ARE PRODUCT INNOVATION-ORIENTED FIRMS PREPARED FOR EFFECTIVE PRODUCT CUSTOMIZATION?

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Abstract: *Growing demand for customized solution offers instead of standardized products is reality in many business sectors on both B2B and B2C markets. While this approach is well developed in some B2B sectors it is not that often in majority of B2C markets. Rapid technology development within past years gives more possibilities to increase production flexibility in wider range of production sectors. This will lead in increasing level of product customization shortly.*

Purpose of this article is to summarize the research on how the product innovation oriented companies are prepared in terms of their internal infrastructure for effective customized product solution development and delivery to their customers. Two interlinked researches were performed through Czech, Austrian, German and Swiss product innovation oriented manufacturing companies. Quantitative research compares whether and how customized product offer is communicated by companies to their market. Qualitative research was performed in form of five case studies to deeper observe and study internal technical and production infrastructure of the selected companies. Results of performed quantitative research were statistically evaluated and tested. Outcomes of qualitative research gives deeper knowledge of the infrastructure used in selected companies for development and production of customized products. The research proves increasing focus of the companies on offer individualization.

Keywords: *Customer Solutions, Relationship Marketing, Product Customization, Market Orientation, Product Management, Machine Building Sector, Solution Management.*

JEL Classification: *M11, M31.*

Introduction

For many decades competitive advantage was primarily based on technological aspects connected with a company's ability to develop and manufacture products. Thus items like capital, raw materials, production capacity and capability or human resources were scarce (Kellen, 2003). The situation has changed dramatically within the past few decades with the international business environment's globalization. Increased competitiveness in this environment has led to increased focus on customer requirements (Franceschini et al., 2015) and relationship processes (Tuli et al., 2007). Thus superior knowledge of customers and their needs is the new scarcity (Kellen, 2003) and the capability to offer solutions (Biggemann et al. 2013). Efforts towards customer requirement knowledge led to the rapid development of relationship marketing and customer relationship management, known as CRM (Payne & Frow, 2005). CRM is a great help to companies trying to increase their business competitiveness. On the other hand, CRM concentrates primarily on aspects outside the company, namely towards customers, and a stronger internal focus on solution development processes is also crucial (Bennett et al., 2001).

1 Statement of a problem

1.1 Conceptual background

In order to develop complex approach methodology to customized product development and management, the Customer Solutions Management concept was introduced in Chlebovský (2016). The Customer Solutions Management (CSM) concept encompasses a strong focus on customer requirements through solution development and its delivery and implementation to a further focus on success measurement, control and requirement revisions for the next complete cycle.

CSM is based on Customer and Market Orientation concepts developed in the past and also uses principles of Total Quality Management (TQM), Project Management and Knowledge Management as supporting tools. Especially in manufacturing companies, an efficient CSM concept cannot exist without strong ICT tools supporting business processes in information systems such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Business Process Management (BPM), Product Lifetime Management (PLM), Manufacturing Execution System (MES) and Advanced Planning and Scheduling (APS).

1.1.1 Customer Orientation and Market Orientation

A strong orientation towards customers was being discussed as early as in Strong (1925). A more detailed definition of customer orientation was then described in Saxe & Weitz (1982). They define customer-oriented selling as the practical application of marketing concepts to the individual personal interaction between salesperson and customer. They also introduced the SOCO Scale (Sales Orientation – Customer Orientation Scale) for measurement of customer orientation. The sales approach of customer orientation is typically sorted into relationship selling and adaptive selling (Wilson, 1995). Focusing on customer expectations has been seen as a very important part of customer orientation (Weitz, 1981).

The market orientation business approach was first introduced in Drucker (2012), where a marketing-oriented approach was introduced as an alternative to the product oriented concept. A more systematic concept of market orientation was presented in Webster (1988) and later also in Kohli & Jaworski(1990), Jaworski & Kohli (1996), Narver & Slater (1990) and Ruekert (1992). All these sources present the influence and relation of a company's market orientation to its business performance. They also define the basic principles of market orientation in customer focus, competition focus, stakeholder focus and focus on company flexibility. Two models for market orientation measurement were developed – MKTOR by Narver & Slater (1990) and MARKOR by Kohli, Jaworski & Kumar (1993). Both models' primary focus is on customers. While MKTOR is primarily based on measurement and feedback, MARKOR emphasizes proactivity of personnel throughout the company structure.

Even though there are noted contradictions between customer and market orientation based on internal conflicts between sales and marketing departments in the company (Kotler, Rackham & Krishnaswamy, 2006), there are also joint approaches of both concepts (Shapiro, 1988).

1.1.2 Customer Need Identification & Prioritization and Solution Development

An important basis for customer solution focus is customer needs identification and prioritization. Identification and consequent prioritization of customer requirements is part of various customer satisfaction models. Kano et al. (1984) deals with must-be, one-dimensional and attractive requirements of products. A more complex approach combining customer requirement identification, prioritization and product development can be seen in Total Quality Management (TQM) models (Akao, 1990). Many authors are working with the Quality Function Deployment (QFD) model based on the TQM approach. QFD (Akao, 1990; O'Connor, 1994; Cohen, 1995) is a concept of product development based on superior customer requirement knowledge working with the so-called House of Quality Matrix (Wasseman, 1993). Some authors combine KANO and QFD concepts (Matzler & Hinterhuber, 1998; Tan & Pawitra 2001) to achieve greater effectiveness in the product development process.

Customer solution development has to be processed after customer requirement identification and prioritization. Manufacturing companies especially have to be strong in engineering to ensure effective innovations (Garcia, R., & Calantone, R. 2002). Working in innovation cycles requires parallel activities in marketing and engineering. Thus concurrent engineering and simultaneous engineering were introduced (Ma et al. 2008). Both concepts enable parallel innovation cycle management and higher flexibility of the organization leading to lean production concepts (Womack et al. 1990).

In order to ensure the required flexibility and efficiency within an organization, strong project-based management is crucial. Such companies are called Project Based Firms (PBF) (Whitley, 2006). Jones et al (1997) shows that strong project-based management leads to a lighter organizational structure of the company. Several authors also describe the relation between project-based management and marketing, primarily seen in relationship marketing and networking (Webster, 1992).

Besides project-based management of the company, a strong focus on product management and effective knowledge management are also important inside the organization. Product management is typically seen in the process basis of Product Lifetime Management (PLM) (Gorchels 2003). Successful product management requires product managers to have a strong personality (Katsanis et al., 1996), because of an unclear definition of competences in the organization whereby product managers have to coordinate activities through various company departments. Major processes that have to be handled by product managers are branding, marketing communication, product stock planning, pricing management and distribution management (Tyagi & Sawhney, 2010).

Effective knowledge management gives a company a strong tool for enhancing internal know-how and experiencing real-time sharing (Wasko & Faraj, 2005).

1.1.3 ICT Infrastructure supporting the Concept

It is evident in the 21st century that such a complex approach to customer solutions requires an ICT system support. The reality in the majority of firms is that unrestrained development of their ICT infrastructure that does not necessarily reflect the required systemic and strategic business strategy (Gudanescu et al., 2010). This unrestrained development is significantly influenced by rapid and unrestrained development of the entire ICT sector. ICT system implementation in any company thus becomes a very complex and multidisciplinary task that requires precise adaptation of implemented ICT

tools according to the company business strategy (Marchand et al. 2001). To ensure full and efficient ICT tool support to the business processes within the company, processes have to be in line with the so-called ICT requirement pyramid (Gudanescu et al., 2010).

There are many published texts related to ICT support of product development and production processes. Typically, those publications are focused on a particular phase such as the design stage or process planning, while some are more complex covering multiple phases (Fu Qiu et al, 2008). Generally the ICT support of the internal processes is covered within Competitive intelligence of the company (Calof & Wright, 2008, Molnár & Střelka, 2012).

The coordinated use of described concepts and tools towards customer solutions is not often seen in companies. It is more likely found in B2B-oriented companies than in the B2C sector. Rapid technological development in recent years has increased production flexibility in a wider range of manufacturing sectors. This will shortly also lead to increased levels of product customization in higher quantity and mass production sectors (Chlebovský, 2016).

ICT infrastructure in the production companies typically consists of the following information systems: ERP (Enterprice Resource Planning, BPM (Business Process Management), PLM (Product Lifecycle Management), MES (Manufacturing Execution System) and APS (Advanced Planning and Scheduling). All the systems require mutual cooperation and coordination in the company (Videcká, 2016).

2 Research Methods

In order to map how well companies are prepared for the described trend of increased need for individualized products from the customer side, the following two pieces of research were performed: The first one was quantitative and involved product innovation-oriented companies in both the B2B and B2C sectors. This research should answer the following research question:

Q1: Is product innovation-oriented B2B firms' internal infrastructure supporting product customization more developed in comparison to B2C companies?

The quantitative research was undertaken by analysing and comparing whether and how the customized product offered is communicated by selected product innovation-oriented manufacturing companies to their customers in both the B2B and B2C sectors and how it is supported by ICT infrastructure.

Besides the quantitative research, qualitative research was also performed. Qualitative research was made in the form of five case studies to more deeply observe and study the internal technical and production infrastructure of the selected companies.

Both pieces of research were undertaken in Czech, Austrian, German and Swiss product innovation-oriented companies.

Quantitative research was undertaken by analysing the selected companies' capability to offer product customization and its support via ICT tools. The European company database Amadeus provided by Bureau van Dijk was used for the company selection in all four countries under the same search criteria. According to Yamane (1967) two basic criteria are needed to determine the appropriate sample size: the level of precision and confidence level. In socio – economic sciences the confidence level $\alpha = 0.05$ is usually

used. For the purposes of the paper the level of precision +/- 10% was used. The confidence level is $\alpha = 0.05$. On the basis of these criteria the 100 companies are appropriate sample size in relation to the size of population.

Sample set covers 100 manufacturing firms (25 in each country) with the highest number of registered patents. Patent statistics are widely used as a good metric and indicator of the product innovation-orientation of the company and thus the number of registered patents was used as a selection criteria within the search strategy.

Database searching was processed for each country in the following steps:

1. Region/Country/region in country: The Czech Republic / Austria / Switzerland / Germany, 2. NACE Rev. 2 main section: C. Manufacturing 3. Number of patents: Top 25. When it comes to business sectors, the most involved in all countries are machine-building in B2B and automotive in both B2B and B2C. There are also strong food processing and pharmaceutical sectors in Switzerland covering both B2B and B2C markets.

The second step was the definition of proper metrics to be evaluated in each selected company. Based on discussions with experts, the metrics shown in Tab. 1 were selected.

Tab. 1: Used research metrics

Metric	Available values
Communicated offer of individualized product/solution	0 - no, 2 - part of products, 5 - all products
Modular product structure	0 - no, 2 - part of products, 5 - all products
Available tools for individual product specification	0 - no, 2 - limited (f.e. inquiry sheet), 5 - actively used
Product configurator	0 - no, 2 - part of products, 5 - all products

Source: authors

The sum of the points gained by each company provides an overall product customization index. The theoretical maximum that can be gained by a company is 20 points. MS Excel was used to register the measured values in evaluation sheets. The data stored in MS Excel was further processed in order to test given hypotheses. Statistical tests were performed to test research hypotheses using statistics software.

Qualitative research is very often used to observe, describe and prove research models in specific organizations (Eisenhardt, 1989, 1991). Thus case study research was chosen in this situation.

Since the machine-building sector is one of the most covered by quantitative research, there were five companies selected that represent the full supply chain in the machine-building sector from component production through distribution to final machine-building and assembly. The selected companies also represent different size categories from large global corporations through to medium and small businesses to micro companies. They are located in all European countries involved in this research: Switzerland, Germany, Austria and the Czech Republic. All five companies represent the B2B sector.

A research case study template was created prior to the research execution primarily covering the following groups of information: company business basics, product group characteristics, marketing and sales process characteristics, product customization capabilities, strategic development plans, ICT systems used, and competition

characteristics. All groups of information described were specifically focused on current and future capabilities of the companies in customer solutions development.

Data collected for the case study protocols were obtained from three major sources:

1. Secondary source research within the past four years – primarily financial reports, annual reports (if applicable) and Amadeus database data (Bureau Van Dijk, 2015) were used.

2. Observations inside all five companies at regular intervals within the period 2013 – 2016.

3. In-depth interviews with company managers at all management levels in all companies. Interviews were performed in the period of June to September 2016.

3 Problem solving

Quantitative research

General outcomes of the quantitative research are summarized in Tab. 2. It shows the value calculations of product customization index gained by researched companies.

Tab. 2: Quantitative research outcomes summary

Target market	Maximum	Minimum	Average	Median	Variance	St. deviation
B2B	17	0	11.91	12	12.73	3.57
B2C	17	0	10.34	11	33.00	5.74
Company location:						
Czech Rep.	15	0	8.6	9	18.58	4.22
Austria	17	6	12.38	12	10.49	3.17
Germany	17	4	10.92	12	24.75	4.87
Switzerland	17	0	10.8	12	19.58	4.34

Source: authors

Based on the research question respective zero and alternative hypotheses were formulated:

H10: Product innovation oriented B2B firms' internal infrastructure supporting product customization is more highly developed in comparison to B2C companies.

H11: Product innovation oriented B2B firms' internal infrastructure supporting product customization is not more highly developed in comparison to B2C companies.

Statistical testing of hypothesis H10 and H11 were performed based on the values gained. For the statistical testing a sample set from companies from all involved countries divided into two groups was created – the first group were companies targeting business customers (B2B) and second group involves companies targeting consumers (B2C). Out of a total 100 companies involved in the research, 65 were in the B2B group and 35 in the B2C group.

It is necessary to conduct the test of normality to find out if parametric or non-parametric testing will be used. The Shapiro-Wilk test is used to test the normal distribution of data.

H0 The data sets come from normal distribution.

HA The data sets do not come from normal distribution.

Tab. 3: Tests of Normality

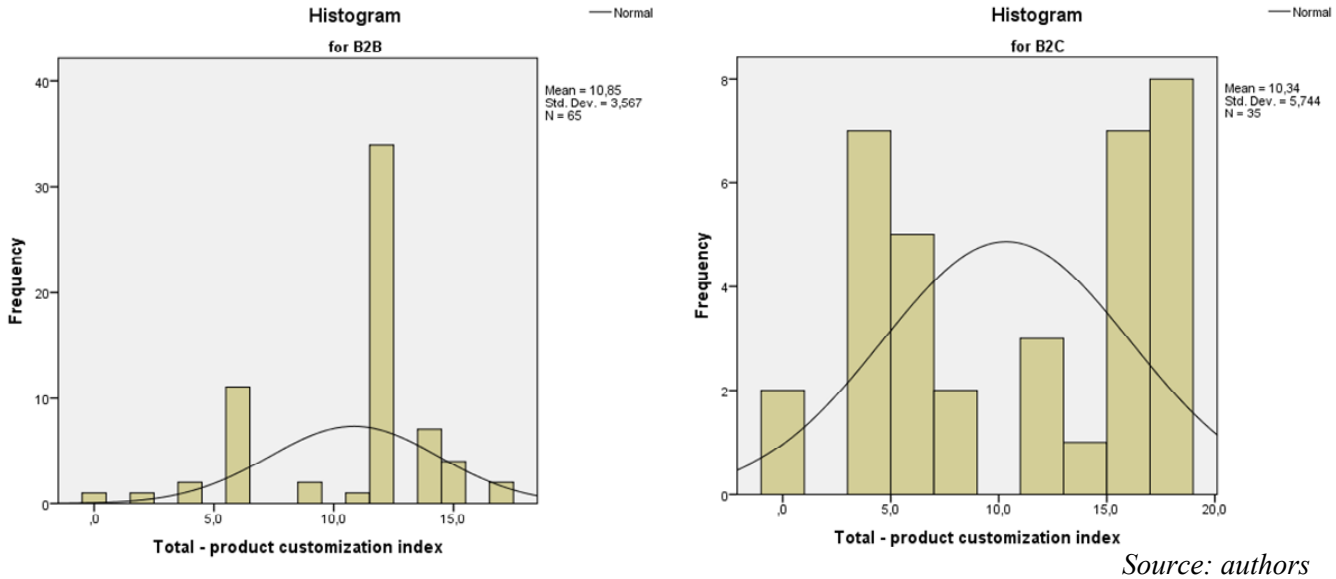
B2B / B2C		Shapiro-Wilk		
		Statistic	df	Sig.
Total – product customization index	B2B	0.832	65	0.000
	B2C	0.864	35	0.000

Source: authors

Normal distribution of data is not proven. P-values (Sig.) are lower than the chosen significance level 0.05. The H0 hypothesis about the normal distribution of data is rejected.

The following histograms show the distribution of data.

Fig. 2: Histograms for B2B and B2C companies



Source: authors

The non-parametric Mann-Whitney U test is used to test the H10 hypothesis. The test is based on the rank of values and compares the means of selected data sets. Results are shown in Tab. 4 and Tab. 5:

Tab. 4: Ranks

B2B / B2C		N	Mean Rank	Sum of Ranks
Total - product customization index	B2B	65	50.36	3273.50
	B2C	35	50.76	1776.50
	Total	100		

Source: authors

On the basis of the average mean rank it is obvious that the data sets are very similar. If there is a statistically significant difference, it will be found out by statistical testing.

Tab. 5: Test Statistics[a]

	Total - product customization index
Mann-Whitney U	1128.500
Asymp. Sig. (2-tailed)	**0.947**

a. Grouping Variable: B2B / B2C

Source: authors

P-value of Mann-Whitney U test is 0.947. It is higher than the value of significance level 0.05 thus the H0 is rejected. There is no statistically significant difference between B2B and B2C.

Qualitative research

Tab. 6 and Tab. 7 summarize results of the qualitative research. Tab. 6 shows a brief summary of the capability and approach to individualized product development. It also shows metrics measures of each company gained from within the quantitative research. Tab. 8 shows the actual internal ICT infrastructure of the 5 involved companies.

Tab. 6: Qualitative research results summary – company basics and individualized product development capability

	AAA	BBB	CCC	DDD	EEE
Company size / number of employees	large / 2000+ worldwide	Medium / 200 in Germany	Medium / 20 in Austria and Czechia	Small / 20 in Czechia	Micro / 10 in Czechia
Annual turnover (mil. EUR)	250+	25	12	4	1,5
Product type	components	Components	Components, services	Systems / machines	Systems / machines
Internal focus	Product technology	Customized solutions, technology	Customized solutions	Customized solutions	Product technology
Capability of product individualization	Limited but growing with configurable products	Good, stable	Insufficient engineering	High	Limited
Communicated offer of individualized product/solution	Yes, all products	Yes, all products	Yes, all products	Yes, all products	Yes, part of the products
Modular product structure	Yes, part of the products	Yes, part of the products	Yes, part of the products	Yes, part of the products	Yes, part of the products
Available tools for individual product specification	Yes, actively	Yes, actively	Limited	Limited	Limited
Product configurator	Yes, part of the products	No	No	No	No

Source: authors

Tab. 7: Qualitative research outcomes summary – use of ICT systems in selected companies to support customized product offer

Company	ERP	CRM	BPM	PLM	APS	MES
AAA	Yes	Yes	Limited	CAD/CAM	Yes	Yes
BBB	Yes	Limited	No	CAD/CAM	No	No
CCC	No	Yes	Yes	Limited	No	No
DDD	Yes	No	No	CAD	No	No
EEE	Limited	No	No	CAD	No	No

Source: authors

This summary shows that typical company ICT infrastructure does not cover all the required systems. The research undertaken also confirms general statistics that are summarized in Tab. 8.

Tab. 8: Summary of secondary source statistics available

Information System	Available statistics summary
Enterprise Resource Planning (ERP)	ERP systems were used by 36% companies located in the EU in 2015. At the same time there are significant differences in ERP system use by company size – it is used by 30% of small companies, by 60% of medium sized and by 80% of large corporations.
Customer Relationship Management (CRM)	CRM systems were used by 31% companies located in the EU in 2015. At the same time there are significant differences in CRM system use by company size – it is used by 28% of small companies, by 47% of medium sized and by 60% of large corporations.
Business Process Management (BPM)	According to research undertaken among global managers, they see 25 – 40% of company processes fully automated.
Product Lifecycle Management (PLM)	CAD systems are used by the vast majority of manufacturing companies. It is used by almost 100% of medium and large manufacturing companies.
Advanced Planning and Scheduling (APS)	The APS system is not used by many companies. There are no detailed statistics available.
Manufacturing Execution System (MES)	The APS system is not used by many companies. There are no detailed statistics available.

Source: modified from Eurostat statistics (2015)

4 Discussion

Both pieces of research undertaken, quantitative and qualitative, show important results that can be summarized as follows:

The statistical tests performed show that there are no differences in internal infrastructure supporting product customization in B2B and B2C companies. Looking more deeply into the data collected within the quantitative research, the following outcomes can be seen:

- Companies in both the B2B and B2C sectors are doing well in product modularity and availability of the tools needed for individualized product specification. The average and median values of both company groups are equal in these two criteria.
- Results regarding the ability to communicate product individualization capability shows the advantage of B2B-oriented companies. B2B sector-oriented companies gained an average value of 4.2 out of a maximum 5.0 compared to 1.94 gained by B2C sector-oriented companies.
- B2C companies on the other hand are excellent in the product configurator criterion, where the median is 2.0 in comparison with 0.0 in the B2B group of companies.

These results are in accordance with the actual business experience where companies in the B2B sector are offering very flexible product individualization in comparison with the B2C sector, where product modularity and easy module configuration is typically the preferred choice of product individualization.

An important result of the quantitative research is also a comparison based on country of company location. It is evident that Czech companies are behind their counterparts from more highly developed economies in overall ability to offer and communicate individualized product solutions to their customers.

Qualitative research results mapping ICT infrastructure of the selected companies show that companies involved in the research are well-equipped when it comes to

digitalization of their research and development processes using CAD systems. Companies are also well-equipped when it comes to basic operational information systems – they typically use any of the ERP systems. On the other hand, additional ICT infrastructure is very limited or even almost non-existent. Among the companies researched, APM and MES systems are only used by the global corporation AAA. Even the CRM system is not used by all the companies researched.

Conclusion

This article presents a summary of two pieces of interlinked research undertaken on a product innovation-oriented firm's capability to offer individualized product solutions to their customers. The focus of the research was on the firm's internal infrastructure, primarily the ICT tools needed to offer customized product solutions to customers.

The quantitative research analyses whether and how the customized product offered is communicated by selected product innovation-oriented manufacturing companies in B2B and B2C sectors in the Czech Republic, Austria, Germany and Switzerland.

The qualitative research is in the form of five case studies to more deeply observe and study internal technical and production infrastructure of the selected companies with a primary focus on the ICT system infrastructure that is essential for the capability of individualized products offered to customers.

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