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Digitalization and New Product Development in Manufacturing SMEs:

A Comparative Study of Germany and Japan*

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Abstract

This report presented descriptive results of a novel survey on IT practices in the context of new product development (NPD) in German and Japanese manufacturing SMEs. Based on dedicated questionnaire-based surveys in both countries, the report demonstrated that there are a number of commonalities between German and Japanese SMEs. It is found that German firms are more advanced in use of digital applications, while Japanese firms are more likely to be involved in collaboration for NPD. However, this difference disappears when the business environment faced by both samples is controlled. In terms of business performance impacts of digitalization and NPD process, a complementarity between them regarding specific business partners (supplier or customer firms) is found in Japan, while digital applications with multiple users is positively correlated with business performance in Germany.

Keywords : Digital Transformation, SMEs, Open Innovation

JEL Classification: L25, O36

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1. Introduction

Digitalization has a transformative impact on innovation in firms and markets. New business models based on digital technologies are disrupting traditional industries. An ubiquitous IT infrastructure enables sharing goods and services such as Uber and Airbnb. Big data analytics and artificial intelligence (AI) technologies are used for condition-based maintenance (CBM), by which industrial machinery producers can provide new value to their customers. The advancement of automated driving technology may change the landscape of mobility-related goods and services completely. Digitally connected sensor technologies allow a firm to understand its customer's needs precisely, and to deliver value added services timely via digital infrastructures. Accordingly, a manufacturer is required to adopt solution-oriented business models in the evolving 'science economy', instead of sticking to product-oriented ones in the industrial economy (Motohashi, 2014).

Servitization, referring to the phenomenon of increasing value added by services provision related to the product, was pointed out even before internet was started (Vandermerwe and Rada, 1988). However, recent IT technologies enable efficient implementation of product related services (Rymaszewska et al., 2017). Cusumano et al. (2015) discuss on the relationship between servitization and competitive strategy of product firms. Product related services are categorized into three (1) smoothing (such as technical service), (2) adapting (such as customization service) and (3) substituting (such as cloud service of storage and computer power). The first two are complement to the product and its emergence is basically beneficial to the producer. In contrast, the new entry of service provider of the last category could disrupt existing product providers. In general, an advancement of internet platform and new IT applications such as AI and IoT, opens new opportunities of such product related services, both by existing producers and new entry of service providers.

Therefore, two opposite forces, tightening business relationship with supplier and customers, and disrupting such existing relationship for new business opportunities, are intermingled in the process of digitalization. It is found that interdependency in supply chain becomes stronger in a digital era (Vendrell-Herrero et al., 2017). Co-innovation between supplier and its customer has been investigated for a long time, particularly in the case of automotive industry (Dyer, 1996; Sako, 1991). However, collaboration in innovation with business partner (such as supplier and customer) is not one-to-one relationship, but a firm seeks for multiple partners in IoT era. For example, GE offers IoT platform, called PREDIX, which facilitate ecosystem of its business customers to develop their new business solutions using GE's products such as jet engine, energy plant and heath care equipment. Therefore, creating eco-system or platform to attract

business players providing complementary goods and services is also important business strategy actions (Adner, 2013; Gawer and Cusumano, 2013). In addition, a firm has to be aware new industry boundary where digitalization allows disruptive innovators entry in the market (Porter and Heppelmann, 2014). In this sense, innovation ecosystem in those industries spans widely to some areas which are totally separated in era of traditional manufacturing mode.

This paper presents the results of a comparative study of manufacturing SMEs from Germany and Japan, based on the questionnaire survey on the changing nature of manufacturing processes and new product development. The two countries show a similar industrial structure, with a relatively high share of manufacturing industry compared to other OECD countries. In both countries, SMEs play an important role for the competitiveness of the manufacturing sector in the global market. However, German firms tend to face stronger international competition as they face neighboring countries with a similar institutional setting, while markets in Japan are more bounded resulting from the geographical situation as an island. The higher costs of approaching foreign markets for Japanese firms may also contribute to stronger and more specific relations to business partners (such as customers). Therefore, it is useful to compare firms in the two countries in terms of the degree of digitalization of new product development processes, and to investigate the factors behind likely differences.

The organization of this paper is as follows. The next section presents the questionnaire-based survey that was conducted in both countries and the sample characteristics of our dataset. Then, the survey results are compared across the two countries, followed by descriptive regression results, to see the factors behind the diffusion of IT practices as well as its impact on firm performance. Finally, the paper concludes with a summary of findings as well as future venues of studies based on our dataset.

2. Survey and sample distribution

A comparable questionnaire survey is designed focusing on small and medium sized manufacturers (as well as product related service providers such as software and technology service firms) to obtain a picture of digital driven servitization and ecosystem activities in Germany and Japan. A targeted firm is often a supplier to a large firm and is required to know better its corporate customer. In addition, some of them are eager to find new customers either in their current business or new business, in a digital transformation of industry. Therefore, we may be able to detect emerging pattern of IT use and ecosystem activities in their new product development process.

A survey of German manufacturing SMEs that was carried out as part of the official German

Innovation Survey. The German Innovation Survey is conducted by the Centre for European Economic Research (ZEW), Mannheim, and is the German contribution to the Community Innovation Survey (CIS) of the European Commission and designed as an annual panel survey (so-called Mannheim Innovation Panel, MIP). The data used in this paper relate to the survey wave conducted in the year 2018 and refers to the reference year 2017. The sample of the SME survey includes all manufacturing firms with 10 to 499 employees that participated in the MIP 2018 survey and that reported to have introduced product innovation during 2015 and 2017, or to have ongoing product innovation projects at the end of 2017. The data was collected through a computer-assisted telephone interview (CATI) which started in November 2018 and was finished in early January 2019. The response rate of CATI survey was 68% (749 SMEs participated out of 1,102 firms). The data of the CATI survey was linked to the data that has been collected in the German Innovation Survey in order to complement the data set with information on cooperation, collaboration with universities, financial data and some general characteristics of the firm (Rammer, 2019).

In Japan, a paper-based questionnaire survey of SMEs was conducted, by RIETI, called “Survey on Changing Nature of Manufacturing Process and New Product Development”. The sample was drawn from the firms listed in J-Good Tech and New Value Chain NAVI, both of which are websites for matching SMEs with potential (corporate) customers. The websites are organized by SMRJ (Organization of Small and Medium Sized Enterprises and Regional Innovation, Japan), a non-profit organization affiliated with METI (Ministry of Economy, Trade and Industry), and it is based on voluntary registration by a firm who wants to present its technology and/or products to potential customers via the website. The survey started on October 1, 2018, and was finished on November 15, 2018. The response rate was 32.6% (1,629 effective responses out of 5,000 randomly sampled firms). Basic firm information such as industrial classification, employment size and revenue has been added from the DB Cosmos data (Motohashi, 2019).

In order to conduct a comparative study of German and Japanese SMEs, we use only the data of firms that reported product innovations. For the German data, this implied to exclude 52 firms from the sample. For the Japanese date, a much larger number of firms had to be excluded since the survey in Japan targeted all types of SMEs. A substantial number of the surveyed SMEs in Japan did not report product innovation according to the definition of OECD Oslo Manual. In addition, we focus on manufacturing firms, so that non-manufacturing firms (software and technical services) are excluded from this comparative study. Finally, the sample size reduces to 697 for Germany and 512 for Japan.

Table 1 and Table 2 show the composition of the surveyed SMEs by employment size and industry,

respectively. The Japanese sample consists of a higher share of smaller than the German sample. For example, there is a large numbers of very small firms with no more than 10 employees in Japan, while there are few such observations in Germany since the German sample is restricted to firms with at least 10 employees. The largest firm in the Japanese sample has 300 employees, based on the definition of SME in Japan, while the German sample includes a large share of medium-sized firms with more than 100 and up to 499 employees.

Table 1. Employment size distribution

	Germany	Japan
-10	20	157
11-50	331	266
51-100	131	73
101-	215	42

Table 2. Industry distribution

	Germany		Japan	
FOOD, BEVERAGES, TOBACCO	36	5.2%	11	2.1%
TEXTILE MILL PRODUCTS	28	4.0%	16	3.1%
PRINTING AND ALLIED INDUSTRIES	63	9.0%	25	4.9%
CHEMICAL, PETROLEUM AND COAL PRODUCTS	61	8.8%	51	10.0%
IRON AND STEEL, METAL PRODUCTS	110	15.8%	120	23.4%
GENERAL-PURPOSE, PRODUCTION MACHINERY	137	19.7%	87	17.0%
ELECTRONIC PARTS, DEVICES	65	9.3%	26	5.1%
ELECTRICAL MACHINERY, ICT EQUIPMENT	78	11.2%	83	16.2%
TRASPORTATION EQUIPMENT	27	3.9%	20	3.9%
MISCELLANEOUS MANUFACTURING INDUSTRIES	92	13.2%	73	14.3%
TOTAL	697	100.0%	512	100.0%

The industry distribution is pretty much the same in the two countries. “Iron, steel and metal products”, “General machinery” and “Electrical machinery” are the three major industry classes in both countries.

Most firms are in the B2B business (Figure 1). It should be noted that the definition of the category is a bit different between the two countries. In Japan, B2B and B2C businesses are asked separately, while in the German questionnaire, a three category choice ('mainly B2B', 'mainly B2C', 'B2B and B2C about equally important') was used. Therefore, the share of firms with both B2C and B2B is higher in Japan, but more than 90% of firms have a corporate customer, instead of individuals.

Figure 1: Business type

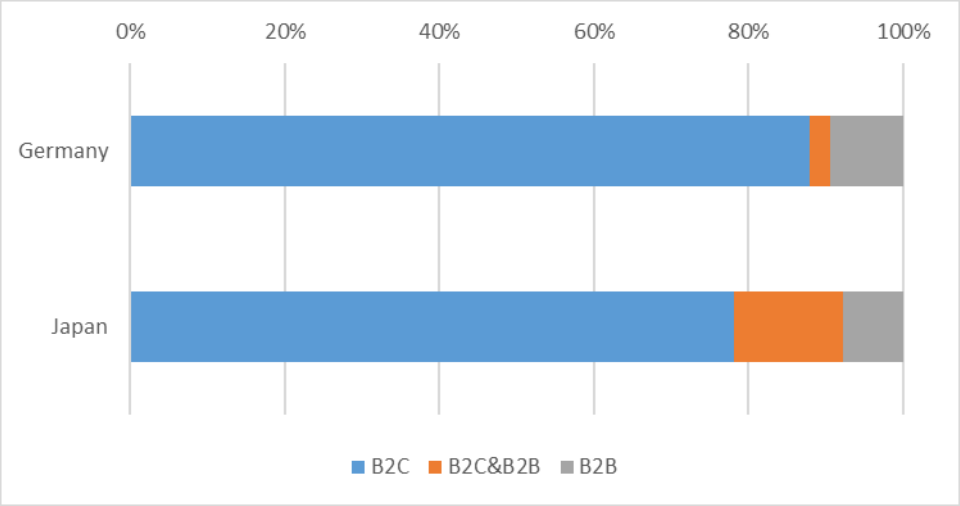


Figure 2 and Figure 3 show how many different customers and competitors an SME typically has. In general, manufacturing SMEs in both country have small number of (corporate) customers, as well as competitors, implying they are doing business in niche markets. It is also found that Japanese SMEs have a smaller number of customers and competitors. This can be caused by a size effect (smaller firms in Japan). Another factor can be that German SMEs serve the entire EU market, while Japanese SMEs do business mainly in their home market (Japanese firm as customer). As the EU market is bigger than the Japanese market, there are more potential customers and competitors for German SMEs.

Figure 2: Numbers of customers

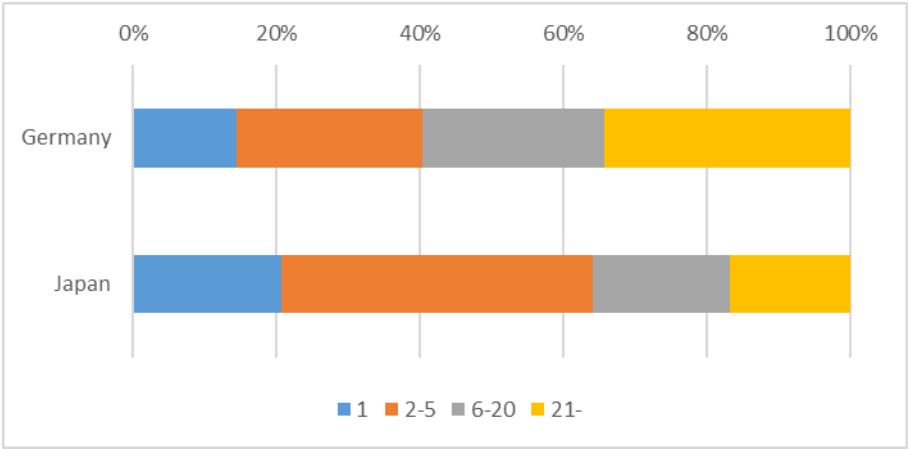
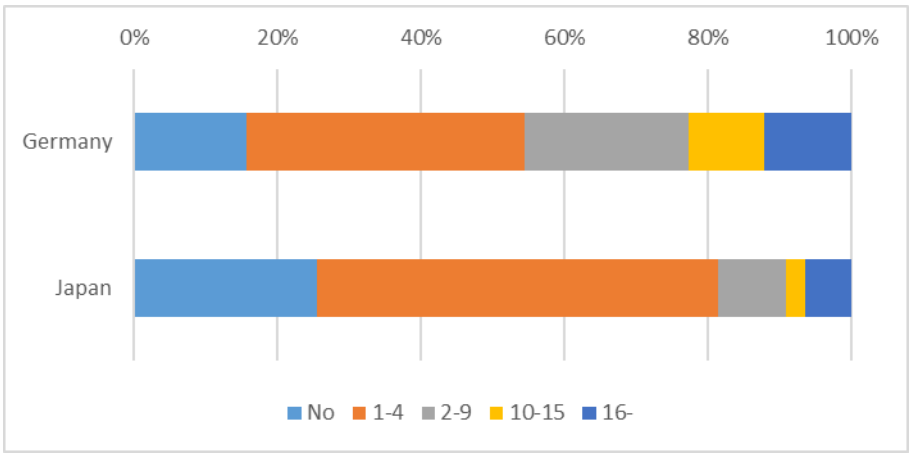


Figure 3: Numbers of competitors



3. Comparative statistics

In this section, we provide comparative statistics for German and Japanese SMEs as regards to the firms' business environment, the introduction of IT practices, their innovation strategy (including the role of open innovation) and digital interactions with customer. In all graphs, an item with asterisk (*) indicates the difference between Germany and Japan is significant at the 1% level, after controlling for size (log of employment) and industry (dummy variables corresponding to the classification of Table 2).

In terms of the business environment, new waves of IT applications such as big data analysis and IoT is perceived as an important factor for their business, particularly in Germany (Figure 4). Other relevant characteristics of the business environment for German SMEs are “additional service to the product” and “increasing share of international customers”. The latter represents the increasing opportunities for German SMEs to reach out to customers beyond the domestic markets thanks to the harmonization and economic integration within the EU. In contrast, Japanese SMEs respond more to “cooperation with other firms for NPD” and “shorter time to develop new product” as well as “additional service to the product”. Therefore, one of key differences across two countries is that German SMEs seek for a broader customer base including international markets, while Japanese ones try to address existing customer requirements by shorting NPD cycles and by closer linkages to their business partners.

Figure 4: Business environment

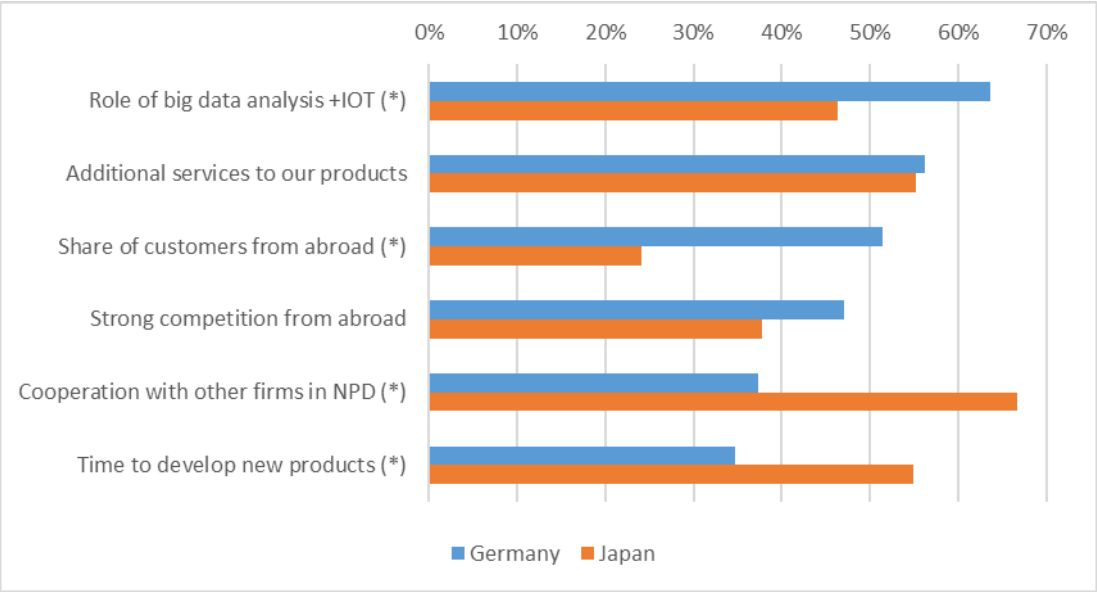


Figure 5 looks at collaboration for innovation. It is confirmed that more cooperation with business partners (customer and supplier firms) is found for Japanese SMEs. But it should be noted that there is some difference in the definition of collaboration across the two countries. In the German questionnaire, the term ' cooperation' was used, which usually refers to a written agreement to jointly develop a new product. In case a customer orders the firm to develop a new product, or commissions a NPD contract, this would not be seen as a cooperation. However, such relationships are not excluded in the Japanese data. A substantial interaction between a supplier and a customer is found in the automotive industry for NPD, and many studies show that such close relationships contribute to overall industrial competitiveness of the Japanese auto industry (Dyer, 1996; Sako, 1991).

Other than customer and supplier collaboration, there are not big differences across countries, except for collaborations with PRIs, which is higher in Japan.

Figure 5. Collaboration for innovation

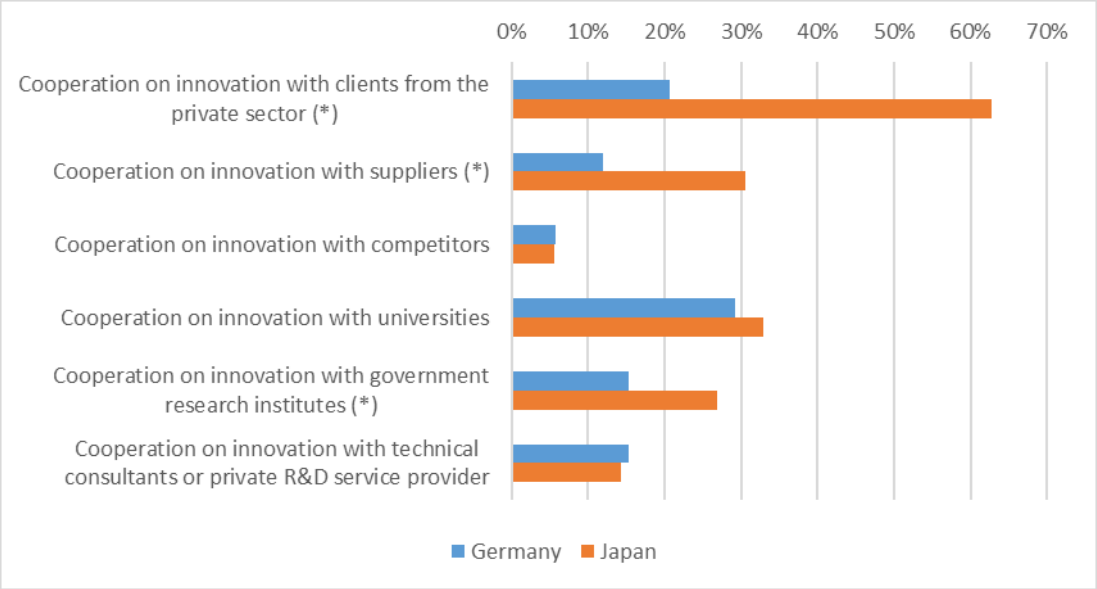


Figure 6 shows the share of firms which have introduced various IT practices, spanning from traditional IT such as data collaboration with business partners to new IT such as AI and social network. It is found that German firms introduce various IT tools more likely than Japanese firms. More than 70% of German firms with data collaboration with customers and suppliers, while less than 50% of Japanese firms do so. But this result may also be affected by differences in definitions. In the German survey, data collaboration refers to the exchange of data with customers and suppliers by digital tools, such as SAP software packages. In contrast, in the Japanese survey, a respondent takes the definition of collaboration in a more rigid way, such as data exchange for new product service delivery. Another difference in the concept is digital platform. In Germany, it refers to some digital market place for product trade, while participation of IoT consortium is asked in Japan.

However, the interpretation of German SMEs' advancement in various IT practices does not change after taking into account for likely definitional biases. For all items except cloud computing, German firms are more likely to adopt the respective IT practice, revealed by differences at 1% statistically significance level.

Figure 6. Introduction of IT practices

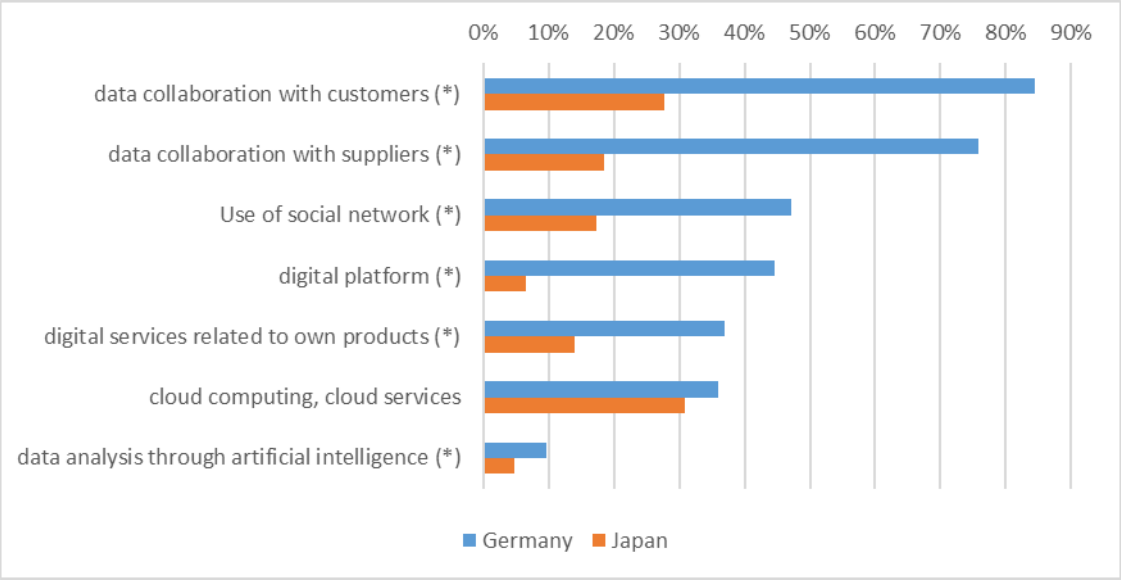
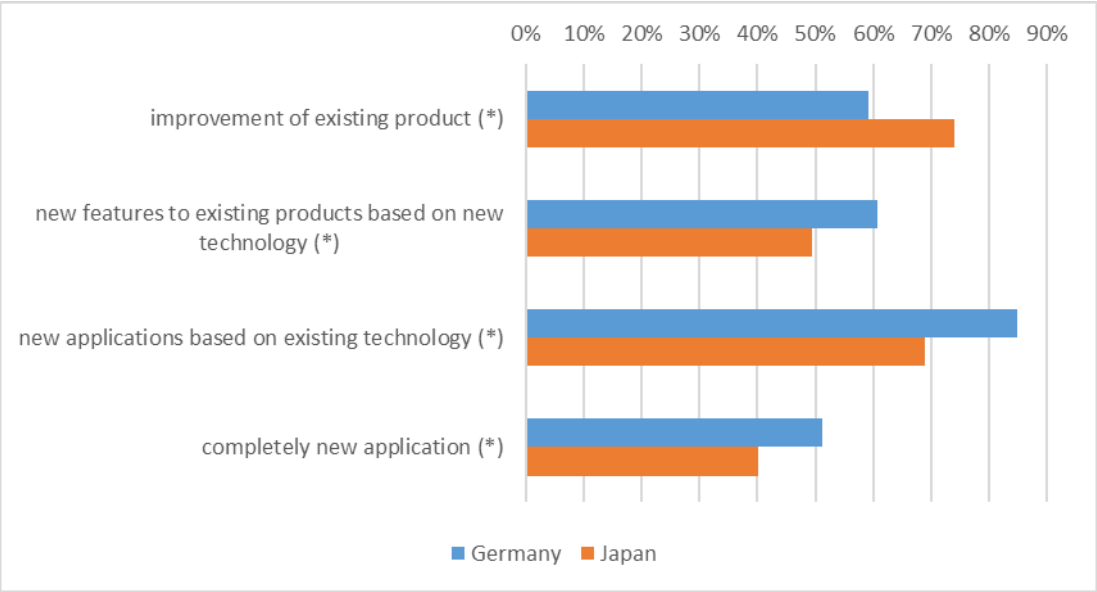


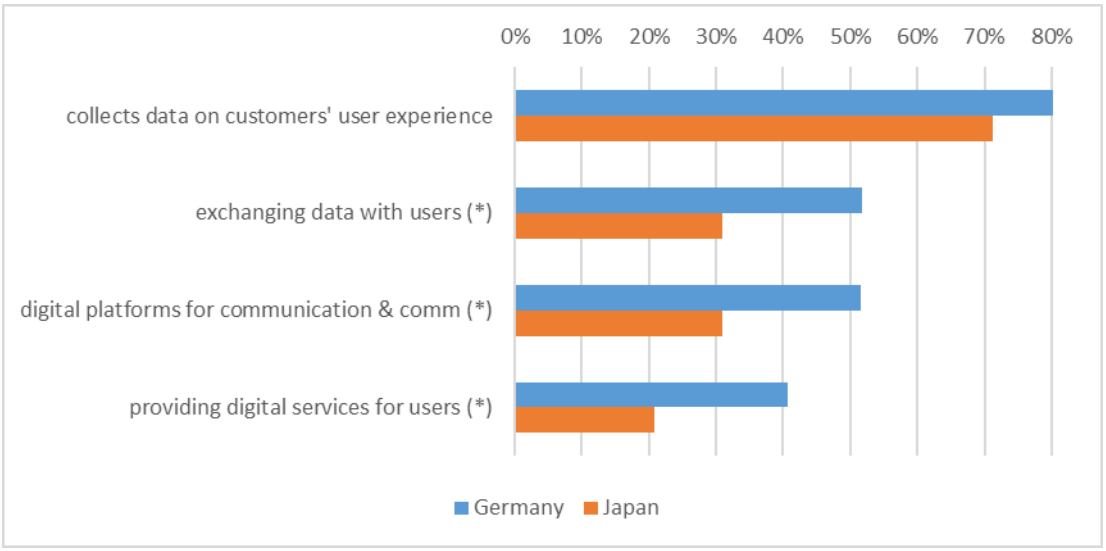
Figure 7 shows the type of new product and its link to new technology. Four combinations are distinguished that refer to the concept of exploration (new) vs. exploitation (existing) in terms of market and technology (Daneels, 2002). In the Japanese sample, the largest category is improvement of existing products (exploitation in both market and technology), while new applications based on existing technology (exploitation of technology combined with market exploration) is the largest for the German sample. The differences in the likelihood across countries are all statistically significant at the 1% level.

Figure 7. Type of new product



Finally, the state of digitalization of customer relationship is compared (Figure 8). Most SMEs are collecting data on customer experience with their products (80% for German, 70% for Japanese). For other types of digital practice, German SMEs are more advanced, such as digital service provision and the use of digital platforms.

Figure 8. Digitalization of customer relationship



4. Digitalization and firm performance

In this section, descriptive regression results for digitalization and firm performance are presented. First, Table 3 shows the results of the determinants of IT practices. Explanatory variables include

firms' perception of various business environment items, the competitive environment of firms, and a Japan dummy as well as interaction terms of business and competitive environment and the Japan dummy. In addition, we control for industry and size. Estimations are performed by Probit models. In this table, only statistically significant coefficients are indicated as ++ for positive at 1% level, + for positive at 5% level, - for negative at 5% level, and -- for negative at 1% level.

(Table 3)

We have already seen that German firms are more likely to introduce various IT tools as compared to Japanese ones (Figure 6). However, the regression results in Table 3 show that these differences originate from business environment factors. In general, statistical significances across countries of IT diffusion and open innovation practices disappear after controlling for the business environment and firm characteristics. The dummy variable for Japan is negative at the 5% level only for IoT consortium and social networks, but not statistically significant for all other IT practices. In addition, for most of the interaction terms of business environment and the Japan dummy, no statistically significant coefficients are found. Therefore one can conclude that the relationship between business environment factors and IT practices is common for both countries.

Among the seven types of IT practices, there are two different kinds of applications, i.e., IT used for existing business partners (digital services delivery, customer data and supplier data) and IT for broader business development (digital platform and social networks). Even though there are some differences in the concept of “customer/supplier linkage” and “digital platform” between both countries’ surveys (refer to P.9), the common concept across counties is that the former one is IT for bilateral relationship, while the latter one is for interacting multilateral partners. It is found that firms that perceive a stronger requirement for cooperation with other firms, are more likely to introduce the former type of IT applications, while firms that report that their business environment is characterized by an increasing role of big data and IoT are more likely to use the latter type of IT applications. Furthermore, Japanese SMEs lag behind German ones for the latter one (IoT consortia/platforms and social networks), though one should not overrate this result as the underlying definitions and perceptions of these IT practices differ between the two countries.

Table 4 shows the regression results for using digital tools in NPD processes with the same explanatory variables as used in Table 3. Here, there are some differences across countries, in terms of the correlation with business environment factors. Regarding data exchange with users for NPD, “additional service to the product” is positively related in German SMEs, while it is not the case of Japanese SMEs. In addition, this activity is found more for customized product in German firms, while the same relationship is not found in Japan. As for using digital platforms for NPD, we find consistent results across countries with respect to “strong competition from

abroad” and “role of big data and IoT” which are both positively correlated. As for digital service delivery, “additional service to the product” and “role of big data and IoT” are positively related in German firms, while “cooperation with other firms in NPD” is negatively related in Japanese ones. Finally, we find that Japanese firms are more actively engaged in the activity of collecting user experience data.

(Table 4)

Finally, regression results on the determinants of product innovation performance are presented (Table 5). Product innovation performance is measured by the extent to which a firm's expectations on the performance of the firm's most important product innovation have been met. Expectations refer to the volume of sales, the return on sales, the acquisition of new customers, and the technological performance of the new product. Order logit models of four types of business performances by using the following explanatory variables are estimated in Germany and Japan, separately.

- Collaboration for NPD with customer or supplier (business partner)
- Use of digital platform (digitalization with multilateral partners)[1]
- Digital linkage with customer or supplier (business partner) (digitalization with specific partner)
- Interaction term of collaboration with business partner for NPD and digitalization with specific partner
- Use of digital data from customer for NPD
- Exchange of data with customer for NPD
- Use of digital platform for NPD
- Digital service delivery with new product
- Regular update of customer experience with product
- Log of employment size and industry dummy variables

(Table 5)

There are some differences across two countries. First, complemental relationship between open innovation and digital linkage with business partner is found in Japan, but not in Germany. These firms with both types are more likely to perform better in terms of sales, profit and finding new

[1] Use of digital market place for German survey and participation in IoT consortium for Japanese survey

customer for Japanese firms. Second, positive and statistically significant coefficients are found for use of digital market place in Germany, in terms of all four measures. Third, use of digital platform in NPD is positively associated with firm performance, particularly for Japanese firms. Finally, a firm collecting user experience data is likely to perform better in both Germany and Japan.

5. Conclusion

This report presented descriptive results of a novel survey on IT practices in the context of new product development (NPD) in German and Japanese manufacturing SMEs. Based on dedicated questionnaire-based surveys in both countries, the report demonstrated that there are a number of communalities between German and Japanese SMEs. First, the business environment is a main driver for the use of IT practices in both countries. This is particularly true for the opportunities that new technologies provide ('technology push' from new forms of big data analysis or IoT approaches), and for customer requirements (as revealed by a need for more cooperation with customers and a need to upgrade products by additional services). Japanese SMEs perceive a stronger push to shorten product development times, which contributes to stronger data collaboration with suppliers. It seems that such a backward integration helps to make NPD processes more efficient, particularly is some development steps are performed in close cooperation with suppliers. German SMEs that follow a customization strategy are more likely to use cloud services than their Japanese counterparts. This result can be linked to a more pronounced specialization strategy of these SMEs. While focusing on close customer interaction, they rely on IT service providers to run their IT facilities, hence saving resources for their core business.

We find some more differences between German and Japanese SMEs when it comes to the use of digital tools in the NPD process. German SMEs that operate under a business environment that strongly requires add-on services to the firms' main products are more likely to exchange product data with users through digital channels than Japanese SMEs do. It seems that German SMEs are further in leveraging the opportunities of digital data models (e.g. predictive maintenance) to provide additional services to their customers. On the other hand, Japanese SMEs are more frequently collecting user data if they feel a pressure to speed up their NPD process. In Germany, user data collection may be complicated by rather rigid data protection law. Again, we find a positive impact of customization strategy on the use of digital tools in Germany, with a higher propensity of German SMEs to use exchange product data with users and to collect data from users. In the latter case, the close ties between SMEs and their customers in case of a customization strategy seems to overcome barriers from data protection regulation.

For the perceived performance of the SME's most important product innovation, it is found that

IT use for multilateral partners (digital market place) has positive impact in Germany, while IT use for bilateral partner (supplier or customer firm) shows business performance impact in Japan. In addition, a complementarity between digitalization of supplier/customer relationship and collaboration on NPD with such business partner is found in Japan. Therefore, Japanese SMEs use more digital applications for collaboration with existing business partner, as compared to German ones.

However, it should be noted that use of digital platform is positively correlated with business performance not only in Germany but also in Japan. Furthermore, collecting user experience data with its product is beneficial to both German and Japanese firms. Therefore, neither intensifying business relationship with specific business partner or broadening up business opportunity with new business partners is a golden rule in digital and open innovation era. Our results may reflect a complicated nature of the organization of business relationship in a transition process by opening up new digital applications enabled by AI, big data and IoT.

While the study provides fresh insight into the role of IT practices in innovating SMEs in a cross-country comparison, there some caveats have to be made, particularly with respect to the comparability of survey results. Although the questionnaires used in the two countries had been highly harmonized, there remain differences in definitions, translation, and the understanding of key terms by respondents. For that reason, not all country differences that we found can be attributed to differences in firm behavior or in the institutional, infrastructural or legal environment. A panel study would be one way to largely eliminate these restrictions and to learn more on the role of digitalization for the innovation performance of SMEs in Germany and Japan.

Table 3: Determinants of the use of digitalization

	Digital service	Digital platform	Social Net	Customer data	Supplier data	Cloud	AI
(Business Ennvironment)							
Strong competition from abroad					+		
Share of customers from abroad							
Additional services to our products	++						
Time to develop new products							
Cooperation with other firms in NPD	+				+	+	
Role of multi-purpose technologies in NPD							
Role of big data analysis +IOT		++	+			++	
(Type of business)							
Number of customers							
Number of competitors							
Dummy for customized product						+	
Japan Dummy		-	-				
(Interaction with Japan dummy)							
Strong competition from abroad							
Share of customers from abroad							
Additional services to our products							
Time to develop new products					+		
Cooperation with other firms in NPD							
Role of multi-purpose technologies in NPD							
Role of big data analysis +IOT							
Number of customers							
Number of competitors							
Dummy for customized product						-	
Log (employment)							
Japan * Log (employment)			--				

Table 4: Determinants of using digital tools for NPD

		Exchange data with user for NPD	Use digital Platform for NPD	Digital service delivery	Collect user ex data
(Business Ennvironment)					
	Strong competition from abroad		+		
	Share of customers from abroad				
	Additional services to our products	++		+	+
	Time to develop new products				
	Cooperation with other firms in NPD				
	Role of multi-purpose technologies in NPD				+
	Role of big data analysis +IOT		++	+	
(Type of business)					
	Number of customers		++	+	
	Number of competitors				
	Dummy for customized product	++			
Japan Dummy					+
(Interaction with Japan dummy)					
	Strong competition from abroad				
	Share of customers from abroad				
	Additional services to our products	--			
	Time to develop new products				+
	Cooperation with other firms in NPD			-	
	Role of multi-purpose technologies in NPD				
	Role of big data analysis +IOT				
	Number of customers	+		-	
	Number of competitors				
	Dummy for customized product	-			-
Log (employment)		--			
Japan * Log (employment)		+			

Table 5: Determinants of product innovation performance

	Germany				Japan			
	Sales	Profit	New customer	Tech improve	Sales	Profit	New customer	Tech improve
Cooperation with business partner (coop)	-0.215	-0.539	-0.365	0.120	-0.424	-1.087	-0.503	-0.268
	(0.25)	(0.63)	(0.47)	(0.12)	(0.82)	(2.08)*	(0.96)	(0.51)
Use of digital platform (multilateral)	0.809	0.698	0.488	0.749	0.394	0.337	0.755	-0.200
	(2.97)**	(2.66)**	(2.00)*	(2.48)*	(0.77)	(0.64)	(1.32)	(0.37)
Data linkage with business partner (bilateral)	0.142	-0.152	0.302	-0.571	-0.924	-1.304	-1.057	-0.816
	(0.32)	(0.34)	(0.73)	(1.15)	(1.30)	(1.82)+	(1.45)	(1.13)
Coop*bilateral	0.177	0.639	0.387	-0.048	1.424	1.599	1.543	0.568
	(0.20)	(0.72)	(0.47)	(0.05)	(1.76)+	(1.97)*	(1.89)+	(0.70)
Use of digital data from customer	0.798	0.628	0.257	0.114	0.378	0.435	0.050	0.039
	(2.79)**	(2.25)*	(0.99)	(0.36)	(0.94)	(1.09)	(0.13)	(0.10)
Exchange data with user for NPD	-0.059	-0.318	-0.022	0.209	0.819	0.612	0.155	0.225
	(0.21)	(1.17)	(0.08)	(0.66)	(2.11)*	(1.60)	(0.39)	(0.59)
Use digital Platform for NPD	-0.751	-0.346	-0.349	-0.335	0.786	0.967	1.352	1.056
	(2.75)**	(1.33)	(1.42)	(1.12)	(2.07)*	(2.52)*	(3.37)**	(2.74)**
Digital service delivery	-0.173	0.182	0.355	0.212	0.546	0.250	-0.219	0.099
	(0.58)	(0.63)	(1.30)	(0.63)	(1.37)	(0.62)	(0.53)	(0.24)
Collect user experience data	0.061	0.360	0.557	0.839	0.587	0.759	0.909	0.835
	(0.20)	(1.23)	(1.94)+	(2.72)**	(1.53)	(1.98)*	(2.40)*	(2.16)*
Log (employment)	-0.032	-0.069	-0.096	0.159	-0.105	-0.198	-0.169	-0.214
	(0.27)	(0.60)	(0.88)	(1.19)	(0.72)	(1.37)	(1.14)	(1.46)
1st Cut	-3.179	-2.318	-1.202	0.351	0.023	-0.633	-1.113	-1.459
	(4.34)**	(3.40)**	(1.88)+	(0.50)	(0.03)	(0.83)	(1.49)	(1.91)+
2nd Cut	-0.061	-0.228	0.999	1.036	2.867	2.317	1.471	1.684
	(0.09)	(0.34)	(1.57)	(1.46)	(3.51)**	(2.96)**	(1.96)*	(2.20)*
Industry Dummy	YES	YES	YES	YES	YES	YES	YES	YES
# of observations	312	312	312	312	167	166	167	168

References

Adner, R. (2013), *The Wide Lens: What Successful Innovators See That Others Miss*, PORTFOLIO/PENGUIN Publisher, New York

Atzori, L., Iera, A. and G. Morabito (2010), The Internet of Things: A Survey, *Computer Networks*, 54(15), 2787-2805

Cusumano, M., Kahl, S. and F. Suarez (2015), Services, industry evolution and the competitive strategies of product firms, *Strategic Management Journal*, 36(4), 559-575

Dyer, J. H. (1996), Specialized supplier networks as a source of competitive advantage: evidence from the auto industry, *Strategic Management Journal* 17(4), 271-291

Gawer, A. and M. Cusumano (2013), Industry Platforms and Ecosystem Innovation, *Journal of Product Innovation Management*, 31(3), 417-433

Iansiti, M. and R. Levien (2004), *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability*, Harvard Business School Press, Boston, MA

Motohashi, K. (2019), Digitalization of manufacturing process and open innovation: Survey results of small and medium sized firms in Japan, *RIETI Policy Discussion Paper Series*, 19-P-005

Motohashi, K. (2014), *Revitalization of Japanese Industrial Competitiveness*, Nikkei Publishing Ltd. Tokyo Japan (in Japanese)

Porter, M. and J. E. Heppelmann (2014), How smart, connected products are transforming competition, *Harvard Business Review*, 92(11), 64-88

Rammer, C. (2019), Digitalization, servitization and open innovation in SMEs: Survey results from Germany

Rymaszewska, A., Helo, P. and A. Gunasekaran (2017), IoT powered servitization of manufacturing – an exploratory case study, *International Journal of Production Economics*, 192, 92-105

Sako, M. (1991), The role of “trust” in Japanese buyer-supplier relationships, *Ricerche Economiche*, XLV: 449-474

Vandermerwe, S. and J. Rada (1988), Servitization of business: adding value by adding services, *European Management Journal*, 6(4), 314-324

Vendrell-Herrero, F., Bustinza O., Parry, G. and N. Georgantzis (2017), Servitazation, digitalization and supply chain interdependency, *International Marketing Management*, 60, 69-81