rounds of pretest by 15 industrial experts, we finalize the questionnaire and send it to 1233 industrial professionals who have experience of using foundry services. Total 936 responses are received that makes the return rate is 75.9%. 67 responses are judged as invalid due to the incomplete data and obvious guessing answer. To take the invalid responses out, we have 869 valid responses that account for 70.5% of total sample.

Among the 869 observations, 34.8% come from the IDM, 47.5% come from the Fabless, 10.2% come from IP and Design Service vendor, and 7.2% come from the system companies. The job function distribution covers manufacturing, design, engineering, sales/marketing, information technology, and logistics. Regarding the job level distribution, 4.5% of the participants hold VP and above position, 18.8% is director level, 36.8% is functional manager and the remainder 39.9% is staff engineers. As to the geographical distribution, 33% responses come from the Asia Pacific Region, 10.5%

from European, 11.3% from Japanese, and 45.2% from North America.

III. ANALYSES AND RESULTS

A. Focus Group Study

In the focus group study, we try to induce the participants to provide their thoughts about the existing and possible service offerings that are critical to their business success as complete as they can. The participants in the first focus group seem not very proactive to express his/her thoughts and most of the services mentioned are existing services, such as masking service, 3rd party IP service, failure analysis, etc. Nevertheless, many innovative thoughts on the services are raised in the second and the third session. For example, one participant offers an idea on "low wafer price". Intuitionally, "low wafer price" should not be a "service" since it is simply a result of business transaction negotiation. However, the participant further explains what he really means is that the foundry should provide a forecasted wafer price in advance before a new product design is initiated. The rationale behind that is: Given the fact that current product life cycle is getting shorter and shorter and the wafer fabrication time is usually 2 to 3 months long, if customers can obtain the wafer price forecast as early as possible, they can have a better new product rollout plan with flexible pricing strategy to increase the market hit rate. A lesson-learn: If a foundry still engages with its customers to deal with the price of wafer manufacturing in a goods-dominant logic, it would lose the business to its competitors who adopt service-dominant logic thinking to provide customers with the "low wafer cost" service.

By analyzing the characteristics and contents of these thoughts of service offered by the panel experts, this study categorize them into ten types of service offerings as shown in table 1.

Design Support service is related to those services that can facilitate customer to implement its design on the foundry's technology platform. For instance, advanced IC product may have millions of logic gates so that it is very hard for customers to have all the circuit design complete in house unless they have sufficient design resources. Therefore, the foundry is ordinarily asked to look for the proven intellectual property (IP) to reduce customer's time to market.

Mask Technology service is an essential service due to the mask is used to print the circuit patterns on the wafer. Mask service includes optical phase correction (OPC) adjustment, shape simulation, thickness simulation, and so on. Product Prototype service provides customer with lower cost shared mask and wafer to validate their new product concept. Customers can also use this service to do small volume production to test the market in a more economic way.

Flexible Production service and Package & Test service refers to the operational supports in the wafer fabrication process. Operational efficiency improvement and flexibility are the major goals for the two services. It commonly includes lot expediting, lot split process, inventory management, etc.

TABLE 1 TYPE OF SERVICE OFFERINGS

	Design Support	Mask Technology	Product Prototype	Flexible Production	Package & Test
FG1	6,7,11, 12,13	10	16	2,8,9	5,14
FG2	2,13	1	12	6,8,11	7,20
FG3	2,4,7,9, 10,17,20	1	5	6,11,13	14,24,25 ,27
	Engineering Analysis	Customer Logistics	Quality & Reliability	Information Technology	Turnkey Solution
FG1	1,17			4,15	3
FG2	9,17,19	4,25,26	5,18	3,10,14,15, 16,22,23,24	21
FG3	8,19,23, 30	12,15,16, 29,32	21,22	3,18,26	28,31

Note: The numbers in the table are the code that represents the service provided by focus group participants

When a new product pilot runs in the foundry, there may be some engineering issues that lead to low production yield or even functional fail. To resolve these problems, process technology experts will conduct an engineering analysis to figure them out. For example, failure analysis is a common element of Engineering Analysis service. To prevent the yield loss from mass production, the foundry needs to provide Quality and Reliability service such as quality assurance plan and statistical process control cycle for all the products.

Information Technology service and Customer Logistics service represent the major "on-line" and "off-line" communication channel between the foundry and customers. For example, when a customer design engineer needs the latest version of foundry design kits, she/he can either download them from the foundry's website (on-line form)or call the account specialist to deliver them (off-line form).

Finally, we find many participants talk about the need of so-called Turnkey Solution. To some customers, it may be very time-consuming to deal with different vendors by themselves. For instance, Microsoft might outsource its XBOX ASIC fabrication to a foundry and hope the foundry can be the single window to handle all the assembly and test activities. In this situation, it intends to ask the foundry to provide a turnkey solution service so that the customer can save time from simplifying its non-core business.

Except for the service identification, the focus group study also investigates what attributes contribute to the service value. A content analysis is employed to decide the service value attributes by counting the specific

keywords such as low cost, real time, quality, automation, etc. The higher frequency the keyword told by the participants, the more possible it relates to contribute the value to the service. We conclude five value drivers from the analysis: Flexibility, Technology, Quality, Time to Market and Cost Effectiveness.

TABLE 2 STATISTICS OF SERVICE VALUE AND VALUE DRIVERS

Service Offering		**Design Support**		**Mask Technology**		**Product Prototype**		**Flexible Production**		**Package & Test**		**Engineering Analysis**		**Customer Logistics**		**Quality & Reliability**		**Info. Tech.**		**Turnkey Solution**	
Value Driver	*Region*	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Time to Market	All	5.73	1.45	6.07	1.09	5.75	1.38	6.01	1.06	4.78	1.79	5.41	1.56	5.96	1.09	5.47	1.35	5.40	1.46	4.86	1.82
	Asia	5.83	1.25	6.09	0.90	5.95	1.20	6.18	0.85	4.97	1.60	5.78	1.16	6.04	0.95	5.62	1.15	5.72	1.19	4.88	1.74
	Euro	5.62	1.64	6.10	1.01	5.68	1.58	5.99	0.88	4.66	1.95	5.27	1.42	6.04	0.81	5.19	1.43	5.44	1.33	4.68	1.78
	Japan	5.80	1.17	5.79	1.16	5.71	1.24	5.80	1.10	5.21	1.38	5.72	1.25	6.03	1.05	5.34	1.25	5.50	1.25	5.27	1.27
	N.A.	5.71	1.51	6.11	1.12	5.71	1.41	6.01	1.11	4.68	1.86	5.29	1.69	5.92	1.16	5.49	1.40	5.29	1.56	4.81	1.92
Flexibility	All	5.46	1.37	5.65	1.18	5.55	1.36	5.90	1.05	4.73	1.73	5.21	1.49	5.88	1.10	5.38	1.28	5.36	1.42	4.75	1.76
	Asia	5.57	1.18	5.60	0.99	5.72	1.18	6.03	0.88	4.86	1.53	5.51	1.15	5.88	0.90	5.47	1.09	5.54	1.21	4.84	1.68
	Euro	5.18	1.57	5.82	0.98	5.41	1.63	5.87	0.95	4.68	1.85	5.29	1.39	6.00	0.86	5.34	1.37	5.51	1.32	4.52	1.77
	Japan	5.47	1.05	5.33	1.25	5.44	1.34	5.72	1.08	5.13	1.32	5.28	1.30	5.95	1.09	5.15	1.29	5.45	1.14	5.25	1.25
	N.A.	5.48	1.43	5.69	1.23	5.55	1.37	5.90	1.10	4.63	1.82	5.11	1.59	5.86	1.18	5.40	1.31	5.27	1.52	4.68	1.84
Cost Effective	All	5.59	1.48	5.85	1.25	5.87	1.16	5.87	1.16	4.86	1.84	4.89	1.58	5.38	1.34	5.23	1.34	5.21	1.49	4.90	1.83
	Asia	5.62	1.44	5.75	1.23	5.54	1.38	5.93	1.14	4.96	1.62	5.22	1.32	5.44	1.17	5.41	1.24	5.44	1.31	4.99	1.73
	Euro	5.29	1.60	5.77	1.10	5.24	1.63	5.72	1.09	4.59	1.86	4.84	1.39	5.27	1.20	5.05	1.46	5.13	1.29	4.73	1.84
	Japan	5.65	1.35	5.75	1.41	5.57	1.38	5.77	1.18	5.44	1.47	4.95	1.46	5.07	1.38	4.90	1.34	5.20	1.35	5.43	1.37
	N.A.	5.61	1.50	5.90	1.25	5.63	1.40	5.90	1.16	4.77	1.92	4.81	1.67	5.43	1.39	5.27	1.34	5.16	1.58	4.81	1.90
Quality	All	5.74	1.37	5.88	1.06	5.60	1.32	6.07	0.96	4.80	1.78	5.48	1.49	6.19	1.05	5.84	1.22	5.46	1.44	4.86	1.76
	Asia	5.72	1.08	5.88	0.92	5.64	1.22	6.07	0.88	4.96	1.55	5.81	1.14	6.20	0.84	5.95	0.95	5.68	1.20	4.96	1.72
	Euro	5.53	1.59	6.05	0.83	5.42	1.50	6.19	0.75	4.63	1.87	5.44	1.38	6.27	0.76	5.73	1.46	5.59	1.36	4.66	1.77
	Japan	5.76	1.08	5.63	1.17	5.35	1.21	5.76	1.03	5.14	1.25	5.60	1.17	6.07	1.04	5.70	1.15	5.42	1.19	5.23	1.22
	N.A.	5.77	1.44	5.90	1.10	5.66	1.33	6.10	0.99	4.73	1.88	5.38	1.61	6.20	1.13	5.85	1.26	5.39	1.53	4.80	1.84
Technology	All	5.72	1.51	5.83	1.18	5.47	1.51	5.95	1.07	4.57	2.01	5.58	1.66	5.89	1.20	5.84	1.34	5.24	1.62	4.68	2.02
	Asia	5.81	1.20	5.83	1.05	5.54	1.39	5.88	0.95	4.71	1.73	5.92	1.00	5.99	0.98	5.78	1.13	5.54	1.30	4.68	1.88
	Euro	5.77	1.01	6.08	0.75	5.67	1.11	6.00	0.86	4.95	1.45	5.73	1.33	5.96	0.99	5.92	1.06	5.49	1.18	5.01	1.25
	Japan	5.61	1.24	5.35	1.36	5.09	1.41	5.60	1.15	4.96	1.46	5.77	1.17	5.76	1.11	5.72	1.22	5.19	1.25	5.05	1.32
	N.A.	5.75	1.59	5.88	1.21	5.52	1.51	6.02	1.10	4.48	2.12	5.46	1.85	5.88	1.29	5.90	1.36	5.16	1.75	4.64	2.13
Total Value	All	4.36	1.71	5.69	1.26	5.43	1.47	5.99	1.07	3.97	1.75	4.92	1.59	5.82	1.24	5.49	1.34	5.13	1.39	4.02	1.69
	Asia	4.88	1.44	5.64	1.11	5.46	1.35	6.07	0.93	4.03	1.56	5.09	1.41	5.74	1.29	5.41	1.31	5.51	1.23	4.17	1.57
	Euro	3.90	1.77	5.49	1.53	5.25	1.68	5.96	0.88	3.72	1.79	4.78	1.64	5.68	1.24	5.47	1.41	5.28	1.28	3.76	1.73
	Japan	4.36	1.64	4.86	1.49	5.35	1.38	5.51	1.21	3.89	1.57	4.94	1.37	5.55	1.35	5.24	1.20	4.89	1.24	4.11	1.44
	N.A.	4.30	1.76	5.88	1.14	5.46	1.48	6.05	1.08	4.00	1.82	4.89	1.66	5.90	1.20	5.56	1.35	5.05	1.45	4.00	1.75

B. Large-Scale Survey Study

Table 2 shows the descriptive statistics of the survey results. Flexible Production, Customer Logistics, Mask Technology, Quality & Reliability, Product Prototype and Information Technology are the six services that have the perceived value score higher than 5 points. As stated above, Flexible Production and Mask Technology are directly related to the wafer fabrication, so they can be identified as "core" services because wafer can not be manufactured without using them. Quality & Reliability bring in relatively high value could be simply because it is a fundamental competitive factor in semiconductor market. Due to the cost of mask set increase exponentially, customers value the Product Prototype service more and more since it can largely reduce the risk of design fault. Interestingly, Customer Logistics service receives the second high points while the focus group experts think they are only a collection of necessary daily operational supports. Since the previous literature claims the technical dialogue between design and manufacturing specialties is an unstructured construct that will cause very high transactional cost [7][9], we conjecture that the Customer Logistics service actually play an important role on resolving various collaboration problems that can not be standardized and automated but face to every level of employees in customer company everyday. Similarly, Information Technology service not only can help conquering the technical dialogue problems, but enable the customers to control the production information in a real time manner.

Compared with the other service offerings, Package & Test service and Turnkey Solution service have relatively low value perceived by customers. It might because there are lots of independent assembly and test companies, such as ASE and SPIL, and the IDM and large fabless customers usually have their own assembly and test facilities so that these two services are more attractive to smaller and system product customers. The score of Design Support service is relative low as well. However, it seems that the value perceived by customers is quite different from region to region. For instance, Asia Pacific customers perceive much higher value of Design Support service than the other regions do.

When analyzing the data from different region, in general, Asian and North American customers perceive higher value of service offerings. Actually, most of the fabless companies are located at Asia and North America and that might be the root cause simply because they have longer history to collaborate with the foundry than their Japanese and European counterparts (usually are IDM) have. Specifically, European customers seem not to value the Design Support service by granting score lower than 4 points. Since the European semiconductor firms are

mainly large IDM such as ST, Infineon, NXP, they might intend to treat foundry as a backup capacity rather than a product development partner. Furthermore, it shows that Japanese customers perceive relatively low value on Mask Technology service than other region. Due to Japanese customers are also large IDM and usually have mask fab in house, the foundry's service could be less attractive to them especially when their own offering is much better.

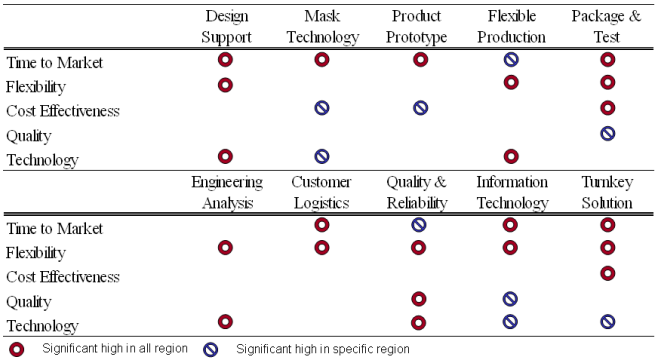

Fig. 1. Service offering vs. value driver

By multiple regression analysis, this study tests the correlation between each service offering perceived value and respective value driver for establishing a relation matrix (see Fig. 1.) It exhibits that almost all service offering value is driven by flexibility value except Mask Technology and Product Prototype. The possible explanation is that the two service offerings are usually "must steps" when produce a new IC product. Time-to-Market is another important value driver that reflects the characteristic of time-based competition for this industry. The other three value drivers are selectively to impact perceived service value and the effect is significant in different regions. This matrix is a very primitive step to study the impact of value driver on service offerings and further details need to be discovered by more research.

IV. CONCLUSION

Semiconductor manufacturing service provider, the foundry, has been playing more and more important role in the industrial value network. However, the service contents and value are not well studied. Based on the service-dominant logic thinking, this study identifies major service offerings by focus group research to outline the ingredients of so-called foundry service and conducts a large-scale survey to explore the value and value drivers perceived by customers. The research results exhibit the perceived value and key value drivers are quite different among service offerings. It also suggests foundry companies tailoring value propositions for different region customers when design the service offering portfolio.

REFERENCES

[1] A. Chatterjee, D. Gudmundsson, R.K. Nurani, S. Seshadri, and J.G. Shanthikumar, "Fabless-foundry partnership: models and analysis of coordination issues," *IEEE Trans. Semiconductor Manufacturing*, vol. 12, no. 1, pp. 42–51, Feb. 1999.

[2] C.M. Chou and J.M. Chen, "Facilitating New Product Development with Collaborative E-Commerce System: An Investigation in Semiconductor Industry," *Journal of Information Management*, vol. 14, no. s, pp. 139–162, Oct. 2007.

[3] J.W. Creswell, *Qualitative Inquiry and Research Design: Changing Among Five Tradition.* CA: SAGE Publications, Inc., 1998.

[4] D.R. Cooper and P.S. Schindler, *Business Research Methods.* NY: McGraw-Hall Companies, Inc., 2003.

[5] M. Ehret, "Managing the trade-off between relationships and value networks. Towards a value-based approach of customer relationship management in business-to-business markets," *Industrial Marketing Management*, vol. 33, no. 6, pp. 465–473, Aug. 2004.

[6] R.A. Krueger and M.A. Casey, *Focus Group: A Practical Guide for Applied Research.* CA: SAGE Publications, Inc., 2000.

[7] K. Monteverde, "Technical dialog as an incentive for vertical integration in the semiconductor industry," *Management Science*, vol. 41, no. 10, pp. 1624–1638, Oct. 1995.

[8] R.F. Lusch, S.L. Vargo, and G. Wessels, "Toward a conceptual foundation for service science: contributions from service-dominant logic," *IBM System Journal*, vol. 47, no. 1, pp. 5–13, 2008.

[9] J.T. Macher, "Technological development and the boundaries of the firm: A knowledge-based examination in semiconductor manufacturing," *Management Science*, vol. 52, no. 6, pp. 826–843, Jun. 2006.

[10] J.T. Macher, D.C. Mowery, and T.S. Simcoe "e-business and disintegration of the semiconductor industry value chain," *Industry and Innovation*, vol. 9, no. 3, pp. 155–81, Dec. 2002.

[11] W.A. Neu and S.W. Brown, "Forming successful business-to-business services in goods-dominant firms," *Journal of Service Research*, vol. 8, no. 1, pp. 3–17, Aug. 2005.

[12] J.N. Sheth and C. Uslay, "Implications of the revised definition of marketing: From exchange to value creation," *Journal of Public Policy & Marketing*, vol. 26, no. 2, pp. 302–307, Fall, 2007.

[13] Q. Tu, M.A. Vonderembse, T.S. Ragu-Nathan and B. Ragu-Nathan, "Measuring modularity-based manufacturing practices and their impact on mass customization capability: A customer-driven perspective," *Decision Sciences*, vol. 35, no. 2, pp. 147–168, Spring. 2004.

[14] S.L. Vargo and R.F. Lusch, "Evolving to a new dominant logic for marketing," *Journal of Marketing*, vol. 68, no. 1, pp. 1–17, Jan. 2004.

[15] S.L. Vargo and R.F. Lusch, "Service-dominant logic: Continuing the evolution," *Journal of the Academy of Marketing Science*, vol. 36, no. 1, pp. 1–10, Mar. 2008.

[16] X. Zhang, G. Wang, J. ShangGuan, and Y. Xiao "Value co-creation with customers and its impact on capability," *Proceedings of IEEE IEEM 2007*, pp. 2087–2091, Singapore, December 8-11, 2007.