ISSN 2543-6597

Bialystok University of Technology
Faculty of Engineering Management

sciendo

ISMSME
International Society for Manufacturing, Service and Management Engineering

Engineering Management in Production and Services

Volume 11 • Issue 3 • 2019

www.empas.pb.edu.pl

Frequency

ECONOMICS AND MANAGEMENT
is published quarterly since 1998

As of the beginning of 2017 the journal
is published under a new name:
ENGINEERING MANAGEMENT
IN PRODUCTION AND SERVICES

Copyrights ©

Publisher

Bialystok University of Technology
Wiejska 45A, 15-351 Bialystok, Poland

The International Society
for Manufacturing Service
and Management Engeneering (ISMSME)

Submission

Papers for submission should be prepared according to the *Authors Instructions* available at www.empas.pb.edu.pl

All papers should be submitted through the electronic submission system

Editor-in-Chief

Joanna Ejdys
Bialystok University of Technology
Faculty of Engineering Management
Wiejska 45A, 15-351 Bialystok, Poland
Phone: (+4885) 746 9802
Fax: (+4885) 663 1988
e-mail: j.ejdys@pb.edu.pl

Indexation

Journal is indexed in SCOPUS, EBSCO Business Source Ultimate (Complete), Norwegian Register for Scientific Journals, Series and Publishers, Index Copernicus, ERIH PLUS, Google Scholar, Central European Journal of Social Sciences and Humanities, Research Papers in Economics (RePEc), BazTech and BazEkon databases

Deputy Editors-in-Chief

Łukasz Nazarko
e-mail: l.nazarko@pb.edu.pl

Katarzyna A. Kuźmicz
e-mail: k.kuzmicz@pb.edu.pl

Editorial Office Secretary

Danuta Szpilko
Bialystok University of Technology
Faculty of Engineering Management
Wiejska 45A, 15-351 Bialystok, Poland
Phone: (+4885) 746 9880
Fax: (+4885) 663 1988
e-mail: d.szpilko@pb.edu.pl

Editorial Office

Bialystok University of Technology
Wiejska 45A, 15-351 Bialystok, Poland
Phone: (+4885) 746 9825
Fax: (+4885) 663 1988
www.empas.pb.edu.pl

Technical Editors

Krzysztof Stepaniuk
e-mail: k.stepaniuk@pb.edu.pl

Tomasz Trochimczuk
e-mail: t.trochimczuk@pb.edu.pl

Ministry of Science and Higher Education
Republic of Poland

Publishing of four issues of the "Engineering Management in Production and Services" journal in English – tasks financed in the framework of the contract no. 710/P-DUN/2019 by the Ministry of Science and Higher Education from the funds earmarked for the public understanding of science initiatives.

Table of contents

SPECIAL SECTION

New perspectives on B2B marketing – connecting marketing and technology

Editorial – Dariusz Siemieniako

GUEST EDITOR:

Dariusz Siemieniako

Bialystok University of Technology, Poland
e-mail: d.siemieniako@pb.edu.pl

DOI: 10.2478/emj-2019-0027

Rapid changes in the contemporary business world impact on the understanding of the theory and practice of a company and its relationships with customers. Cognitive computing and Big Data Analytics have opened up new options for marketing solutions that allow for the integration of Internet technology into the business, industry sector and decision-making process. The rapid development of the Internet of Things (IoT), as well as artificial intelligence (AI) and machine learning solutions implemented by companies, facilitate increasingly more adequate and value-creating machine to machine (M2M) interactions. All of these changes in technology translate into opportunities for marketers. The theory and practice of B2B marketing require to carefully consider the influence of technology on value creation, including innovations. More research efforts are required into value creation and communication in the world of IoT, AI and M2M interactions with regard to relationships between customers and sellers. It can be helpful to analyse industry-specific contexts as well as contexts of the emerging vs developed markets.

This special section aims is to present a wide spectrum of new perspectives on B2B marketing with a special focus on the connection between marketing and technology. The focus here has been chosen to encourage new and critical views. This special section showcases papers that offer innovative insights into issues surrounding mostly B2B marketing and technology, which advance our understanding of the contemporary B2B marketing fuelled by technological changes in a modern business world. Most of the papers within this special section are related to the International Conference on Collaborative Innovation Development — CID Conference, which took place on June 10–11, 2019, at the Faculty of Engineering Management of Bialystok University of Technology.

This special section opens with a timely paper Marketing principles for Industry 4,0 — a conceptual framework by Katarzyna Nosalska and Grzegorz Mazurek. The paper advances the understanding of the Industry 4.0 phenomenon in the context of changes taking place in the area of marketing in general and in industrial markets in particular. The second paper Operationalising Responsible Research and Innovation – Tools for Enterprises by Lukasz Nazarko and Borisas Melnikas explores Responsible Research and Innovation (RRI) as a novel approach to governing science and innovation. This paper proposes a range of approaches that help operationalise RRI, such as AHP, weighted indicators, maturity models and Data Envelopment Analysis. Artificial intelligence and business relationships are the focus of the paper Development of Intelligent Agents through Collaborative Innovation by Mateusz Kot and Grzegorz Leszczynski. The authors present research-based evidence on the scope of collaboration between users of Business Virtual Assistants (BVAs) and providers in the process of BVA development, which is influenced by user interpretation through sensemaking. The paper Integration of digital technologies in the sphere of construction in Russian Federation by Elena Aleksandrova, Victoria Vinogradova, Galina Tokunova focuses on changes in collaboration innovations in business relationships applicable to the Russian construction sector in the period of digitalisation. The following two articles deal with consumer motivations of value co-creation. The study by Anna Dewalska-Opitek and Maciej Mitręga entitled "Appreciate me and I will be your good soldier". The exploration of antecedents to consumer citizenship provides tentative evidence for some extrinsic and intrinsic motivation behind consumer inclination to engage in customer citizenship behaviour (CCB) and co-creating with brands they prefer. The research also showcases the multidimensionality of CCB. The paper Internet-based consumer co-creation experience of the new product development process by Viktoria Khrystoforova and Dariusz Siemeniako shows the interest of consumers in being involved in the online co-creation of new product development. The study indicates that the lack of required knowledge results in hesitance to participate among some consumers.

I thank the reviewers for the valuable time given to offer helpful and constructive comments. Special gratitude goes to the editorial team: Prof. Joanicjusz Nazarko, Assoc. Prof. Joanna Ejdys and Dr. Danuta Szpilko for providing a platform for six papers, which will hopefully facilitate a further debate on links between B2B marketing and technology.

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 2 May 2019
accepted: 15 September 2019

pages: 9-20

Marketing principles for Industry 4.0 — a conceptual framework

Katarzyna Nosalska, Grzegorz Mazurek

ABSTRACT
The holistic approach to Industry 4.0 requires a broader look at the changes taking place in the area of marketing. Therefore, this article mainly aims to present an outline of changes in marketing for companies implementing the concept of Industry 4.0 in the context of Design Principles of Industry 4.0. The authors propose a conceptual framework for Marketing in Industry 4.0, deriving from the guidelines for designing strategies to implement Industry 4.0.
The paper allows a better understanding of the Industry 4.0 phenomenon in the context of changes in the area of marketing in general and in industrial markets in particular. The conceptual framework presented in the article suggests a need for a new approach to shaping marketing strategies and the marketing mix in the Fourth Industrial Revolution and helps in identifying the key areas for the marketing mix according to the Industry 4.0 concept.

KEY WORDS
Industry 4.0, digital marketing, digital transformation, Fourth Industrial Revolution

DOI: 10.2478/emj-2019-0016

Corresponding author:

Katarzyna Nosalska

Kozminski University, Poland
email: k.nosalska@gmail.com

Grzegorz Mazurek

Kozminski University, Poland
e-mail: gmazurek@kozminski.edu.pl

Introduction

The current changes in production methods and the business environment of manufacturing companies, caused by the development of new digital technologies, tend to be described as the Fourth Industrial Revolution. Industry 4.0 and Smart Manufacturing are related expressions, often used interchangeably (Liao et al., 2017). The concept refers to a deep digital transformation of value chains, business models, products, and services. The changes that are shaping this transformation are happening in two integral business areas, namely, production and business management, and involve a development of smart factories that communicate in real time via the Internet of Things in an ecosystem composed of machinery, a network of factories, and people (Kagermann et

al., 2013). Cloud technologies and the ability to perform an intelligent analysis of large data volumes also enable the integration of value chains, both vertical — occurring inside companies — and horizontal — involving other market participants (Jarocka and Wang, 2018; Saucedo-Martínez et al., 2017). This phenomenon has a direct impact on the changes in the management domain of a product lifecycle and on the relationships with stakeholders in the market. The digital solutions of Industry 4.0 change humans as consumers and affect their work processes and behaviour. Moreover, considering the extremely dynamic and even exponential development of technology and its impact on society, one can claim that changes also occur in the areas of marketing activities and marketing tools aiming to adapt them to the new reality of today's markets (Daviy et al., 2017; Sterev, 2017; Mazurek, 2019; Mazurek and Nosalska, 2018).

A review of the relevant source literature has shown a gap in research regarding the impact of Industry 4.0 on marketing. Therefore, the authors have prepared a literature analysis with regard to marketing theory to present a conceptual framework of marketing in Industry 4.0. This article uses qualitative methods and offers a wide literature review to propose five main marketing principles for the era of the Fourth Industrial Revolution and discuss their impact on the overall marketing mix.

1. Literature review

1.1. Industry 4.0 — a definition

The Fourth Industrial Revolution determines the changes in the domain of manufacturing. It concerns a shift in the production practice — from mass to personalised production — which results in greater flexibility of production processes and provides means to satisfy the individual needs of different customers more effectively.

The term is also a direct reference to the changes that have taken place over the course of history under the influence of the spread of new manufacturing technologies, which have prompted radical changes in production, society, economy, culture, and business. The First Revolution started with mechanical production relying on the power of steam and water (the so-called Age of Steam), taking place in the late 18th century. The Second Revolution began in the early 20th century, driven by the development of electricity, which contributed to the growth of mass production. Then, during the 1970s, the development of computers and the automation of production processes initiated the following — third — industrial revolution. Currently, new digital technologies, such as Virtual Reality, Augmented Reality, Big Data Analytics, Cyber-physical Infrastructure (CPS), Internet of Things, Additive Manufacturing, Cloud Computing, Smart Sensors, Artificial Intelligence, Mobile Technologies, and Autonomous Robots and Systems, are causing material changes in the business environment and our everyday lives (Mittal et al., 2017; Pfohl et al., 2015; Mazurek, 2019). These disruptive technologies are shaping the Fourth Industrial Revolution.

The importance of these phenomena has also been noticed at the level of governments of multiple countries (Kagermann et al., 2013; Li, 2018). Many government authorities have proceeded with the introduction of development schemes to increase the digitisation of production companies and to facilitate the achievement of higher industrialisation index rates. One of such schemes is the concept of Industry 4.0, which was first proposed in Germany in 2011. The term is used in Europe interchangeably with the Fourth Industrial Revolution, and it is this concept, around which the scientific discourse concerning digitisation revolves now. The concept has also been popularised under different names in different parts of the world. For instance, the names functioning in the US include the Industrial Internet of Things (IIoT) or Smart Manufacturing, or the Internet of Things, which describes a broader range of changes. The terms refer to similar phenomena encompassing the advancing digital revolution, and, thus, fit in the general digital transformation trend occurring today.

Many different definitions of Industry 4.0 are present in the source literature. Authors, e.g. Hermann, Pentek, and Otto (2015), Wang et al. (2017), Sandengen et al. (2016) and Tupa et al. (2017), briefly define Industry 4.0 as a collective term describing changes in the technological scope and the organisation of value chains. This approach reveals two main aspects of the digital transformation in question — its technological aspect and its business aspect.

Many authors emphasise the importance of the holistic approach to Industry 4.0, treating the changes caused by digitisation very broadly. Strandhagen et al. (2017) define Industry 4.0 as an "umbrella term" referring to a number of concepts and affecting many disciplines in the industry. Generally, defining the scope of Industry 4.0 requires listing its specific aspects. For example, Saucedo-Martinez et al. (2017) sequentially refer to the meaning of Industry 4.0,

i.e. (1) the integration of complex machines and devices with sensor and software networks used to predict, control and improve business activities that have a social impact, (2) a new level of organisation and value chain management throughout the entire product lifecycle, (3) a common term for technology and value chain organisation concept, (4) a holistic system including IT solutions, people, machines, and tools, enabling the flow of goods, services and data in a controlled manner in the value chain, using autonomous processes and the possibility of high data flow capacity and information necessary to make decisions.

Therefore, based on a review of different definitions, Industry 4.0 can be defined as a concept of organisational and technological changes that involve the integration of value chains and new business models, smart products, and services. These changes are driven by individual needs of customers, the development of digital technologies, data integration, and common access to the Internet (Saucedo-Martínez et al., 2017).

The concept is actually materialised through a network of digital factories, the operation of which is based on cyber-physical systems that create virtual copies of physical applications that can make autonomous decisions. Such cyber-physical systems work with and exchange data among themselves, people, and other smart factories, thereby creating one element of a larger ecosystem of the Internet of Things. The smart products they manufacture can also react to changes happening in their surroundings in real-time and make autonomous decisions on their operation (Wang et al., 2016; Mittal et al., 2017).

1.2. Role of costumers in a digital ecosystem

The original impulse to introduce new solutions based on digital technologies was to change the method of manufacturing goods by turning from mass production to mass personalisation. It was caused by a strong trend that involved customer demands for custom products. The application of the latest technological solutions and the creation of flexible production lines result in the costs of personalised low-volume production remaining still similar to the costs of mass production. Customer needs are the factor that triggers the changes described above. Therefore, if the customer and the product have a significant impact on the transformation processes, one can claim that marketing plays a considerable role in business operations pursued in their respective markets during the time of the industrial revolution (Bettiol et al., 2017).

The activities pursued by companies aiming to implement the Industry 4.0 concept are targeted at individual customer requirements, calling for customer-oriented organisations (von Leipzig et al., 2017). The customer is treated as the company's partner who co-creates the product. The process of integrating data in the value chain enables a fuller interaction between the customer and the company at virtually every stage of value creation. By applying technologies — such as virtual reality, 3D print, or smart design tools, which are also supported by extensive communication with the customer — the customer can participate in creating the product at an early stage of research and development (R&D). The ability to use fast prototyping that involves 3D printing, combined with the easy operation of product configuration software allows companies to work closely with customers and, consequently, satisfy each customer's expectations to receive a customised product. An example of such a process is what companies who manufacture running shoes offer to their customers, making it possible for them to order footwear that perfectly fits each customer's foot (for example, NIKEiD, Adidas Futurecraft). Such cooperation with the customer may be even more extensive in the B2B area. An example of such a practice in the B2B market is the 3DExperience platform of Dassault Systèmes. It is a virtual space that lets a number of people communicate and create innovative products (Dassault Systemes, 2018). Co-creation reinforces the value proposal even further by offering customers the option to personalise their own products and services.

According to a forecast by PwC (Reinhard et al., 2016), changes caused by the implementation of digital solutions show a large potential for changes in data analytics to improve customer relations and analyse each customer's behaviour (so-called customer intelligence). This facilitates access to products, sales, and marketing channels. These changes will include, among others, management of the order placement process and further development of customised products. Such progression of data integration along the entire value chain enables the transmission of data all the way from the production stage to centralised production planning systems and even further — into integrated customer service systems. Data coming from every stage of the product lifecycle will thus become a new information resource for marketing and will be useful for the value creation process.

One of the factors for gaining competitive advantage in the industry of the future is the ability to function effectively in business network ecosystems (Teece and Linden, 2017). Therefore, the multitude of stakeholders who co-create value and cooperate with a company at various stages of value creation will be able to create new possibilities but also spawn new obligations in terms of marketing.

The fundamental element of the development of digital transformation is the existence of a digital ecosystem wherein spontaneous interactions between objects, people, and business units occur enabled by data exchange processes (Saarikko et al., 2017). Therefore, cooperation and deeper integration between smaller market players give all the ability to succeed in global markets. According to Cisco (Bradley et al., 2015), as many as 40% of companies will face the risk of insolvency in the next few years if they do not meet the challenges posed by the new reality of cooperation taking place now in the digital world. Referring to the Darwinian theory of the biological ecosystem, also in the digital network, adaptation to the changing business environment becomes a condition for the survival in the market of today and of the future (Kreutzer and Land, 2013; Moore, 1993).

A viable solution for enabling integration and activity in a network is the digitisation of companies and effective process management in the entire value chain. This means that enabling the growth of a digital ecosystem is provided naturally by new technologies and the ubiquitous Internet, which is also a natural progression of the trend of the Internet of Things. According to McKinsey's forecasts, the number of devices interconnected within this network by 2025 will exceed 50 billion objects, that is 2.7% of all products manufactured, reaching the potential for the world economy that amounts to between USD 4 and 11 trillion (McKinsey Global Institute, 2015).

1.3. Strategic business changes caused by digital transformation

The market of today is becoming more and more unpredictable, forcing companies to adopt a more flexible outlook on their own strategies. The phenomena that companies face, such as the blurring of the boundaries between industries, the shortening of supply chains, or the occurrence of coopetition, affect the ongoing process of strategic decision-making and involve changes in marketing activities with respect to value distribution. When analysing the market and designing a strategy, marketing teams must fully consider all of these factors.

The rapidly progressing digital transformation and the implementation of Industry 4.0 solutions also create opportunities to redefine the previous nature of business operations and create new business models or introduce innovations to the existing ones. Innovations in products, processes or services alone are not sufficient any longer to stay fully competitive (Gassmann et al., 2017). A study (Planing and Pfoertsch, 2016) conducted among leading production companies has proven that their strategic decision fields belong to two main dimensions — digitisation of products or services and digitisation of business models. The authors of this study suggested that to be fully successful, companies had to follow these two strategic directions simultaneously. However, at present, companies most frequently follow the pathway towards digitisation of their products. This choice may be caused by a focus on the technological dimension of the phenomenon, translating into opting for the simplest solution, which is equipping products with data sensors. This choice enables companies to collect information from the product use phase and use that information further to offer complementary value and to profile the product based on the customer's behaviour history.

In Industry 4.0, a digital product should be considered not only as the physical result of the manufacturing process but also as an intelligent source of data collected from the process of its use. The product also gains a new virtual dimension, thereby creating a digital equivalent of a physical product called a digital twin. In a not too distant future, the purchasing process for technology components may change completely. It will be necessary for the customer to create a digital twin of any product to be able to simulate the entire process and test the product first in the virtual phase before the actual acquisition of the physical equivalent. Such an activity makes it possible to reduce customer costs and enable the customer to make the right investment decision (Uhlemann et al., 2017).

As MIT's Capgemini studies show (Westerman at al., 2012), to reach the highest digital maturity, which directly affects the financial results gained, it is necessary for companies to develop strategic and technological investments simultaneously for successful organisational changes within their structures. The entire digitisation process should, therefore, be treated as a project that involves extensive changes both in the company and in its positioning in the digital business ecosystem.

2. Conceptualisation

Aiming to structure marketing changes caused by the impact of new digital technologies and the frequently growing number of new business models, the authors of this paper propose a conceptual framework for marketing in Industry 4.0. The development and structuring of the concept involved the use of the qualitative method proposed by Jabareen (2009), which defines a conceptual framework as "a network or a plane of linked concept". This method of analysis offers a procedure of theorisation for building conceptual frameworks based on the grounded theory method. The analysis is supported by a broad literature review performed in the area of research on the development of the Industry 4.0 concept in the context of changes taking place in the domain of marketing.

The authors have put together two concepts — the Design Principles of Industry 4.0 (Hermann et al., 2016) and the popular Marketing 4.0 concept offered by Kotler, Kartajaya, and Setiawan (2016). The method makes it possible to combine two multidisciplinary areas of knowledge — technology and business — allowing a better understanding of the Industry 4.0 phenomenon related to changes in the area of marketing in general and in industrial markets in particular.

When analysing the source literature and the principles of the concept of Industry 4.0, one may notice that the main elements of a marketing mix remain under the considerable influence of the Fourth Industrial Revolution. This also necessitates changes in the planning of marketing tools, which has been defined by Kotler, Kartajaya, and Setiawan (2016) in the Marketing 4.0 concept. This stage of the marketing mix evolution not only focuses on the digital dimension of the relationship but also combines online and offline interactions between the customer and the company, using digital technologies to strengthen the actual customer engagement.

The traditional marketing mix has undergone multiple evolution stages, transforming from 4Ps to 4Cs (co-creation, currency, communal activation, and conversation; Kotler et al., 2016). However, in the case of companies that implement Industry 4.0 solutions, effective marketing strategies that yield positive results require an innovative outlook on the marketing mix as well as a profound understanding of the holistic meaning of the Industry 4.0 definition. This approach is all the more suitable if we relate it to the main phenomena that mark the Fourth Industrial Revolution, meaning the processes of integration of data in value chains. Data generated at various stages of value creation become available to each one of the chain elements, bringing about new opportunities to use diverse data in the value creation process. Also, new business models that form one of the main pillars of Industry 4.0 make it necessary to look at the marketing mix from a new perspective.

Aiming to derive the basic principles for marketing that should form the basis for the creation of effective marketing strategies, it is reasonable to take a closer look at the four principles of Industry 4.0 as defined by Hermann, Pentek, and Otto (Hermann et al., 2015, 2016), which facilitate the transformation of companies and the actual achievement of digital maturity according to the concept of Industry 4.0. The principles support companies in identifying and implementing Industry 4.0 scenarios and lie at the core of the functioning of companies according to Industry 4.0. These principles are (1) Interconnection, (2) Information Transparency, (3) Decentralised Decision, and (4) Technical Support — Virtual and Physical Assistance. They also have their own implications for both organisation management and marketing.

The authors of this paper offer an interpretation of these four principles in the context of the need to use them in the process of building a marketing strategy and planning a marketing mix. Based on the Design Principles and literature review, a conceptual framework for marketing in Industry 4.0 has been presented.

2.1. Design principles of Industry 4.0 in the context of marketing

Interconnection

As already mentioned, interconnections between the elements of a digital ecosystem are the essence of the Fourth Industrial Revolution. Machines, devices, products and people are connected to the Internet of Things, thereby creating the highest degree of network development — the Internet of Everything. This way, all of the interconnected objects can share information, which becomes the basis of cooperation aimed at achieving common goals. We can distinguish three types of cooperation within the IoE: human–human, human–machine, and machine–machine. It is important to maintain the interoperability of the ecosystem and the modular nature of these solutions, aimed at making it easier for companies to adapt

themselves smoothly to the dynamic changes in the market and to better meet individual requirements of their customers. Modularity is extremely important in product design as it facilitates configuring an individual version of a product according to specific customer requirements. It is also a basic property that makes it possible to build a product configuration tool which is then used by customers as part of offer customisation.

Information transparency

Aiming to effectively integrate the growing number of interconnected objects and people and create virtual copies of a physical company, transparency and – in some measure – standardisation of information flow and processes is required. It is an indispensable element of effective data exchange between the stakeholders of a business ecosystem, and an essential feature of the integration of value chains and supply chains. To draw reasonable conclusions and make good decisions, data coming from sensors must be connected with other contextual information about a process, about the condition of the devices, and about the products, and then be analysed and interpreted accordingly.

To benefit from full transparency of the decisions being made, the results of data analyses must be made available to all participants of a given value chain in real-time. The cooperation based on transparent data is clearly illustrated by the functioning of the business platform model, wherein data exchange standards and the ability to share those standards are imposed by the creator of the system, while the decisions concerning the use are assigned to participants of a given platform. These new sources of information coming from business partners and various stages of product life are a major challenge to marketing and an area for new opportunities to take better advantage of marketing in the efforts to shape a full marketing mix.

Decentralised decisions

Decentralised decisions are based on the interconnection of objects and people as well as on the transparency of information placed along the entire value chain. This kind of network makes it possible to use local and global information for more effective business decision-making. This way, participants of the ecosystem are given a chance to make autonomous decisions based on generally available data.

Naturally, trust is another aspect mentioned in the open and sharing economy theory, which is important here as well. Strengthening the sense of trust between partners is one of the challenges posed for the Fourth Industrial Revolution. To overcome this challenge and build strong relationships based on mutual trust, it is important to implement solutions in the field of cybersecurity and change the organisational culture of enterprises. The issue of decentralised decisions and trust also concerns the ability of companies to design smart products that are able to make autonomous decisions and react to the stimuli in their environment in real-time. One of the most advanced examples of a smart product is Tesla, an autonomous car. It paves the way for similar solutions not only in technology development but also in terms of legal regulations.

Technical support — virtual and physical assistance

Owing to the growing complexity of production and business processes in the reality of the Fourth Industrial Revolution, people are supported by virtual and physical assistants based on new technologies (e.g. tablets with smart software, smartphones, robots, virtual assistants, and robo-advisors). Such systems visualise and aggregate information transparently to facilitate informed decisions. The application of virtual reality is one example that uses technologies to help customers make decisions. There are already many solutions based on this technology, and they make it easier, for instance, to choose a flat and its furnishing or configure the interiors of a car. Virtual and augmented reality solutions reinforce the cognitive stimuli that motivate the customer to select the most suitable offer (Scholz and Smith, 2016). Another example of innovative application of technology may be the design of a virtual reality-based training simulator by Siemens. This solution makes allows accelerating the training of employees in difficult conditions or in distant targeted workplaces (Schröder, 2018), e.g. on drilling platforms.

To sum up, the Design Principles of Industry 4.0 (Hermann et al., 2016) provide a set of main directions and suggestions for implementing marketing strategies and creating a marketing mix. These include:

- ensuring connectivity with the customer and the product (connectivity) and using the possibility of collecting and analysing data throughout the product lifecycle to recognise the needs and customer behaviour in greater detail, even in real-time (cognitivity), which gives an opportunity to

co-create value with the customer at every stage of product creation (co-creation), personalised customer communication (conversation), and cooperation in the supply chain (cooperation);
- the ability to use data from the entire product lifecycle to implement product servitisation and new business models;
- the development of product autonomisation;
- the digitisation and data integration in the value chain (vertical and horizontal), enabling transparent exchange and sharing of data between business partners, customers and company employees;
- taking advantage of product simulation and virtualisation capabilities (creating digital twins of physical products);
- the creation of a product offer based on the principles of standardisation and modularity;
- making use of digital customer assistants.

2.2. Principles for marketing in industry 4.0

Speaking of a digital business ecosystem, we talk about the connectivity of and among stakeholders, which enables cooperation, communication, as well as the co-creation of personalised value that is created on the basis of data available in real-time and coming from the cognitive processes that analyse customer behaviour. Both customers and other market participants, e.g. business partners or suppliers who participate in a vast digital business ecosystem, should be treated as stakeholders of the ecosystem. Therefore, based on an in-depth literature review of the idea of Industry 4.0, the authors propose a set of the main principles of marketing for the Fourth Industrial Revolution. These principles are:
- Cooperation,
- Conversation,
- Co-creation,
- Cognitivity,
- Connectivity.

These five principles can be combined by a context of using the approach to the marketing mix and thus offer an innovative concept. In the new proposition of the marketing mix, the creation of a product is based on co-creation, and its promotion involves mutual communication with product stakeholders in the market, while the distribution is based on the cooperation in a full business ecosystem, and its price is determined dynamically based on the data gathered from the cognitive processes that analyse customer behaviour in real-time. All four elements then merge, utilising the basic principle of connectivity (see Fig. 1). The implementation of these principles is possible with the use of new digital technologies and by building strategies according to the Industry 4.0 concept.

Co-creation

We are currently talking about products being co-created by customers through their active involvement in the value creation process, e.g. by selecting customised parameters of a product being ordered via an online configuration tool, or about the impact of customer voices and opinions shared on social media, and about the impact on brands and products. The cooperation with a customer taking advantage of mobility and Internet access reinforces the innovative nature of products and enables companies to perform a quick validation and tests of their new projects. We can then already speak of the customer as a co-designer, a co-marketer, a co-brander, and a co-producer. Then, undoubtedly, we can conclude that the customer's knowledge and knowledge about the customer become the company's greatest asset.

The Fourth Industrial Revolution and the new technologies that come with it position the customer

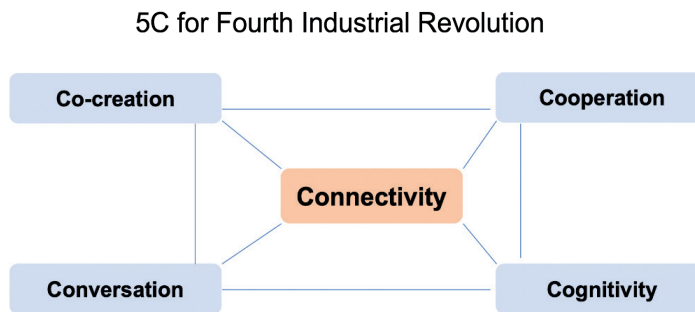

Fig. 1. Marketing Principles for Industry 4.0

in yet another role, releasing the customer from full and active engagement in the product co-creation process. In a digital ecosystem, the customer co-creates value unknowingly, by making the data on the manner of using a given product available and thus enabling the company to adjust their offer even more precisely to fit the customer's needs. By analysing historical data, artificial intelligence algorithms can learn and become able to discover the hidden needs of customers rather than just react to the circumstances.

Thanks to data-collecting sensors and artificial intelligence algorithms, we are already dealing with smart products. Such products allow for the analysis and interpretation of data, the prediction of failures, and autonomous decision-making. The advancing technology of AI-based voice assistants opens an entirely new chapter in the domain of product development, thereby starting the process of an actual product humanisation. Therefore, the most important task is to develop the Smart Product vision, and from a technical point of view, to ensure the access to data provided by the customer and the connection of products to the Internet. Then, under such circumstances, the customer participates in "unconscious co-creation" of value. However, the psychological aspect of opening customers to new technologies and ensuring the security of the data they generate is equally important. Looking at a product as a source of access to very reliable user data, companies should start creating new business models. The "as a service" model is currently one of the most popular solutions, which gives companies a new way to obtain income not only from the sale of products but also from, e.g., renting products to be used by customers. Tires-as-a-service implemented by Michelin is one example of this model (Frontere, 2013). "Engine-as-a-service" called TotalCare, offered by Rolls-Royce, is another example (Rolls-Royce, 2014). In this model, the company offers jet engines as part of a "power by the hour" payment, thus enabling payments to airlines for the use of their engines depending on several variables, including the duration of the flight. Therefore, the use of new business models today considerably diversifies portfolios of companies and offers still newer opportunities to build a competitive advantage in this new industrial revolution.

Conversation

Considering the increasing focus of companies on their customers, which is aimed at personalising the products and services they offer, companies are gradually adopting new strategies of brand promotion using the dialogue with their customers to benefit from long-term engagement and interaction. Using generally accessible mobile technology, the modern customer of today is a digital native who has an enormous power to influence brands through their ongoing activity pursued in social media or blogs and by sharing their thoughts and opinions online. Nowadays, it is possible to engage in direct conversations with customers on the Internet in real-time. The application of intelligent algorithm solutions and modern big data technologies leads to the development of new communication tools, such as chatbots, virtual assistants, and even marketing automation solutions. A message based on the strategy of attraction and the use of content marketing and digital content distribution channels can all encourage customers to enter into a dialogue with a company through the provision of useful content that matches their unique current needs as they are appropriately profiled.

Most of all, the Fourth Industrial Revolution offers many new ways of collecting customer data in real-time, which reinforce the need to apply real-time marketing. The voice assistant solutions mentioned here earlier, such as Siri or Google Assistant, can "talk" with the customer on the level of human bonding and, thereby, completely revolutionise the assumptions made for brand promotion strategies.

Cooperation

In a digital ecosystem, partnership and cooperation become the basis for the operation of companies that do not consider their participation in the market only in terms of competition with other brands any longer, but instead take the opportunity to work with them and take advantage of their best competencies (Subramaniam et al., 2019). One of the most popular examples of cooperation between two large competitive brands is the current ongoing partnership between Apple and Samsung in the area of supplying components for Apple products.

Cooperation can also be seen manifested in the formation of smart supply chains, wherein technology makes it possible for all chain participants to use a transparent data system to increase supply effectiveness and reduce the time to market. For example, by gaining access to data sources generated by partners and using big data technology, companies may indeed transform business models and outline new opportunities for cooperation in the value chain. This strategy enables them to arrive at an additional, unique

information asset, which could never be accessed without initiating this kind of cooperation. On the other hand, companies more and more frequently reduce their supply chains and distribution networks by turning to new business models and e-commerce solutions. This change is illustrated by the project announced in late 2017 for the construction of a joint sale platform for Unilever, Mars, and Reckitt Benckiser, which – according to the announcements – would offer products cheaper by about 30% compared to the prices normally offered in the traditional sales channels (The Telegraph, 2017).

When creating a product distribution plan, one should also bear in mind that a company is a part of a larger ecosystem, where strong cooperative ties with other market participants are what matters. It is important to remember to work towards making the most of these ties.

Cognitivity

The Internet makes it easier for customers to control prices through auctions and negotiations with multiple suppliers of the desired product. It also allows companies to adjust their prices dynamically to the current demand — or the preferred customer profile — in real-time. This concept is clearly illustrated by the diversification of the fare rates in Uber, which vary depending on the time of day and the volume of orders at a particular time and in a particular place. The ability to profile customers based on an analysis of the history of their activity on the Internet — or even the operating system they use — enables airlines to diversify rates depending on their customers' outlined profiles. Amazon is a master in the domain of use of customer data and market trends as it searches its databases and reacts to the current demand for a particular product range, profiling any special offers for each customer and any complementary products, thereby determining these prices dynamically.

Considering the growing volume of data generated in sales and coming directly from smart products, we will gain more and more opportunities in the future to utilise variables found in the price selection algorithms. Therefore, the answer to the traditional question being "how much does it cost?" is far from simple.

Connectivity — the holy grail for 5Cs

Looking at the above four principles and the examples given, we may conclude that they would not have become practicable if it had not been for the Internet. It is the Internet that forms the basis of the digital ecosystem seen today and gives us the exact ability to exchange data gathered from sensors. All digital technologies indeed achieve their real value only when such connectivity is employed. This feature not only unites the concept of the marketing mix presented here but also defines the key role that connectivity plays in this list and, indeed, predestines this role and its outcomes for becoming one of the major marketing principles of the Fourth Industrial Revolution.

3. Discussion of the results

The scientific discourse on Industry 4.0 focuses currently mainly on the technological aspects of the occurring changes. The holistic meaning of Industry 4.0 suggests a need for a multidisciplinary approach to identifying the changes emerging in various areas of business operations. Using this approach as a direction to follow in the understanding and developing the concept (in both practical and scientific fields), the authors have proposed the main marketing principles for Industry 4.0.

The authors also emphasise that technologies are only "enablers". They make it possible to develop relationships in business ecosystems, facilitating communication between market participants. It is not enough to implement a single technology in a company without considering all the processes in the related value chain and the stakeholders who create it. A competitive advantage based only on the implementation of new technologies is by its very nature only short-term (Carr, 2003). Only a strategic organisational change, effective process management, a redefinition of production paradigms, a change in business models, an openness to cooperate, and a willingness to participate in a digital ecosystem provide unique opportunities to entities seeking a long-term advantage.

The role of technology and IT systems is crucial – but it is not the only factor that counts. Without applying a new strategy, it is not possible to take full advantage of the introduced organisational changes. For this reason, an effective strategy produces the synergetic effect formed between the use of new technologies and innovative business solutions. Several examples of these impact areas related to various technologies on business operations and marketing are described in Table 1. As the examples suggest,

Tab. 1. Examples of technologies supporting Marketing Principles in Industry 4.0

Marketing Principles (5Cs)	Supporting technology	Changes brought by the supporting technologies
Connectivity Cooperation Communication Co-creation	IoT and 5G	The technologies make it possible to obtain data on the use of products directly from the customer in real-time Such technologies connect multiple devices and products into a network of independent objects, which are additionally supported by artificial intelligence algorithms that can make autonomous decisions
Connectivity Cooperation Communication Co-creation	Cloud Computing	It enables the formation of a network for the exchange of transparent data available to every network participant. It facilitates the building of a digital ecosystem and the creation of new business models (e.g. a business platform model or Product as a Service)
Cognitivity	Big Data	An analysis of large data volumes makes it possible to identify regularities and market trends, thereby offering cognitive conclusions on the use of products and customer behaviour previously unavailable to marketing planning. This focus enables more dynamic pricing
Cognitivity	AI	It facilitates the identification of customer behaviours and the prediction of their preferences and needs and makes it possible to offer a more personalised complementary value to customers
Co-creation	3D Printing	It enables customers to take part in fast prototyping and testing of products already at the research and development stage and extends the spectrum of product personalisation, offering the highest possible level of customisation
Co-creation Cooperation	VR/AR	It enables better visualisation of a company's offer through the use of each customer's personal sense of space. This facilitates designing products in a three-dimensional virtual space
Co-creation Cooperation	Simulation	It makes it possible to create a digital twin that gives an opportunity to test the functionality of a given product before buying it

these are also enablers within the meaning of the theory of five marketing principles of the Fourth Industrial Revolution as presented below.

Conclusions

All five marketing principles not only intertwine through the existing component of connectivity. They also form a holistic concept of creating innovative and effective marketing tools in the times of the Fourth Industrial Revolution. If contemporary companies prove their ability to adopt these rules as guidelines to plan their revolutionary marketing strategies, this move will offer them a unique and new perspective for standing out and building greater long-term competitive advantages that should lead to even greater business success in the modern digital business ecosystem.

The presented conceptual framework highlights the area and direction of further research in the field of marketing in the context of the development of Industry 4.0, which can enrich the existing scientific literature with new perspectives for a better understanding of the emerging changes brought by digital transformation.

Literature

Bettiol, M., Capestro, M., & Di Maria, E. (2017). *Industry 4.0: The strategic role of marketing*. Padova.

Bradley, J., Loucks, J., Macaulay, J., Noronha, A., & Wade, M. (2015). *Digital Vortex. How Digital Disruption Is Redefining Industries*. Retrieved from https://www.cisco.com/c/dam/en/us/solutions/collateral/industry-solutions/digital-vortex-report.pdf

Carr, N. G. (2003). IT Doesn't Matter. *Harvard Business Review*. Retrieved from https://hbr.org/2003/05/it-doesnt-matter

Dassault Systemes. (n.d.). 3DEXPERIENCE. Retrieved from https://www.3ds.com/about-3ds/3dexperience-platform/

Daviy, A. O., Paklina, S. N., & Prokofyeva, A. S. (2017). Digital manufacturing: New challenges for marketing and business models. *Russian Management Journal*, *15*(4), 537-552.

Frontere, N. (2013). *Business Model Innovation in the tyre Industry*. Retrieved from https://www.slideshare.net/NomieFrontre/business-model-innov

Gassmann, O., Frankenberger, K., & Csik, M. (2017). *Nawigator Modelu Biznesowego*. Warszawa, Poland: Helion.

Hermann, M., Pentek, T., & Otto, B. (2015). *Design Principles for Industrie 4.0 Scenarios: A Literature Review*. Working Paper No. 01/2015.

Hermann, M., Pentek, T., & Otto, B. (2016). *Design principles for Industrie 4.0 scenarios*. Proceedings of the

Annual Hawaii International Conference on System Sciences, 2016-March, 3928-3937. doi: 10.1109/HICSS.2016.488

Jabareen, Y. (2009). Building a Conceptual Framework: Philosophy, Definitions, and Procedure. *International Journal of Qualitative Methods*, *8*(4), 49-62. doi: 10.1177/160940690900800406

Jarocka, M., & Wang, H. (2018). Definition and classification criteria of logistics services for elderly. *Engineering Management in Production and Services*, *10*(4), 65-75. doi: 10.2478/emj-2018-0023

Kagermann, H., Helbig, J., Hellinger, A., & Wahlster, W. (2013). *Recommendations for implementing the strategic initiative Industrie 4.0. Final report of the Industrie 4.0 Working Group*. *Acatech*. doi: 10.13140/RG.2.2.14480.20485

Kotler, P., Kartajaya, H., & Setiawan, I. (2016). *Marketing 4.0: Moving from Traditional to Digital*. New Jersey, United States: John Wiley & Sons, Inc.

Kreutzer, R. T., & Land, K.-H. (2013). *Digital Darwinism - Branding and Business Models in Jeopardy*. Berlin Heidelberg, Germany: Springer-Verlag.

von Leipzig, T., Gamp, M., Manz, D., Schöttle, K., Ohlhausen, P., Oosthuizen, G. (2017). Initialising Customer-orientated Digital Transformation in Enterprises. *Procedia Manufacturing - 14th Global Conference on Sustainable Manufacturing, GCSM*, *8*, 517-524. doi: 10.1016/j.promfg.2017.02.066

Li, L. (2018). China's manufacturing locus in 2025: With a comparison of "Made-in-China 2025" and "Industry 4.0". *Technological Forecasting and Social Change*, *135*(October), 66-74. doi: 10.1016/j.techfore.2017.05.028

Liao, Y., Deschamps, F., Loures, E. de F. R., & Ramos, L. F. P. (2017). Past, present and future of Industry 4.0 - a systematic literature review and research agenda proposal. *International Journal of Production Research*, *55*(12), 3609-3629. doi: 10.1080/00207543.2017.1308576

Mazurek, G. (2019). *Transformacja cyfrowa - perspektywa marketingu* [*Digital transformation - a marketing perspective*]. Warszawa, Poland: PWN.

Mazurek, G., & Nosalska, K. (2018). Wykorzystanie marketingu treści na rynku przemysłowym B2B – badania empiryczne [The use of content marketing on the B2B industrial market – empirical research]. *Marketing i Rynek*, *4*, 405-416.

Mazurek, G. (2014). Network Value Creation Through Marketing. *Management and Business Administration. Central Europe*, *22*(4/127), 70-77.

McKinsey Global Institute. (2015). *The Internet of Things: Mapping the Value Beyond the Hype*. Retrieved from https://www.mckinsey.com/~/media/McKinsey/Business Functions/McKinsey Digital/Our Insights/The Internet of Things The value of digitizing the physical world/Unlocking_the_potential_of_the_Internet_of_Things_Executive_summary.ashx

Mittal, S., Kahn, M. A., Romero, D., & Wuest, T. (2017). Smart Manufacturing: Characteristics, Technologies and Enabling Factors. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*. doi: 10.1177/0954405417736547

Moore, J. F. (1993). Predators and Prey: A New Ecology of Competition. *Harvard Business Review* (May-June).

Pfohl, H.-C., Yahsi, B., & Kuznaz, T. (2015). The impact of Industry 4.0 on the Supply Chain. *Proceedings of the Hamburg International Conference of Logistic (HICL)-20* (August), 32-58. doi: 10.13140/RG.2.1.4906.2484

Planing, P., Pfoertsch, W., & AG, D. (2016). The Digital Business Transformation Paths From Manufacturer To Digital Ecosystem Provider - Analyzing the Strategic Options of Large Corporations Towards Digitalization. *Summer Internet Proceedings*, *18*(2), 66-70.

Reinhard, G., Jesper, V., & Stefan, S. (2016). *Industry 4.0: Building the digital enterprise*. *PwC*. Retrieved from www.pwc.com/industry40

Rolls-Royce. (2014). TotalCare. Retrieved from https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/investors/results/presentations-and-briefings/2014-totalcare-tony-wood-tcm92-57735.pdf

Saarikko, T., Westergren, Ulrika H., & Blomquist, T. (2017). The internet of things: Are you ready for the Internet of Things? *Business Horizons*, *60*, 667-676. doi: 10.1016/j.bushor.2017.05.010

Sandengen, O. C., Estensen, L. A., Rodseth, H., & Schjolberg, P. (2016). High Performance Manufacturing - An Innovative Contribution towards Industry 4.0. *Proceedings of the 6th International Workshop of Advanced Manufacturing and Automation*, *24*(Iwama), 14-20. doi:10.2991/iwama-16.2016.3

Saucedo-Martínez, J. A., Pérez-Lara, M., Marmolejo-Saucedo, J. A., Salais-Fierro, T. E., & Vasant, P. (2017). Industry 4.0 framework for management and operations: a review. *Journal of Ambient Intelligence and Humanized Computing*, *June*. doi: 10.1007/s12652-017-0533-1

Scholz, J., & Smith, A. N. (2016). Augmented reality: Designing immersive experiences that maximize consumer engagement. *Business Horizons*, *59*(2), 149-161. doi: 10.1016/j.bushor.2015.10.003

Schröder, S. (2018). Simulation and Virtual Realities: Training in the Virtual World. Retrieved from https://www.siemens.com/innovation/en/home/pictures-of-the-future/digitalization-and-software/simulation-and-virtual-reality-immersive-training-in-virtual-worlds.html

Sterev, N. (2017). Marketing Leadership: the Industry 4.0 Need of Next Generation Marketing. *Trakia Journal of Sciences*, *15*, 99-103. doi: 10.15547/tjs.2017.s.01.018

Strandhagen, J. W., Alfnes, E., Strandhagen, J. O., & Vallandingham, L. R. (2017). The fit of Industry 4.0 applications in manufacturing logistics: a multiple case study. *Advances in Manufacturing*, *5*(4), 344-358. doi: 10.1007/s40436-017-0200-y

Subramaniam, M., Iyer, B., & Venkatraman, V. (2019). Competing in digital ecosystems. *Business Horizons*, *62*, 83-94. doi: 10.1016/j.bushor.2018.08.013

Teece, D. J., & Linden, G. (2017). Business models, value capture, and the digital enterprise. *Journal of Organization Design*, *6*(8). doi: 10.1186/s41469-017-0018-x

The Telgraph. (2017). E*nd of the supermarket? Big brands sign up for high-tech service that could cut prices by a third.* Retrieved from https://www.telegraph.co.uk/

news/2017/10/31/end-supermarket-britains-biggest-brands-sign-direct-selling/

Tupa, J., Simota, J., & Steiner, F. (2017). Aspects of Risk Management Implementation for Industry 4.0. *Procedia Manufacturing*, *11*(June), 1223-1230. doi: 10.1016/j.promfg.2017.07.248

Uhlemann, T. H. J., Lehmann, C., & Steinhilper, R. (2017). The Digital Twin: Realizing the Cyber-Physical Production System for Industry 4.0. *Procedia CIRP*, *61*, 335-340. doi: 10.1016/j.procir.2016.11.152

Wang, S., Wan, J., Li, D., & Zhang, C. (2016). Implementing Smart Factory of Industrie 4.0: An Outlook. *International Journal of Distributed Sensor Networks*, *2016*. doi: 10.1155/2016/3159805

Wang, Y., Ma, H. S., Yang, J. H., & Wang, K. S. (2017). Industry 4.0: a way from mass customization to mass personalization production. *Advances in Manufacturing*, *5*(4), 311-320. doi: 10.1007/s40436-017-0204-7

Westerman, G., Tannou, M., Bonnet, D., Ferraris, P., & McAfee, A. (2012). The Digital Advantage: How Digital Leaders Outperform their Peers in Every Industry. *MIT Sloan Management Review*, 1-24. Retrieved from https://www.capgemini.com/fi-en/wp-content/uploads/sites/27/2017/07/The_Digital_Advantage__How_Digital_Leaders_Outperform_their_Peers_in_Every_Industry.pdf

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 5 June 2019
accepted: 10 September 2019

pages: 21-28

Operationalising Responsible Research and Innovation – tools for enterprises

Lukasz Nazarko, Borisas Melnikas

ABSTRACT
Responsible Research and Innovation (RRI) is an emerging paradigm and a novel approach to governing science and innovation with the aim of making them ethically acceptable and socially desirable. RRI concept has become a popular term as a result of making it a cross-cutting theme for the Horizon 2020 Framework Programme. Up to date, research on the topic has focused on conceptual problems (relation with similar concepts as well as ethical, moral, philosophical, cultural underpinnings and assumptions) and on the possibilities of making the concept relevant to the Research & Innovation community in Europe and worldwide. Despite some initial efforts, there is still a need to further develop methods and techniques that could make RRI a useful framework for conducting innovation activities, especially in the business environment. The aim of this paper is to propose a range of approaches that help operationalise RRI. The approaches employ methods such as weighted indicators, maturity models and scorecards.

KEY WORDS
Responsible Research and Innovation, responsibility, innovation, engineering, technology management, Technology Assessment

DOI: 10.2478/emj-2019-0017

Corresponding author:

Lukasz Nazarko

Vilnius Gediminas Technical University, Lithuania
e-mail: l.nazarko@ieee.org

Borisas Melnikas

Vilnius Gediminas Technical University, Lithuania
e-mail: borisas.melnikas@vgtu.lt

Introduction

Technological progress and radical innovation carry promise of a higher life quality but at the same time are inseparably connected with risks and uncertainties. Many inventions also raise critical ethical issues. Genetically modified organisms (including food), vaccinations (especially for children), shale gas drilling, gene editing, mass surveillance, nanotechnologies, robotics, brain-machine interface – these are just examples of controversial topics where hopes and fears collide in society. Supporters and opponents of particular scientific and technological achievements may have very diverse mixes of values and beliefs. They support their positions with scientific evidence and economic considerations that may overlap or diverge. In this context, strong tensions may arise.

OECD identifies several trends that are currently prominent in the Science, Technology and Innovation (STI) policy practices. The first trend is related to design thinking and experimentation as novel approaches to policy formulation and delivery, with the aim of making STI policy more agile. The second trend concerns the digitalisation of STI policy which enables basing the policy on evidence that can be uncovered thanks to sophisticated big data analysis techniques. The last trend, which is relevant to the topic of this paper, is the growing influence of Responsible Research and Innovation, which places greater emphasis on broader public engagement in STI policymaking (OECD, 2016).

There is a growing tendency to see science, technology and innovation not as a goal *per se* but a crucial means to tackle societal problems and Grand Challenges. This calls for an inclusive, anticipatory governance of technological change that includes assessment of benefits and costs and an active shaping of future development pathways. In this light, increased attention is paid to a concept called Responsible Research and Innovation (RRI).

Since the introduction of the RRI concept around 2011, RRI principles have diffused into policy agendas, funding programmes and governance arrangements. European Commission has funded dozens of RRI-related projects with the amount of more than 100 million EUR (Nazarko, 2019). The aims of those projects were related to grounding the RRI concept in the current theory and making this concept relevant to various groups of stakeholders. In author's opinion, the challenge that still needs further effort concerns the perception and reception of RRI in the business/industry environment. This paper's goal is to contribute to this effort by proposing several approaches to operationalising RRI for enterprises. The work starts by summarising the current discourse on the topic of responsibility in research and innovation. Next, it reviews the achievements of projects that aimed at developing RRI-related tools for enterprises. Finally, author's original concepts of RRI-related tools are proposed. The paper ends with conclusions and indication of further research directions.

1. Responsible Research and Innovation – concept still under construction

Responsibility is a term that, at the first glance, is non-controversial. Everyone agrees that people, businesses, state institutions should be responsible and act responsibly. However, there is no clarity as to what it means to be responsible or act responsibly in the context of research and innovation activity. As Pavie et al. (2014) conclude, responsibility for a firm is just as hard to define as for an individual. In the recent years, a number of definitions and interpretations of RRI has been proposed (Tab. 1).

The third column of Tab. 1 is the evidence of how diverse the perspectives on RRI might be. At the same time, some common lines of thought can also be distinguished: shared responsibility among various stakeholders, future orientation, focus on societal and environmental challenges, stress on reflection, deliberation, openness and inclusion.

Ceicyte (2019) presents a useful distinction between normative and processual approach to RRI (Tab. 2). Having in mind the variety of approaches to RRI it is necessary to delineate the boundaries of research field(s) that deal with RRI. The same author provides a comprehensive overview of perspectives though which RRI can be analysed (Tab. 3).

Performed literature review resulted in the conclusion that a large portion of earlier scientific publications about RRI relate more to STI policy actors and public institutions rather than to industry (Grunwald, 2014). This is also reflected in the composition of project consortia that have ran RRI-related activities funded through European Union's Horizon 2020 programme. Clear majority of the consortia members are universities and public funding agencies with for-profit organisations constituting less than 15% of all participants (Nazarko, 2019). However, recent publications address the business context more intentionally (Halme and Korpela, 2013; Gurzawska et al., 2018). The awareness is rising among scholars and policy makers that making RRI relevant to enterprises is the primary challenge and the ultimate test of the significance of RRI as a conceptual framework guiding innovation. This paper attempts to strengthen the RRI concept and contribute to the current discourse (Flipse et al., 2015) by offering ideas for operationalising RRI at the organisational level.

2. Overview of RRI-related initiatives

Reflection on responsibility in the context of research and innovation activity is not a new phenomenon and it has been present in academic, policy and business circles for decades. However, the very

Tab. 1. Definitions and interpretations of RRI

Author(s)	Definition/Interpretation	Distinguishing elements
Sutcliffe (2011)	1. The deliberate focus of research and the products of innovation to achieve a social or environmental benefit 2. The consistent, ongoing involvement of society, from beginning to end of the innovation process, including the public & non-governmental groups, who are themselves mindful of the public good 3. Assessing and effectively prioritising social, ethical and environmental impacts, risks and opportunities, both now and in the future, alongside the technical and commercial 4. Where oversight mechanisms are better able to anticipate and manage problems and opportunities and which are also able to adapt and respond quickly to changing knowledge and circumstances 5. Where openness and transparency are an integral component of the research and innovation process	Social or environmental benefit as the main goal Involvement of society Assessing social, ethical and environmental risks Anticipatory and adaptive Open and transparent
Grunwald (2011)	RRI as a new umbrella term with new accentuations which may be characterized by: - involving ethical and social issues more directly in the innovation process by - integrative approaches to development and innovation; - bridging the gap between innovation practice, engineering ethics, technology assessment, governance research and social sciences (STS); - giving new shape to innovation processes and to technology governance according to responsibility reflections in all of its three dimensions mentioned above; - in particular, making the distribution of responsibility among the involved actors as transparent as possible	Distribution of Responsibility Reflection about responsibility at all levels of the innovation process
Geoghegan-Quinn (2012)	Responsible Research and Innovation means that societal actors work together during the whole research and innovation process in order to better align both the process and its outcomes, with the values, needs and expectations of European society. RRI is an ambitious challenge for the creation of a Research and Innovation policy driven by the needs of society and engaging all societal actors via inclusive participatory approaches	Alignment of processes and its outcomes with the society's values, needs and expectations
von Schomberg (2012)	A transparent, interactive process by which societal actors and innovators become mutually responsive with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)	Multidirectional (mutual) responsibility of societal actors Ethical acceptability Social desirability
van den Hoven (2013 and 2014)	Responsible Innovation is an activity or process which may give rise to previously unknown designs either pertaining physical world (...), the institutional world (...) or combinations of these, which when implemented expand the set of relevant feasible options regarding solving a set of moral problems	Providing new options for solving pertaining moral/ethical problems
Stigloe et al. (2013)	Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present	Future-oriented look at collective responsibility
Owen et al. (2013)	The first and foremost task for responsible innovation is then to ask what futures do we collectively want science and innovation to bring about, and on what values are these based?	Collective nature of RRI processes Future orientation
Stahl (2013)	RRI is a higher-level responsibility that aims to shape, maintain, develop, coordinate and align existing and novel research and innovation-related processes, actors and responsibilities with a view to ensure desirable and acceptable research outcomes	RRI as meta-responsibility
Pavie and Carthy (2013)	RRI is an iterative process throughout which the project's impacts on social, economic and environmental factors are, where possible, measured and otherwise taken into account at each step of development of the project, thereby guaranteeing control over, or at least awareness of, the innovation's impacts throughout the entire life cycle	Relevance for business context Reflection on impact through the entire product life cycle
Wilford (2015)	RRI re-engages the individual with personal responsibility at the same time as reinforcing institutional responsibility. This means that RRI creates a step-change in the way that those who are engaged in research and innovation should consider the impact of what they do	Combination of personal responsibility and institutional responsibility
Gianni (2016)	RRI is a model and an active process by which we can achieve the social objectives set by the European Commission, i.e. the development of research and innovation for the sake of increasing the general level of well-being in democratic societies.	Duality of RRI: model (normative dimension) and process (processual dimension) RRI valid in a democratic society

Tab. 2. Conceptual distinction between normative and processual approach to RRI

Responsible Research and Innovation	RRI as a **normative goal**	To tackle the Grand Challenges, solve moral/ethical issues connected scientific and technological development
	RRI as a **normative process**	Making sure that the R&I activities follow the principles of anticipation, inclusion, reflexivity and responsiveness

Source: author's elaboration on the basis of (Ceicyte, 2019).

Tab. 3. Boundaries of the research field and research focus regarding RRI

Responsible Research and Innovation					
Research Subdiscipline	Public Governance	Science and Technology Studies	Business Ethics / CSR	Philosophy of Management	Innovation and Technology Management
Systemic dimension	micro		meso		macro
Sectoral dimension	Industry/Business		Public Administration/Policy Bodies		Universities and Research Institutions
Organisational dimension	Micro (individuals in an organisation)		Meso (teams)		Macro (organization as a whole)
Place in innovation ecosystem	Input		Throughput		Output
Innovation type	Low-tech innovation			High-tech innovation	

Source: author's elaboration on the basis of (Ceicyte, 2019).

concept of RRI is relatively new (about 8 years since its introduction in the EU jargon) and, as a matter of fact, quite Europocentric. Nevertheless, one can notice that principles similar to those included in the RRI concept have been integrated into innovation policy agendas in some non-EU countries too. Japan's 5th S&T Plan for 2016-2020 focuses on sustainable growth and solving global problems. Funding agencies in Norway and Peru have also been targeted to mainstream RRI principles (OECD, 2016). In the USA, STIR (Socio-Technical Integration Research) project offers an experimental platform for scientists and engineers to incorporate the RRI thinking into their activities.

Horizon 2020 and other EU programmes like Interreg focus on societal challenges and have provided funding for a number RRI-related projects. About 500 participants from ca. 50 countries formed consortia to implement RRI-related projects in the framework of the H2020 programme. Only 5% participants represented non-European countries (Nazarko, 2019). Low number of cross-continental partnerships is a serious problem if RRI is to be promoted globally (van de Poel et al., 2017).

Conducted projects resulted in the development of several interesting self-assessment and self-reflection tools oriented at business actors. "Responsible innovation flash diagnostic" and responsible innovation criteria have emerged from the Karim project (KARIM, 2014). Responsibility Navigator of the ResAgorA project presents a process-oriented view and suggests ten RRI-related principles divided in three groups: 1) Ensuring Quality of Interaction, 2) Positioning and Orchestration, 3) Developing Supportive Environments (ResAgorA, 2016). Classical RRI policy agendas (Ethics, Gender Equality, Governance, Open Access, Public Engagement, Science Education) form the backbone of a comprehensive self-reflection tool developed in the framework of the RRI Tools project. ORBIT Self-Assessment Tool presents a more focused approach as it serves needs of the ICT sector in the United Kingdom (Stahl, 2017). Self-relflection and in-depth assessment tools have also been developed in the ROSIE project ("Responsible and Innovative SMEs in Central Europe"). It is the only project so far that is addressed at enterprises in Central Europe.

Based on the results achieved in the mentioned projects, the following section offers author's original contribution to the development of RRI tools suitable for enterprises.

3. Proposals for Operationalising Responsible Research and Innovation

This section is a result of research performed by the author with the aim of formulating possible and

feasible approaches to implementing RRI in enterprises. The approaches concern either the product (economic viability, ethical acceptability, sustainability, social and environmental desirability) or the process (ethics as a design factor, moral responsibility, legal liability) dimensions of RRI (von Schomberg, 2013).

3.1. Applying weighted responsibility criteria

Innovation may lead to the simultaneous improvement of all (economic, ethical, environmental, social) parameters of a particular product or service. However, a more realistic situation involves the consideration of alternative costs and trade-offs. For example, increasing product's environmental friendliness decreases its economic viability or addressing certain social needs in a designed service may have adverse environmental consequences.

By considering the issue of moral overload (van den Hoven et al., 2012) and enhancing Pavie's proposal (Pavie et al., 2014), the following principle could be applied when assessing if innovation meets RRI criteria:

$$\alpha \mathbf{V}\mathrm{Econ}_{t1} + \beta \mathbf{V}\mathrm{Social}_{t1} + \gamma \mathbf{V}\mathrm{Env}_{t1} > \alpha \mathbf{V}\mathrm{Econ}_{t0} + \\ + \beta \mathbf{V}\mathrm{Social}_{t0} + \gamma \mathbf{V}\mathrm{Env}_{t0}$$

where,
VEcon – contribution of a product/service to economic efficiency and welfare,
VSocial – contribution of a product/service to addressing social problem(s),
VEnv – contribution of a product/service to protecting the natural environment,
t0 – time before the introduction of innovation,
t1 – time after the introduction of innovation,
α – weight of the economic criterion,
β – weight of the social criterion,
γ – weight of the environmental criterion.

It may be noted that weights α, β and γ play a key role in determining the final result of the equation. Determining weights in this context is non-trivial as different stakeholders in the innovation ecosystem will have different views and priorities. In this context, Analytic Hierarchy Process (AHP) could be applied to determine weights. The following characteristics of this method are especially suitable in determining weights of economic, social and environmental value of innovation in the context of RRI principles: 1) AHP derives ratio scales from paired comparisons of criteria, and allows for some small inconsistencies in judgments, 2) Inputs can be actual measurements, but also subjective opinions (Goepel, 2018).

Another interesting evolution of this approach could be the application of Data Envelopment Analysis (DEA) to managing innovation projects portfolio with the focus on their "responsibility potential" (Chodakowska and Nazarko, 2017). Competing innovation roadmaps/trajectories could be evaluated with DEA with the view on how well they transform inputs (e.g. resources and time needed to complete the innovation process) into outputs (economic, social and environmental added value resulting from innovation).

3.2. Applying RRI maturity models

Maturity models are used to evaluate companies and organisations in different aspects of their operation (Rohrbeck, 2011). Some authors propose the application of responsibility maturity models to help companies realise what their level of engagement in RRI-related issues is (Stahl et al., 2017; Pavie et al., 2014). Maturity models related to RRI are more focussed on process (Anticipation, Inclusion, Reflexivity, Responsiveness) rather than on products of innovation. Tab. 4 offers a synthesis of three approaches that could be used in applying RRI maturity models (as they are or as a starting point for customised tools).

Tab. 4. Examples of RRI maturity models

Maturity level	Level name by Pavie et al. (2014)	Level name- by Stahl et al. (2017)	Level name- by Hedstrom (2019)
1	Comply with the law	Unaware	Engaging
2	Anticipating future legal requirements	Exploratory/ reactive	Accelerating
3	Thinking the value chain as an ecosystem	Defined	Leading
4	Developing responsible products and services	Proactive	Transforming
5	Leading the change (communicating and educating to responsibility, create standards, developing responsible business models)	Strategic	-

Source: author's elaboration on the basis of (Stahl et al., 2017; Pavie et al., 2014).

It is worth mentioning that maturity models could be effectively combined with the scorecard approach described below.

3.3. Applying RRI scorecards

Scorecards are rating systems developed to facilitate improvement, comparison and reflection. They are effective benchmarking tools. They are created to be filled in by one entity. It may be used to track company's progress over time or to monitor enterprise's position in the sector (if the same scorecard is used and made public by other companies). Creating an RRI scorecard and distributing it among companies in a particular sector or region may be an instrument of positive competition and a move towards excellence in implementing responsibility approach to innovation.

RRI scorecards may use different criteria and different levels of detail. Criteria may be divided by RRI policy agendas (Ethics, Gender Equality, Governance, Open Access, Public Engagement, Science Education), RRI processual requirements (Anticipation, Inclusion, Reflexivity, Responsiveness), or a wider set of RRI principles (Ethics, Gender equality, Governance, Open Access, Public Engagement, Science Education, Sustainability, Risk Management, Human Wellbeing, Anticipation, Reflexivity, Deliberation, Inclusion, Responsiveness). Example of RRI scorecard is presented in Fig. 1.

Conclusions

Key role of science, technology and innovation in tackling global and societal challenges has already been acknowledged by governments across the globe. Ageing, spread of non-communicable diseases, food scarcity, pollution, depletion of Earth's resources, are among those issues that are hoped to be effectively dealt with thanks to the scientific and technological progress. Such view is reflected in the Daejeon Declaration on STI Policies for the Global and Digital Age signed by the ministers of OECD countries. The declaration reiterates the commitment to support science, technology and innovation to foster sustainable economic growth, job creation and enhanced wellbeing (OECD, 2015).

At the same time, it is evident that ethical and moral implications of research and innovation will

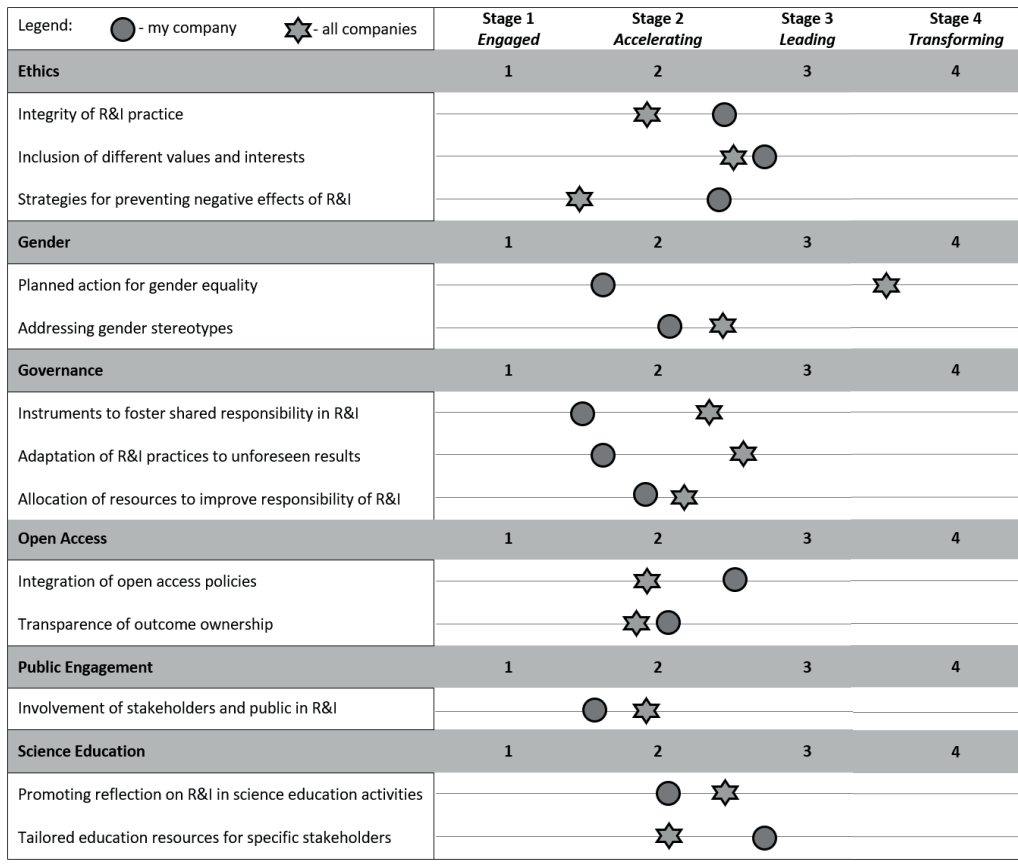

Fig. 1. Example of a RRI scorecard
Source: author's elaboration on the basis of (Pavie et al., 2014; Hedstrom, 2019) and RRI Tools.

put scientists and the R&I community under a closer surveillance and, possibly, critique. Educating the public about science and technology will move towards a more active involvement of different social groups in the science and innovation ecosystems. As noted by OECD, this may put additional pressure on science to provide clear and unambiguous answers and solutions, though it is perhaps just as likely that it will not, since involved citizens may come to better appreciate the provisional nature of much scientific evidence (OECD, 2016).

The RRI policy mix is far from simple and institutionalisation of RRI will not automatically lead to the emergence of a truly responsive, inclusive and reflexive approach to governing innovation (Genus and Iskandarova, 2018). Variety of policy instruments must be put in place at different stages of the R&I processes and at different stages of the policy cycle. There has appeared a tendency to design public and private interventions as dynamic processes that are prudent and preliminary rather than assertive and persistent (Kuhlman et al., 2019).

Operationalising the vision of Responsible Research and Innovation in a form of new priorities, evaluation criteria, corporate practices and governance arrangements will remain a major challenge for a long time. The general ideas of RRI tools for enterprises presented in this paper should be further analysed and developed.

Fears that RRI may be a hampering and delaying factor in scientific progress and may weaken the innovation capabilities and the competitive capacity of national economies are reasonable and should not be ignored. These tensions should be a subject of an in-depth interdisciplinary discussion that involves researchers from fundamental, applied and social sciences as well as humanities. Assessment of the trajectories of emerging technologies would be more holistic and would better relate to the RRI imperatives if future-oriented methodologies (Ejdys and Nazarko, 2014; Ejdys et al., 2015; Halicka, 2015; Nazarko et al., 2015) were utilised more extensively in these processes.

Acknowledgment

This project has received funding from European Social Fund (project No 09.3.3-LMT-K-712-02-0155) under grant agreement with the Research Council of Lithuania (LMTLT).

Literature

Chodakowska, E., & Nazarko, J. (2017). Network DEA Models for Evaluating Couriers and Messengers. *Procedia Engineering*, *182*, 106-111. doi: 10.1016/j.proeng.2017.03.130

Ceicyte, J. (2019). *Implementing responsible innovation at the firm level*. Kaunas, Lithuania: Kaunas University of Technology.

Ejdys, J., & Nazarko, Ł. (2014). Foresight gospodarczy - instrumentem orientacji na przyszłość [Economic foresight as an instrumentof a future-oriented strategy]. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, *340*, 651-664.

Ejdys, J., Nazarko, J., Nazarko, L., & Halicka, K. (2015). Foresight application for transport sector. In M. Fiorini (Ed.), *Clean Mobility and Intelligent Transport Systems* (pp. 379-402). London, Great Britain: The Institution of Engineering and Technology. doi: 10.1049/PBTR001E_ch17

Flipse, S. M., Van Dam, K. H., Stragier, J., Oude Vrielink, T. J. C., & Van der Sanden, M. C. A. (2015). Operationalizing responsible research innovation in industry through decision support in innovation practice. *Journal of Chain and Network*, *15*(2), 135-146. doi: 10.3920/JCNS2015.x004

Genus, A., & Iskandarova, M. (2018). Responsible innovation: its institutionalisation and a critique. *Technological Forecasting and Social Change*, *128*, 1-9. doi: 10.1016/j.techfore.2017.09.029

Geoghegan-Quinn, M. (2012). Responsible Research and Innovation. *Europe's ability to respond to societal challenges. Proceedings of the Science in Dialogues - Towards a European Model for Responsible Research and Innovation.* Odense, Denmark, 23-35.

Gianni, R. (2016). *Responsibility and Freedom. The Ethical Realm of RRI*. London and Hoboken: ISTE and John Wiley & Sons.

Goepel, K. D. (2018). Implementation of an Online Software Tool for the Analytic Hierarchy Process (AHP-OS). *International Journal of the Analytic Hierarchy Process*, *10*(3), 469-487. doi: 10.13033/ijahp.v10i3.590

Grinbaum, A., & Groves, C. (2013) What is "responsible" about "responsible innovation"? In R. Owen, J. Bessant, & M. Heintz (Eds.), *Responsible Innovation. Managing the Responsible Emergence of Science and Innovation in Society* (pp. 119-142). Chichester, Great Britain: John Wiley & Sons.

Grunwald, A. (2011). Responsible Innovation: Bringing together Technology Assessment, Applied Ethics, and STS research. *Enterprise and Work Innovation Studies*, *10*, 9-31.

Grunwald, A. (2014). Technology assessment for responsible innovation. In J. van den Hoven, N. Doorn, T. Swiestra, B. J. Koops, & H. A. Romijn (Eds.), *Responsible Innovation 1* (pp. 15-31). Dordrecht, The Netherlands: Springer.

Gurzawska, A., Mäkinen, M., & Brey, P. (2017). Implementation of Responsible Research and Innovation (RRI) practices in industry: Providing the right incentives. *Sustainability*, *9*(10), 1759. doi: 10.3390/su9101759

Halicka, K. (2017). Main Concepts of Technology Analysis in the Light of the Literature on the Subject. *Procedia Engineering*, *182*, 191-298. doi: 10.1016/j.proeng.2017.03.196

Halme, M., & Korpela, M. (2014). Responsible innovation toward sustainable development in small and medium-sized enterprises: a resource perspective. *Business Strategy and the Environment*, *23*(8), 547-566. doi: 10.1002/bse.1801

Hedstrom, G. S. (2019). *Sustainability: What It Is and How to Measure It*. Boston-Berlin: Walter de Gruyter. doi: 10.1515/9781547400423-202

Inzelt, A., & Csonka, L. (2017). The Approach of the Business Sector to Responsible Research and Innovation (RRI). Foresight and STI Governance, *11*(4), 63-73. doi: 10.17323/2500-2597.2017.4.63.73

KARIM (2014). Introduction to a guide to entrepreneurs and innovation support organization. Retrieved from http://www.nweurope.eu/media/1118/guide_online.pdf

Kuhlman, S., Stegmaier, P., & Konrad, K. (2019). The tentative governance of emerging science and technology — A conceptual introduction. *Research Policy*, *48*(5), 1091-1097. doi: 10.1016/j.respol.2019.01.006

MoRRI (2018). *The evolution of Responsible Research and Innovation in Europe: The MoRRI indicators report*. Retrieved from https://morri.netlify.com/

Nazarko, J., Kuźmicz, K. A., Szubzda-Prutis, E., & Urban, J. (2009). The General Concept of Benchmarking and Its Application in Higher Education in Europe. *Higher Education in Europe*, *34*(3&4), 497-510.

Nazarko, J., Radziszewski, R., Dębkowska, K., Ejdys, J., Gudanowska, A., Halicka, K., Kilon, J., Kononiuk, A., Kowalski, K. J., Król, J. B., Nazarko, Ł., Sarnowski, M., & Vilutienė ,T. (2015). Foresight Study of Road Pavement Technologies. *Procedia Engineering*, *122*, 129-136. doi: 10.1016/j.proeng.2015.10.016

Nazarko, L. (2019). Responsible Research and Innovation – a Conceptual Contribution to Theory and Practice of Technology Management. *Business: Theory and Practice*, *20*, 342-351. doi: 10.3846/btp.2019.32

OECD (2015). *Daejeon Declaration on Science, Technology, and Innovation Policies for the Global and Digital Age*. OECD Ministerial Meeting Daejeon 2015, World Science Forum. Retrieved from https://www.oecd.org/sti/daejeon-declaration-2015.htm

OECD (2016). *OECD Science, Technology and Innovation Outlook 2016*. Paris. doi:10.1787/sti_in_outlook-2016-en

Owen, R., Stigloe, J., Macnaghten, P., Gorman, M., Fisher, E., & Guston, D. (2013). A framework for responsible innovation. In R. Owen, J. Bessant, & M. Heintz (Eds.), *Responsible Innovation. Managing the Responsible Emergence of Science and Innovation in Society* (pp. 27-50). Chichester, Great Britain: John Wiley & Sons.

Pavie, X., & Carthy, D. (2013). Responsible-innovation in practice: How to implement responsibility across an organization. *Cahier Innovation & Society*, *33*.

Pavie, X., Scholten, V., & Carthy, D. (2014). *Responsible innovation: From concept to practice.* Singapore: World Scientific Publishing.

ResAgorA (2016). *Responsibility Navigator*. Retrieved from https://responsibility-navigator.eu/navigator/

Rohrbeck, R. (2011). *Corporate Foresight: Towards a Maturity Model for the Future Orientation of a Firm*. Berlin Heidelberg: Springer-Verlag.

RRI Tools (undated). *Self-Reflection Tool*. Retrieved from https://www.rri-tools.eu/self-reflection-tool

Stahl, B. (2013). Responsible research and innovation: The role of privacy in an emerging framework. *Science and Public Policy, 40*(6), 708-716. doi:10.1093/scipol/sct067

Stahl, B. C. (2017). The ORBIT Self-Assessment Tool. *ORBIT Journal, 1*(2). doi: 10.29297/orbit.v1i2.59

Stahl, B. C., Obach, M., Yaghmaei, E., Ikonen, V., Chatfield, K., & Brem, A. (2017). The Responsible Research and Innovation (RRI) Maturity Model: Linking Theory and Practice. *Sustainability*, *9*(6), 1-19. doi: 10.3390/su9061036

Stigloe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework from responsible innovation. *Research policy*, *42*(9), 1568-1580. doi: 10.1016/j.respol.2013.05.008

Sutcliffe, H. (2000). *A Report on Responsible Research and Innovation*. Retrieved from https://ec.europa.eu/research/science-society/document_library/pdf_06/rri-report-hilary-sutcliffe_en.pdf

van de Poel, I., Asveld, L., Flipse, S., Klaassen, P., Scholten, V., & Yaghmaei, E. (2017). Company Strategies for Responsible Research and Innovation (RRI): A Conceptual Model. *Sustainability, 9*(11), 2045. doi: 10.3390/su9112045

van den Hoven, M. J., Lokhorst, G., & van de Poel, I. (2012). Engineering and the problem of moral overload. *Science and Engineering Ethics*, *18*, 1-13. doi: 10.1007/s11948-011-9277-z

van den Hoven, J. (2013). Value sensitive design and responsible innvation. In R. Owen, J. Bessant, & H. Heintz (Eds.), *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society* (pp. 75-83). London, Great Britain: John Wiley.

van den Hoven, J. (2014). Responsible Innovation: A new look at technology ethics. In J. van den Hoven, N. Doorn, T. Swiestra, B. J. Koops, & H. A. Romijn (Eds.), *Responsible Innovation 1* (pp. 3-13). Dordrecht, The Netherlands: Springer.

von Schomberg, R. (2012). Prospects for technology assessment in a framework of responsible research and innovation. In M. Dusseldorp, & R. Beecroft (Eds.), *Technikfolgen abschätzen lehren* (pp. 39-61). Wiesbaden: VS Verlag für Sozialwissenschaften.

von Schomberg, R. (2013). A vision of responsible innovation. In R. Owen, J. Bessant, & H. Heintz (Eds.), *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society* (pp. 51-74). London, Great Britain: John Wiley.

Wilford, S. H. (2015). What is required of requirements? A first stage process towards developing guidelines for responsible research. *SIGCAS Computers and Society*, *45*(3), 348-355. doi: 10.1145/2874239.2874291

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 30 April 2019
accepted: 15 September 2019

pages: 29-37

Development of intelligent agents through collaborative innovation

Mateusz Kot, Grzegorz Leszczyński

ABSTRACT
This study focuses on the development of a specific type of Intelligent Agents — Business Virtual Assistants (BVA). The paper aims to identify the scope of collaboration between users and providers in the process of agent development and to define the impact that user interpretations of a BVA agent have on this collaboration. This study conceptualises the collaboration between providers and users in the process of the BVA development. It uses the concept of the collaborative development of innovation and sensemaking. The empirical part presents preliminary exploratory in-depth interviews conducted with CEOs of BVA providers and analyses the use of the scheme offered by Miles and Hubermann (1994). The main results show the scope of the collaboration between BVA users and providers in the process of the BVA development. User engagement is crucial in the development of BVA agents since they are using machine learning algorithms. The user interpretation through sensemaking influences the process as their attitudes guide their behaviour. Apart from that, users have to adjust to this new kind of entity in the market and learn how to use it in line with savoir-vivre rules. This paper suggests the need to develop a new approach to the collaborative development of innovation when Artificial Intelligence is involved.

KEY WORDS
Business Virtual Assistants, artificial intelligence, innovation development

DOI: 10.2478/emj-2019-0018

Corresponding author:

Mateusz Kot

Poznań University
of Economics and Business, Poland
e-mail: Mateusz.Kot@ue.poznan.pl

Grzegorz Leszczyński

Poznań University
of Economics and Business, Poland
e-mail: g.leszczynski@ue.poznan.pl

Introduction

Artificial Intelligence technology provides a revolutionary way of collaboration to create innovative products and services and to deliver value for customers. The development of Artificial Intelligence technology gives rise to new challenges and spurs innovations in the process of its development. The reason behind such an effect is the nature of such intelligence, especially machine learning, which gives it the opportunity to develop not only in the traditional way of gathering feedback but also through the observation and analysis of the ongoing interactions with users.

This paper focuses on the collaborative development of intelligent agents and the potential influence that user interpretations of a Business Virtual Assis-

tant (BVA) have on the development of such innovations. The willingness to cooperate can be influenced by actor opinions regarding a BVA or the collaboration with the provider. The way collaborative innovation is performed depends heavily on the way a BVA will be used, and this depends on the attitude of users towards it.

Human actors that use a BVA are placed in a situation, in which they have to communicate with an artificial entity instead of a human being, which can result in various types of attitudes. Therefore, this paper aims to (1) identify the scope of collaboration between BVA users and providers in the process of the development of a BVA software agent, and (2) define the impact that user interpretations of a BVA agent have on this collaboration. This paper connects the concepts of collaborative innovation and sensemaking to reach the research aims. Therefore, this is a multiple-lens contribution (Nicholson et al., 2018). The paper also presents some research questions, the answers to which are based on the preliminary qualitative study. Finally, conclusions are offered.

1. BVA in Business Interactions

Research on Artificial Intelligence concerns any device that perceives its environment and takes actions to maximise its chances to successfully achieve its goals (Russell and Norvig, 2009). Contemporary Artificial Intelligence is a discrete system that performs selected functions in one of three areas: interactions based on natural language, image recognition, biometrics and learning systems. The use of Artificial Intelligence is discussed in many areas of business, also in enterprise management studies (e.g. El Kadiri et al., 2015). Studies focus on data analysis, market forecasting, customer analysis and relationships (e.g. Gordini and Veglio, 2017); sales (Syam and Sharma, 2018) and supply chains (Vendrell-Herrero et al., 2017). However, a gap seems to remain in the area of investigations regarding the development of Artificial Intelligence technology in collaboration with users.

The advancing development of multifunctional and flexible intelligent agents requires much more research, compared to that which exists on agents that perform only one, narrow task (Adams et al., 2012). Such intelligent agents are Artificial Intelligence systems that perceive and operate in a given environment through actuators (Russell et al., 2015). One of the applications used for intelligent agents is a Virtual Assistant. Virtual assistants are software agents that perform specific tasks or services for their users. For example, consumer markets have such agents as Siri by Apple or Google Assistant, and their aim is mainly to improve the device and user interface with the help of natural voice or a keyboard for communication input. An extension of Google Assistant can even call a service provider or schedule a restaurant reservation. In business settings, Virtual Assistants are currently tasked with the scheduling of meetings, but can also be potentially used for initial communications in sales, or to collect offers in a tender in procurement, or to assists in resolving simple issues related to a service/product in customer care, or to communicate with hotels or airlines and gather invoices to assist in travel planning activities in the field of administration. A BVA interacts with humans in a normal business setting, and it does not require any software coordination between parties. Thus, it can be used by customers and suppliers to interact with an organisation. An assistant communicates by an email interface but introduces itself as an Artificial Intelligence agent and not a human. Still, from the connectionist point of view (Kaplan and Haenlein, 2019), as a BVA has elements of cognitive and emotional intelligence, it can be classified as Human-Inspired AI.

From a marketing point of view, Virtual Assistants obtain some features of a product (as they are, essentially, software) that helps to deliver a service as they assist in some activities (still, it will be referred to as "product" in this paper). BVAs are an innovative product because they offer a better solution for some business activities, making communication and scheduling mode effective (Frankelius, 2009). They also offer a new digital experience to human participants of business interactions (Morgan and Piccinini, 2018). As an innovative product, a BVA requires extensive efforts for its design, construction and development. This paper discusses how it can be done in collaboration with BVA users and what impact user interpretations of a BVA agent have on this collaboration.

2. Collaborative development of innovation

The need to reach outside one's boundaries to innovate is a result of points of knowledge dispersed across the business network (Powell et al., 1996).

A single company is rarely able to innovate on its own, as the process requires external resources to function (Hakansson and Snehota, 1996). Brown and Duguid (1991) showed that the creation of new knowledge and learning are fundamentally a social construction process within a community; in other words, a network. Depending on those points of contact with suppliers, customers or research facilities, innovation can be created (Ford and Redwood, 2005).

The external acquisition of new knowledge to create new products, services or solutions is referred to as "open innovation" (Chesbrough, 2006). Collaborative innovation is a specific way of performing open innovation, with the emphasis on the collaborative process between companies in the effort to innovate (Gallaud, 2013, p. 237). It is not simply an exchange of information or a flow of knowledge from one company to another. Rather, it is two or more actors working together with collaborative attitudes in the effort to innovate, i.e. when "organisations agree to pool their resources or to share their information and knowledge to develop one project" (Gallaud, 2013, p. 237). According to Dahlander and Gann (2010), collaborative innovation is an inbound innovation based on sourcing activities. There is no direct pecuniary re-compensation as both companies work together, sharing resources and information in pursuit of a shared goal. It is especially interesting in the case of collaboration between suppliers and their customers, as innovation may not be a part of a product or service itself, but a form of adaptation to minimise costs (Baldwin and von Hippel, 2011). The collaborative development of innovation as a concept accentuates two aspects of collaboration: resources that need to be exchanged and actors who exchange them.

Collaboration between network actors requires the sharing of resources and extensive communication (Baldwin and von Hippel, 2011). The much needed "flow of knowledge" between actors can differ depending on the degree to which actors rely upon each other, the difference between them and how dynamic is the market (Tracey et al., 2004). Tracey et al. (2004) distinguished three types of knowledge flow: transfer, interpretation and transformation. When the market is stable, and the differences between actors are subtle, knowledge is being transferred almost like information — in an easy, more or less coordinated way. In a more dynamic market, the meaning of events and actors is not as obvious. Therefore, both sides have to interpret the information they receive from the other party and turn it into knowledge. If a market is dynamic, differences between actors are substantial due to the potentially different aims relating to the innovation creation, and knowledge has to be transformed by using boundary objects or other tools.

The participation of a customer (or a user) in the development of a new product has been emphasised by authors, who generally agree, that good relationships with customers have a positive influence on outcomes of new product development (Jer et al., 2013; Cuevas-Rodriguez et al., 2014). Involved customers play a vital role in innovative efforts. At the beginning of this process, they can help in solving problems, launching the product, collecting user comments and sharing responsibility (Cui and Wu, 2016). This is especially important in business markets, where specific knowledge and feedback are required (Eslami and Lakemond, 2016). The literature also underlines that a service is co-created by a service provider and its users. Users heavily influence the outcomes and its later development (Gumesson, 2002). Thus, without the openness of a customer to collaborate in the design, development and improvement of new products or services, the process is less effective. Supposedly, such statement undertakes a new meaning when innovative solutions are based on Artificial Intelligence, as in the case of a BVA.

3. Collaborative development of innovation in the case of a BVA

We can set apart three different approaches to the perception of Artificial Intelligence and the way it should be developed. According to a symbolic approach, Artificial Intelligence is based on mathematical models of analysed problems. In the symbolic approach, Artificial Intelligence in the form of computer programs embodies specific dimensions of intelligence. The sub-symbolic approach involves the creation of structures of machine learning that can find patterns and create predictions basing on Big Data. Finally, there is an agent approach that deals with the development of different forms of autonomous entities that observe the environment through sensors, act using actuators and direct their activity towards achieving goals (Nilsson, 1998; Russel and Norving, 2009). When it comes to modern intelligent agents, especially virtual assistants, two latter

approaches are important, because they equip those agents with a capability to show the desired behaviour and change it, and to make decisions based on the obtained knowledge and experience.

Researchers have indicated the need to recognise the help of users of a product or a service in the form of participation in the innovation process of digital solutions (Bogers et al., 2017). When considering the collaborative innovation in the case of Virtual Assistants, the aim of the collaboration differs depending on whether the product is being designed or whether it needs to be improved or further developed at a later stage. In the case of the design of Virtual Assistants, human actors are important for helping them to learn how to interact with people. For example, Facebook has been teaching its M virtual assistant using blended Artificial Intelligence and human trainers as beta users. The aim is to teach the agent to communicate like a human rather than in a "robotic" manner. People make mistakes, use different types of hesitation expressions, such as "hmmm", and they do not always behave rationally. Therefore, a BVA must be shaped considering these humans peculiarities. Another issue is to employ cognitive technology to interact with people on multiple related topics and react to the emotional content of a conversation (Ibrahim, 2019). The innovation can be guided by the provider who gathers feedback and improves algorithms, but more importantly, it can be left to a BVA, which can develop autonomously, thanks to learning algorithms.

When a BVA is implemented, due to machine learning, cooperation with users becomes particularly important. The technology used by Artificial Intelligence allows monitoring and gathering feedback from customers who use verbal and other types of communication. A BVA agent is based on innovative Artificial Intelligence algorithms that learn and evolve with every encounter. Providers can use collaborative innovation to learn the habits of hosts and guests and improve the software. It can be done using machine learning or by getting feedback from the users. However, machine learning needs interactions with users to evolve, and IT developers need feedback from the users. Therefore, the users of the service willingly or unwarily collaborate with the developer of a BVA.

We assume that in the case of a BVA, collaborative innovation can proceed on two levels — the configuration settings and the core of the service. The configuration settings are the basic way users can adjust the service to its needs. This level represents standard functionality in the software and is not a subject of collaborative innovation. The object of interest is the second level, which refers to the functionality and usability of a BVA, and especially the method used by the provider to collaborate with the host and the guest to improve core functionalities and capabilities of an agent.

Three types of actors are involved in the development and use of a BVA. The first is the provider, which is the company that creates the system and develops it through the collaborative innovation process. The second is the host, which is the organisation that hires the BVA software agents for its employees, who use the BVA to set meetings with other stakeholders. The BVA has access to the host's calendar and can manage it to some degree. The third type of actor is the guest, which is the organisation whose employees want to meet with the host employees and have to interact with the BVA in order to do so. Innovation is a process that happens between the provider, the host and the guest requiring some form of collaboration between them. The provider can observe the behaviour of the users to adjust the software and develop new software capabilities. The types of actors are summarised in Tab. 1.

According to the presented literature review and assumptions made by the authors of this article, collaboration with the immediate users — employees of the host and guest organisations — could be important for the provider not only during the new product development process but also when the agent is used

Tab. 1. Types of actors involved in the Collaborative Development of Innovation in the case of a BVA

Type of actor	Definition
Provider	A Provider is the main developer responsible for the creation of a BVA. The Provider sells the agent to the Host
Host	The Host buys the agent from the Provider. Its employees use it to schedule meetings with other actors inside and outside of their organisation. The BVA learns the habits of the employees and has access to their calendars
Guest	Its employees engage in the interaction with the BVA to schedule a meeting with the Host's employees. They are facing a *fait accompli*

on a daily basis, as it can self-improve thanks to machine learning. Thus, the provider, as well as the BVA, need users to interact with the agent and to share their experience with it. However, the interaction with an artificial entity, such as a BVA that uses normal language, can be extraordinary for human actors. As computer programs can be perceived by their users as social actors (Nass et al., 1994), we do not know how a BVA will be interpreted and what effect this will have on the interaction and the collaborative innovation process. Recent studies have shown that people react differently to Artificial Intelligence agents compared to humans (Mou and Xu, 2017), and the way an agent is constructed can have significant effects on human reactions during the interaction (Ciechanowski et al., 2018). User interpretations can, therefore, impact the collaborative innovation process as they shape attitudes of human actors towards the service. We assume that the motivation to give feedback depends on the perception of a BVA.

Surprising events, such as interaction with an artificial entity, can trigger sensemaking (Weick, 1995; Cornelissen, 2011), which "unfolds as a sequence in which people concerned with identity in the social context of other actors engage ongoing circumstances from which they extract cues and make plausible sense retrospectively, while enacting more or less order into those ongoing circumstances" (Weick, Sutcliffe and Obstfeld, 2005, p. 409). Considering the context in which they find themselves as well as their previous experiences and organisational narratives, human actors assess the situation and act accordingly. For example, this means that regarding the sensemaking, human actors will judge a BVA as more or less worthy of their social response, this way impacting on its ability to learn. Sensemaking can influence the provider's ability to innovate a BVA and the direction, in which the agent will evolve. This is due to the fact that the Artificial Intelligence algorithm needs vast amounts of information from users and may be affected depending on the quality of their response and their willingness to cooperate in the collaborative innovation process.

According to the constructivist paradigm, a BVA can be assumed as a new entity that evokes intensive sensemaking. This research assumes it to be a process of learning and sharing information with a BVA (such as Artificial Intelligence) and/or with the provider. The process results in an interpretation of the BVA, that can influence the collaborative behaviour of the host and the guest employees towards the BVA agent or its provider. Thus, motives to share the experience with the provider need an explanation (Bogers et al., 2017).

4. Research method

Our basic question is about the collaboration model of the BVA development and the influence of user interpretations of the BVA on their participation in the development process. In the inter-organisational context, the interactions with a BVA occurs on two levels: individual and organisational. The interface between the provider and the users as an organisation and its employees becomes an important study object (Hargrave and van de Ven, 2006). The BVA provider can bring the host and guest organisations together to collaborate but to develop the BVA, it also needs to engage the host and guest staff for they are the actual interlocutors of interactions.

In this study, BVA providers are treated as key informants as they have to deal with the collaboration between hosts and guest to develop the agents. The study consists of three steps: the first step identifies and compares BVA solutions worldwide. Eight companies that offer BVA solutions worldwide were found (Tab. 2).

Tab. 2. Virtual Assistants worldwide

Project name	Based in	Virtual assistant image
Calendar.help (Cortana)	Redmond	Artificial
Clara	San Francisco	Humanoid
Evie	Singapore	Humanoid
Julie Desk	Paris	Humanoid
Konolabs	Seoul	Artificial
Meet Sally	New York	Humanoid
X.ai	New York	Humanoid
Zazu	Amsterdam	Humanoid

In the next step, e-mail, LinkedIn and Facebook invitations were used to ask CEOs of all providers to participate in interviews. Four out of eight CEOs responded to our invitations. However, some of the interviews had to be discarded as some companies were bankrupt. Finally, two in-depth interviews with the CEOs of Kono and Evie companies were conducted. In one, the BVA is available in the form of a Humanoid, and in another, it is a straightforward

artificial image (Tab. 2). These interviews considered three aspects: the role of the BVA in host/guest interaction, the attributes of the BVA promoted to users, their attitude towards the BVA and the development of the agent. Respondents were open to sharing their knowledge and experience; however, they tended to talk about BVA usage and implementations rather than its development. In the last step, the interviews were analysed according to the scheme of analytical work with qualitative data by Miles and Hubermann (1994). Interviews were coded and deconstructed, then interpreted and, finally, reconstructed to show relationships and insights derived in the interpretation phase and to find explanations and refer them to existing theory and practice.

5. Results

Strategically, both BVA cases are focused on business applications where the host is a company trying to increase the effectiveness of its communication in scheduling meetings with the customers. BVAs are not perceived as an Artificial Intelligence phenomenon, but more as a tool for the scheduling of meetings. In the future, BVAs should be able to organise every aspect of a business trip. According to one of the respondents: "We are trying to reduce the number of actions made by a human, by providing these various innovations". For both companies, the key targets are industries that involve the scheduling of vast numbers of meetings, such as Human Resource departments or healthcare and education institutions. In such cases, BVAs can have an important influence on the effectiveness of work and deliver value to the customers.

In both cases, the providers are trying to improve BVAs by observing and analysing interactions between hosts or guests and their agents. They are aware that scheduling of meetings with the help of a BVA, even though it is set to mimic human interactions, has some peculiarities. In internal meeting scheduling, people do not like to give away too much control. So, even though a BVA could schedule an internal meeting single-handedly, the process must involve more points of contact with the users. This makes users feel involved in the decision-making process. In the case of external communication, the rules are almost identical to real human communication ("Rules of behaviour are no different than if you were interacting with any human being; I think people forget that sometimes. They seem to think that there are new rules that apply to Artificial Intelligence when really the old rules apply best"). These rules are most noticeable when it comes to deciding on the appropriateness of the use of an assistant to schedule a meeting. When dealing with important accounts, it can be out of place to use even a human assistant, as a guest might feel unappreciated. For example, in a job interview, most cultures consider it bad manner to include an assistant.

Interactions with human users are crucial for the development of a BVA as both respondents noted that the main assumption is that a BVA must adapt to humans. Due to that, the interface for interactions is e-mail, and the style of the BVA's messages is comparable to those written by a human assistant. The whole process of including a BVA into the conversation is also similar: the host has to CC the bot to add it to the conversation and introduce it in the e-mail. Then, the agent can send the guest a separate e-mail with a list of proposed dates for a meeting.

Associating a BVA with Artificial Intelligence can evoke a certain user attitude. Currently, people are still learning to interact with Artificial Intelligence agents, so different perceptions and anxieties are possible, and they are not necessarily always realistic. On the other hand, due to the same reason, the connotation attached to Artificial Intelligence can elicit reactions that will make interactions with Artificial Intelligence agents more fluent. Guests are not always aware that they exchange emails with an artificial agent. It happens because people expect a reply from a human. This happens despite clearly given information regarding the third party of the conversation being a bot. Therefore, differences are possible in attitudes towards the introduction of a BVA between those who see it as an artificial entity and those who mistake it for a human. The guests who do not realise the true identity of their interlocutor expect that the BVA will show up at the meeting ("People show up for a meeting and ask, "Where is Evie", "Will Evie be joining us for a meeting". It is not because we want to fool them but because the interaction is more like what people expect from a human being"). For now, as one of the respondents mentioned, this is an interesting topic for the users to discuss. However, this situation is typical for the introductory stage of the product and may be irrelevant in the following stages.

Guests that realise the artificiality of a BVA can be divided based on their reaction. Often, they feel strange when they are involved in a conversation with Artificial Intelligence in interactions typical for a human-to-human interface. It is also important to

state that they are left with no choice when it comes to these encounters. Apart from that, they can be tempted to test the bot, play with it in order to understand its features and boundaries. Especially, hosts can be characterised by this temptation, impairing the development process, by having extraordinary interactions with a BVA. This is why emphasising that the Virtual Assistant is a tool based on Artificial Intelligence has some drawbacks.

6. Discussion

The collaboration between the provider, the host and the guest is crucial for the development of a BVA. However, this collaboration may not take place in the usual format. Due to the use of machine learning algorithms, users influence the development of a BVA with every interaction. The success and effectiveness of the development process depend on attitudes, interpretations and habits of users.

Apart from the interaction pattern, the personality of an assistant needs to be adapted to the attitudes and preferences of human users. Most BVAs are usually created to imitate humans, with the exception of Kono and Calendar.help. Nonetheless, according to the results of the preliminary research, user interpretations of the BVA's identity may be different from what the provider assumed. Through sensemaking processes, users create their own interpretation of a BVA, which is in line with social constructivism (Guba and Lincoln, 1994).

The use of a BVA in a host organisation has wider consequences. Navigating within the rules of business savoir-vivre can be troublesome for those who never had an assistant. BVA technology is affordable for most companies, so it becomes possible for more people to have a quasi-private assistant for the first time. Providers encourage their potential customers to equip every white-collar employee with such assistants and save their time by freeing them from notorious scheduling activities. Managing such assistants requires some knowledge, so could the provision of guidelines could be necessary.

Conclusions

This study suggests some preliminary conclusions. BVAs are developed in the process of collaborative innovation in two ways. The software itself is introduced basing on R&D processes. Then, two ways are possible for development: 1) the provider gathers feedback from its users and by using their experience, creates another version of the software; or 2) the provider designs the Virtual Assistant to learn autonomously using the analysis of interactions with users and machine learning. In the case of the second way, which uses Machine Learning, there might be a need to modify the approach to the collaborative development of innovation. The method of collaboration with learning artificial systems in innovation development must be considered, especially when such systems implement reinforced learning (Kaplan and Haenlein, 2019).

The BVA image is comparable among providers and users. Users are interested in the solution but feel anxious about it. However, this feeling is not related to the use of Artificial Intelligence, but to the way a BVA communicates with users. As scheduling of meetings is usually initiated by a human rather than an artificial entity, the reactions could be influenced by a different propensity to answer an invitation sent by a bot.

A BVA connects organisational aspects with individual interactions, so the propensity of users to cooperate can have a significant impact on the collection of their feedback and collaborative innovation. Users often interact with such form of Artificial Intelligence for the first time, which leads to sensemaking processes. Sensemaking can easily be described as a process "of meaning construction whereby people interpret events and issues within and outside of their organisations that are somehow surprising, complex or confusing to them" (Cornelissen, 2012, p. 118). Sensemaking leads to the identity attribution, which can influence the way people interact with a BVA, the propensity to collaborate with it and share their experiences. Collaborative development of a BVA can require a specific image of the BVA among its users (to influence the sensemaking processes) and acknowledgement that users will learn to interact with the BVA and share their experiences along with consecutive interactions.

Limitations and future research

As research on business applications of Intelligent Agents is still in an early stage, the authors aimed to share their preliminary findings with the academic audience while being aware of the limitations. This

paper is based on preliminary empirical research, namely of two interviews, which may bias the results and conclusions. Data was collected from companies that acted as pioneers on the market, so their interpretations of the innovativeness of BVAs may differ from the followers. Probably, intelligent agents as such were new also for their users (hosts and providers) what might have strengthened the interest but also impart some anxiety on the collaboration.

We expect to broaden the presented results. It will be a consequence of exploring further opinions but also studying other BVA software agents that are being introduced to the market, potentially having different business models in mind. This market is growing: at the beginning of this research, eight providers were identified, while at the end, 20 providers were already operating worldwide. Therefore, getting more data about BVA development in collaboration with hosts and guests as well as the influence of their sensemaking on that collaboration should be continued. This appears to be an absorbing academic task as BVAs are expected to develop from Human-Inspired AI to Humanised AI, which will be a challenge in terms of confidence, change and control of organisations (Kaplan and Haenlein, 2019).

Acknowledgment

This study was conducted as a part of "UEP dla Nauki 2" research project granted by Poznań University of Economics and Business.

Literature

Baldwin, C., & von Hippel, E. (2011). Modeling a Paradigm Shift: From Producer Innovation to User and Open Collaborative Innovation. *Organization Science*, *22*(6), 1399-1417.

Bogers, M., Zobel, A. K., Afuah, A., Almirall, E., Brunswicker, S., Dahlander, L., & Hagedoorn, J. (2017). The open innovation research landscape: Established perspectives and emerging themes across different levels of analysis. *Industry and Innovation*, *24*(1), 8-40.

Ciechanowski, L., Przegalinska, A., Magnuski, M., & Gloor, P. (2018). In the shades of the uncanny valley: An experimental study of human-chatbot interaction. *Future Generation Computer Systems*, *92*, 539-548.

Cornelissen, J. P. (2011). Sensemaking Under Pressure: The Influence of Professional Roles and Social Accountability on the Creation of Sense. *Organization Science*, *23*(1), 118-137. doi: 10.1287/orsc.1100.0640

Cuevas-Rodríguez, G., Cabello-Medina, C., & Carmona-Lavado, A. (2014). Internal and external social capital for radical product innovation: do they always work well together? *British Journal of Management*, *25*(2), 266-284.

Cui, A. S., & Wu, F. (2016). Utilizing customer knowledge in innovation: antecedents and impact of customer involvement on new product performance. *Journal of the Academy of Marketing Science*, *44*(4), 516-538.

Dahlander, L., & Gann, D. M. (2010). How open is innovation? *Research Policy*, *39*(6), 699-709.

El Kadiri, S., Terkaj, W., Urwin, E. N., Palmer, C., Kiritsis, D., & Young, R. (2015). Ontology in Engineering Applications. *Lecture Notes in Business Information Processing*, *225*, 5-9.

Eslami, M. H., & Lakemond, N. (2016). Knowledge integration with customers in collaborative product development projects. *Journal of Business & Industrial Marketing*, *31*(7), 889-900.

Frankelius, P. (2009). Questioning two myths in innovation literature. *The Journal of High Technology Management Research*, *20*, 40-51.

Gallaud, D. (2013). Collaborative Innovation and Open Innovation. *Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship*, 236-241.

Glezer, C. (2002), A conceptual model of an interorganizational intelligent meeting-scheduler (IIMS). *Journal of Strategic Information Systems*, *12*, 47-70.

Gordini, N., & Veglio, V. (2017). Customers churn prediction and marketing retention strategies. An application of support vector machines based on the AUC parameter-selection technique in B2B e-commerce industry. *Industrial Marketing Management*, *62*, 100-107.

Grönroos, C. (2001). The Perceived Service Quality Concept – A Mistake? *Managing Service Quality*, *11*(3), 150-152.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of Qualitative Research* (2nd ed.), 163-194.

Gummesson, E. (2002). Relationship marketing and a new economy: it's time for deprogramming. *Journal of Services Marketing*, *16*, 585-589.

Hargrave, T. J., & van de Ven, A. H. (2006). A collective action model of institutional innovation. *Academy of Management Review*, *31*(4), 864-888.

Ibrahim, A. (2019). A Study About Using a Cognitive Agent in Replacing Level 1 and 2 Service Desk Activities. *Advances in Intelligent Systems and Computing*, 307-316.

Jer, R., Kim, D., & Bello, D. C. (2017). Relationship-based product innovations: Evidence from the global supply chain. *Journal of Business Research*, *80*, 127-140.

Kaplan, A. M., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business Horizons*, *62*(1), 15-25.

Miles, M., & Huberman, A. M. (1994). *Qualitative Data Analysis*, 2nd ed. Thousand Oaks, United States: Sage Publications.

Morgan, A., & Piccinini, G. (2018). Towards a cognitive neuroscience of intentionality. *Minds & Machines*, *28*(1), 119-139.

Mou, Y., & Xu, K. (2017). The media inequality: Comparing the initial human-human and human-Artificial Intelligence social interactions. *Computers in Human Behavior*, *72*, 432-440.

Nass, C., Steuer, J., & Tauber, E. R. (1994). *Computers are social actors*. Proceedings of the SIGCHI conference on Human factors in computing systems, ACM, 72-78.

Nicholson, J. D., LaPlaca, P., Al-Abdin, A., Breese, R., & Khan, Z. (2018). What do introduction sections tell us about the intent of scholarly work: A contribution on contributions. *Industrial Marketing Management*, *73*, 206-219.

Nilsson, N. (1998). *Artificial Intelligence: A New Synthesis*. Morgan Kaufmann.

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly*, *41*(1), 116-145.

Russell, S. J., & Norvig, P. (2009). *Artificial Intelligence: A Modern Approach*, 3rd ed. Upper Saddle River, United States: Prentice Hall.

Russell, S., Dewey, D., & Tegmark, M. (2015). Research priorities for robust and beneficial artificial intelligence. *Ai Magazine*, *36*(4), 105-114.

Shakshuki, E., Koo, H., Benoit, D., & Silve, D. (2008), A distributed multi-agent meeting scheduler. *Journal of Computer and System Sciences*, *74*, 279-296.

Syama, N., & Sharmab, A. (2018). Waiting for a sales renaissance in the fourth industrial revolution: Machine learning and artificial intelligence in sales research and practice. *Industrial Marketing Management*, *69*, 135-146.

Vendrell-Herrero, F., Bustinza, O.F., Parry, G., & Georgantzis, N. (2017). Servitization, digitization and supply chain interdependency. *Industrial Marketing Management*, *60*, 69-81.

Weick, K. E. (1995). *Sensemaking in organisations*, 3rd ed. Sage.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the Process of Sensemaking. *Organization Science, 16*(4), 409-421.

Volume 11 • Issue 3 • 2019

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 30 April 2019
accepted: 15 September 2019

pages: 38-47

Integration of digital technologies in the field of construction in the Russian Federation

Elena Aleksandrova, Victoria Vinogradova, Galina Tokunova

ABSTRACT

The article presents the study that mainly focused on the changes made as a result of collaborative innovations in business relationships developed during the period of digitalisation in the construction field of the Russian Federation. It is a conceptual piece of work based on the systematic approach to the analysis, literature review and comparative analysis. The digitalisation of investment and construction projects is technologically based on the integration of solutions, such as the building information model (BIM), high-performance IT-systems, cloud platforms and the Internet-of-Things, resulting in unified and constant connectivity, specialised mobile applications, robotic equipment, unmanned vehicles, additive technologies, AR/VR services for the analysis of Big-Data, and blockchain technologies. The integration of digital technologies is a radical innovation, which highlights collaborative innovations in business relationships and makes it possible to form a united digital ecosystem that allows firms to manage, control and regulate the full lifecycle of a construction project, and then, the property in real-time. The contribution of this work to the construction field is the offered model for the creation of a digital ecosystem and the described role of the government in the model. Also, this work can be used for the integration of BIM technologies in construction companies.

KEY WORDS

digital ecosystem, digital technologies, investment and construction project, BIM technology, collaborative innovation, digital economy

DOI: 10.2478/emj-2019-0019

Corresponding author:

Elena Aleksandrova

Saint Petersburg State University of Architecture and Civil Engineering, Russia
e-mail: elenale@yandex.ru

Victoria Vinogradova

Saint Petersburg State University of Architecture and Civil Engineering, Russia
e-mail: vittoria.vinogradova@gmail.com

Galina Tokunova

Saint Petersburg State University of Architecture and Civil Engineering, Russia
e-mail: tgf_1608@mail.ru

Introduction

Today, the emergence of a new technological order is accompanied by the simultaneous development of digital technologies, which contributes to the efficiency of the national and global economy. The main reason to implement digital technologies is the aim to increase the speed of decision-making and the management quality of the main business processes. For example, in the report "Digital Dividends", the World Bank underlines that digital technologies help firms to increase productivity, help people to find jobs and expand opportunities, and help governments to provide better public services to citizens. However, the impact of the use of digital technologies depends on improvements of the business climate, the efficiency of the education and healthcare systems

and the existing management practices. These circumstances contribute to changes in roles performed by each participant of economic relations, including the state, in the process of economic transformation (World Development Report, 2016).

In 2017, Russia took action to form and develop the information society at the federal level, within the framework of which, the state programme "Digital Economy of the Russian Federation" was developed. The programme establishes the active role of the state in developing a digital ecosystem, which engages the society in the introduction and use of advanced technologies.

The construction industry is no exception as the latest technologies are already used at all stages of investment and construction projects. Modern technologies — such as information modelling of buildings and structures BIM (Building Information Modeling), Big Data, blockchain, the IoT (Internet of Things), 3D printing, resource-saving technologies, and innovative technologies in new building materials — are widely used in the Russian construction sector. The collaboration between the government and firms plays an important role across different stages of the innovation process.

The article discusses the role played by digitalisation in collaborative innovations that transform business relationships in the construction field, reveals main problems posed by the introduction of modern technologies, analyses possible ways of their use in combination with information modelling, and offers a method for the integration of construction market participants at all implementation stages of a construction project on the basis of a BIM information model.

1. Literature review

Currently, BIM-modelling is the most popular technology in the Russian construction sector. According to the report of NRU MGSU (2016), "BIM is the process of creating and managing information at all stages of the lifecycle of a construction project ("planning" – "design" – "construction" – "operation" – "liquidation")." All participants of investment and construction projects undoubtedly indicate possible advantages of this technology, including multifunctional application, adaptability and flexibility of the model. Such benefits result in the reduction of the number of conflicts and the improved quality of performed work, which reduces the cost and shortens the time required for the implementation of an investment and construction project (Kupriyanovsky et al., 2016).

The state actively facilitates the growing use of BIM-modelling. The Ministry of Construction of the Russian Federation has approved a programme for the introduction of information modelling technology, making it mandatory to use BIM-technologies at the stages of design, construction and operation of a capital construction project funded from the state budget.

Research into the introduction and use of information modelling technologies in Russia revealed the main challenge, which is the lack of official statistical data on the actual number of design, development or construction companies that use the latest technologies in their business. For example, according to the report of NRU MGSU (2016), Russia has about 51 000 project management companies that employ approx. 500 000 designers. This year, more than 100 000 software licenses were sold for the supporting technology of information modelling. However, except for a few dozen of the largest market players, companies rarely declare the use of BIM-modelling and are ready to share practical experience in the implementation of pilot projects. This mostly happens because of an unsuccessful experience with the introduction of BIM-modelling, which occurs due to predictable losses related to implementation as well as unreadiness to absorb such losses. Companies operating in the Russian construction market indicate such barriers as a slowdown in the productivity at the initial stage, the cost increase due to the introduction of such a large-scale technology and the need for organisational restructuring (Talapov, 2015; Kallaur, 2018).

This situation is reinforced by the shortcomings of the regulatory framework and the lack of common national standards for the implementation of construction projects, as well as a common understanding of the lifecycle of a construction project, the shortage of qualified personnel in the labour market, the high cost of software and the need to adapt foreign programmes to Russian conditions (Talapov, 2015; Ginzburg, 2016).

The possibility to use information modelling at all stages of the life cycle of a capital construction project is emphasised by many researchers (Talapov, 2015; Ginzburg, 2016; Churbanov and Shamara, 2018). According to the concept of BIM maturity levels, which was developed by Bew and Richards (2014) to describe the development of information

modelling, levels 0–3 can be distinguished, from 2D to iBIM (integrated BIM). The collaboration in the form of information exchange between different parties begins at Level 2, when the General Model is built and analysed using various programmes in one of the main interfaces, such as IFC (Industry Foundation Class) or COBie (Building Information Exchange). Level 3 BIM or an integrated model implies full cooperation between the participants of the investment and construction project and shared access to a centralised repository of the BIM model.

In addition, the concept of "BIM measurement" should be underlined, which is the number of different indicators of the information model. The 3D model is complemented using new information to develop an n-D BIM model (Ginzburg, 2016; Pilyay, 2017). The first important organisational parameter that complements the model is the time factor. A 4D model contains information about calendar planning and a sequence of actions. 4D was the basis for creating a 5D model, which connects economic information, namely, the financial costs at each stage of implementation. Here, YIT company is one of the few examples available on the Russian market (Mironov, 2018). A 6D model includes information "as built." It reflects the already developed property and is intended for the use at the stage of operation. A 7D model allows to manage and control the property with the help of the data transmission system with built-in sensors and "smart" engineering infrastructure.

The literature on technology information modelling and British standards offers two concepts, i.e., AIM (Asset Information Model) and PIM (Project Information Model), distinguishing between the two models already in terms of creating and managing the asset. This division is rather logical as it provokes the creation of the object technical customer, and often manages another person — the operator. A PIM appears at the stages of object creation (planning, design, construction, reconstruction or restoration), while an AIM collects information related to the current maintenance and management of the property (NBS BIM Object Standard, 2016).

Ginzburg has another point of view, and does not divide the model or its functional application but combines everything into one BLC IM (Building Life Cycle Information Modelling) model. One thing remains clear: information modelling can extend to the entire lifecycle of an object. However, in contemporary Russia, BIM-technologies are mostly used at the design stage, less often at the construction stage, and do not reach further lifecycle stages. The development is mainly hindered by divergent interests of participants of the investment and construction project.

As a result, the most successful application of information modelling technologies used for construction projects was among Russian integrated full-cycle companies, which were able to assess BIM benefits at each stage of the project implementation to maximise the economic effect (Kallaur, 2018). Despite this, it is important to note the study (Churbanov and Shamara, 2018), which analyses the impact of the development of information modelling technologies on the relationship between the participants of the investment and construction project. The model of disintegrated procurement, which is the traditional scheme of relations ("design" – "tender" – "construction"), will attract the contractor at an early stage and consider its technological and resource capabilities, as well as contribute to the development of a management contract.

Integration of BIM modelling is radical innovation. Only radical innovation is relevant to the growth of a company, regardless of whether it is developed internally or through collaboration with domestic or foreign partners (Hsieh et al., 2018).

Collaborative ideation is key for innovation. The implementation of suitable appropriability mechanisms during collaborative ideation is a necessary yet difficult task. This difficulty arises from a high level of uncertainty and a low level of codification because partners work on loosely defined concepts that may change during the collaboration. Firms can employ several appropriability mechanisms to protect their knowledge (Gama, 2019).

The model of integrated procurement or an integrated implementation method of the investment and construction project ("Integrated Project Delivery") will be the basis for interaction between designers and builders and the accelerated development of integrated engineering. In the case of both models, it will trigger the formation of a partnership mechanism based on the principles of risk- and responsibility-sharing, and common interests in the success of the project. Thus, a developed ecosystem contributes to increased locational capital wealth and prosperity (Audretsch et al., 2018).

The BIM technology is the basis for digitalisation of investment and construction processes; however, in the Russian Federation, the blockchain technology has become widespread. Blockchain is a database of sequential operating records that are stored in a dis-

tributed form on different storage devices and is not bound to a single master server (Ablyazov and Petrov, 2019). As part of an investment and construction project, this technology is most interesting from the financial side of the process, especially in the case of transition to the use of smart contracts between the participants of the investment and construction project. In this case, blockchain provides the security of transactions due to the mandatory encryption and distribution of data storage; exceptional transparency of the process, which is ensured by the general and equal access to the history of transactions of all participants; and acceleration of operations due to the absence of intermediaries. Despite the obvious advantages of blockchain, the spread of this technology in Russia is hampered by the high cost of personnel training and the high-energy consumption of the necessary equipment. However, there have been several pilot projects on the conclusion of contracts regarding shared building-based blockchain, for example, when blockchain was implemented in the process of the conclusion of contracts regarding the shared participation, the technical development of which was performed by specialists from Vnesheconombank (Ablyazov and Petrov, 2019).

The use of the blockchain technology in financial smart contracts acts in synergy with BIM modelling, opening up the possibility to build entire databases of projects, building elements and materials, which could be accessed by any developer, and to which any contractor could connect with its product. At the same time, the results of transactions can be immediately visualised in a BIM model. This feature would solve one of the most important drawbacks of n-D modelling — the lack of data security.

Equally broad opportunities for the construction sector are offered by the augmented (AR — Augmented Reality) and virtual (VR — Virtual Reality) realities. The first is rather firmly established in the field of interior design. The most promising application of virtual reality is the ability to review a 3D-BIM project. VR solutions allow to quickly digitise a BIM model for an interactive experience, making it possible to travel inside an object that has not yet been built, for example, using the Virtuix Omni platform. This is convenient for the demonstration of the future project to the customer, as done by the American company BIM-CAVE, and in other cases. During the construction stage, it becomes possible to track the progress of the project remotely, using unmanned aerial vehicles with photographic and laser equipment. This allows avoiding mistakes in the design of the object by analysing it structurally and visually in the context of the future landscape, and during the construction of the project. The main disadvantage of this technology, of course, is the price. Even though the ability to demonstrate the model to the customer does not require significant investments, the developer will face large-scale costs in terms of the management of remote monitoring of the construction progress (Obodnikovy et al., 2018).

In Russia, big data analytics is often used in project management systems and in the analysis of the sales market, as well as in the further management and operation of the finished property, although it is possible to use it very effectively in the implementation of construction and installation works. Firstly, this technology contributes to the adoption of more effective management decisions at all stages of an investment and construction project, and secondly, it allows optimising the design and construction processes, thereby reducing project costs. In the future, the use of big data in conjunction with information modelling will be used in the analysis of a complex generalised information model of the living environment, such as Living Environment Information Modeling, aimed at solving problems related to urban planning (Ginzburg, 2016).

One of the most promising technologies is the Internet of Things, which is a fully automated network of wirelessly connected devices and systems. Due to the IoT, monitoring and timely repair of construction equipment, management of material and technical supply of construction production, energy-saving and safety at the construction site are possible at the construction stage. At the stage of operation of the property, sensors can detect technical defects to warn about the occurrence of pre-emergency situations in communication systems etc. The obvious advantage of using the IoT is cost reduction, but the practical introduction and full-featured application of this technology is a time-consuming and expensive process. Besides, cybersecurity and physical security of sensors are issues of concern at all times. Currently, the IoT in Russia has only become widespread at the stage of real estate operation, and it is used together with resource-saving technologies. One example of such resource-saving technologies is the management system "Smart House", which is a single system of a building operating on the basis of sensors, control elements and actuators and combining power supply, security, heating, ventilation, water supply etc. The use of resource-saving technologies can meet the domestic needs of real-estate users and significantly

reduce operating costs. However, these technologies have not been properly developed in Russia, and the number of equipped buildings is no greater than 0.1%, which is due to the low awareness of the population and, often, high implementation costs.

According to the Analytical Report by J'son & Partners Consulting (2019), IoT platforms can be divided into three types:

- analytical platforms and applications that optimise the consumption of resources and modes of operation of equipment/systems used in buildings and structures;
- IoT-platforms and cloud applications that not only undertake the functional analysis and recommendations regarding the optimal modes of operation of the equipment but also have a control loop (BMS/BAS (Building Management Systems / Building Automation Systems) and BEMS (Building Energy Management Systems));
- computer-aided design systems that implement the concept of 7DBIM, which not only covers the design and construction stages of the building, but also the stage of its operation, and, thus, intersects with the cloud BMS/BAS/BEMS. In the future, the synchronisation of BIM with this technology will carry out the practical implementation of the transition to the sixth or seventh dimension of the BIM model due to the possibility to obtain a continuous flow of data from both the building under construction and the operated building. Data collection through advanced technologies — such as photo-video recording, laser scanning, embedding sensors and transmission devices in the construction equipment, drones, etc. — allow the creation of a real digital copy (digital twin) of the object under construction for the transition from the configuration of the model "as-designed" to "as-built".

3D printing is a method of construction of building structures, which is based on the layer-by-layer build-up of a part by the print head. Printing in the construction process can be used in two ways. The first method involves printing directly at the construction site, with the printer available on-site. The second method is to print separate blocks under factory conditions, and then transport them to the construction site. The use of 3D printing provides productivity growth, reducing labour intensity, increasing the speed of production, and reducing the cost of construction. The 3D printing market in Russia has been growing at a steady pace over the past eight years (in quantitative terms, it has grown ten times), but according to the Analytical Report by J'son & Partners Consulting (2019), Russia's share in the global 3D printing market is only 1.5%. To stimulate the development of 3D printing, competence centres are being established, and national standards are under preparation. The "Comprehensive action plan for the development and implementation of additive technologies in the Russian Federation for the period 2018-2025" has been developed with the aim to consolidate the efforts of Russian scientists and developers of additive production facilities.

The relationship between 3D printing and BIM modelling is especially important at the design stage of a building. Before starting with 3D printing, a 3D model must be created, which is most often made using specialised software. At the same time, the creation of a BIM model permits to determine specific physical properties of different components as well as set more information parameters of a manufacturing technology, which make the design process more flexible and transparent. In the early stages of planning, 3D printing can significantly improve the manufacturing efficiency of building of structures (Ignatova and Utkin, 2019).

2. Research methods

The conceptual design of the study was based on theories that analyse the transformation and integration processes in the national and global economy, in various economic sectors in general and in the construction sector in particular. The focus was placed on the mechanism used for the improvement of the construction sector efficiency on the basis of the integration of its participants. Therefore, the authors considered the theory of inter-organisational interaction and marketing relations from the point of view of the traditional market as well as the transformation of the economy due to the development of digital technologies. The study was conducted on the basis of a systematic approach to the analysis of the problems of construction development.

The unique feature of the article is the analysis of the results derived from own research of construction companies operating on the territory of St. Petersburg and the Leningrad Oblast. The obtained research data, in contrast to the data of official statistics, consider the specifics of informal relations established due to the interaction of participants in the construction market. It is a conceptual work, which captures the complexity of integrating digital technologies in

a business process, linkages in relationships of firms, their basic principles and preconditions, which determine the basic concepts and arguments.

3. Research results

As a scientific concept, relationship marketing describes the formation of long-term relationships with customers and partners, which requires the company to improve business practices to maximise the value of these relationships to the client. Neither the theory of inter-organisational relations (Oliver, 1990) as a scientific methodology nor the concept of relationship marketing (Zieliński, 2013) is new. At the same time, under the conditions of digitalisation, these relations acquire a special status and organisational design. Hence, more detailed consideration is required in terms of the changing role of organisations in the digitalisation of the economy and with the view of collaborative innovation in business relationships. The efficiency of the organisation is achieved by reducing costs resulting from the automation of basic business processes, including at the production level. As a field of material production, construction is a rather complex area of activity. Thus, the implementation of a construction project of a residential building may involve 70 organisations from the beginning of its design to commissioning. Such a great number of participants results in the complex coordination of their activities and in the optimisation of construction project management solutions. In this regard, the digitalisation of the construction field is undoubtedly objectively necessary. According to the study of the effectiveness of BIM-technologies in Russian organisations, the digitalisation of projects contributes to a 25% increase in the net discounted income; the growth of the profitability index to 14–15%; a 20% increase in the internal rate of return; the crushing of the payback period of the project to 17%; and a 30% reduction in the project costs associated with cost reductions at the production stage. Describing the effectiveness presented in the framework of the concept of "relationship marketing", both business partners and consumers of goods and services of construction organisations receive the benefits of digitalisation. Brought together in a single information space, construction project participants create a single concept of the future product. This helps to minimise losses that could be incurred by each participant in relation to the coordination of project details, teamwork, a common vision of the project goals, the possibility of implementing innovative solutions etc. The same positive findings have been demonstrated in construction markets of the UK, Canada, the USA and a number of European countries. Despite various positive aspects noted by construction sector participants, they all boil down to the fact that the formation of relations within the project is based on a mutual benefit (reciprocity) (Assessment of the use of BIM-technologies in construction. The results of the study of the effectiveness of BIM-technologies in investment and construction projects of Russian companies).

BIM-modelling technology is gaining popularity among developers in Russia due to economic efficiency and the possibility of combining it with other software products. The technological basis for the digitalisation of the investment and construction process is the integration of BIM, high-performance IT-systems, cloud platforms and IoT solutions that provide unified and constant connectivity, specialised mobile applications, robotic equipment, unmanned vehicles, additive technologies, AR/VR, services for the analysis of Big Data, and blockchain technologies. Such integration makes it possible to form a united digital ecosystem that allows managing, controlling and regulating the full lifecycle of the construction project, and then, the property in real-time. The synergistic effect can be achieved only by ensuring the compatibility and interaction of technological solutions with the possibility of seamless data exchange, storage, synchronisation and access in real-time (Analytical Report of J'son & Partners Consulting, 2019).

The first prerequisites for the creation of a united digital ecosystem at the state level are replenishing banks of normative-technical and methodological documentation, standard forms of contracts for all participants of the investment and construction project; state information and analytical systems — sources of information about land plots, prices, contract tenders etc. This will form the basis of state requirements and standards for the implementation of BIM modelling at all stages and will ensure timely accounting for changing environmental conditions (Churbanov and Shamara, 2018).

The unified digital ecosystem based on the information model will not only allow the use of all kinds of automated tools but also provide regulated access to data about the object to all stakeholders of the investment and construction project (Analytical Report of J'son & Partners Consulting, 2019).

In general, a BIM model can be represented as a tree, the branches of which are auxiliary technologies. Thus, the use of a BIM-model to bring together the participants of an investment and construction project makes it possible to connect the described technologies — Big Data, blockchain, IoT and 3D-printing — at each section of the project path. During the initial planning of the project, at the stage of acquisition of the site for construction, it is possible to use deep Big Data analysis to identify the needs of potential customers as well as to search among thousands of options for the optimal project. This results in the most acceptable information and analytical system, such as a BIM model of an investment and construction project. Then, the model can be used together with the blockchain technology for the conclusion of contracts and the procurement of construction materials. During construction works, the BIM model is connected to the Internet of Things, allowing the use of various technical means, such as sensors, to monitor the optimal progress of the construction process, adjusting the project in accordance with real-time indications and even for compliance with safety regulations. At the same time, virtual reality technology can be used for greater clarity, allowing to visually inspect the model of the object under construction. It is at this stage that the transition to the as-built (6D-BIM) model occurs at the expense of IoT platforms from the original as-designed model. At the same time, before or during the construction phase, based on the parameters of the BIM model, it is possible to use the 3D printing technology, both for the construction of the capital construction project as a whole or for its individual blocks. Finally, when the investment and construction project is finished, and the stage of operation starts, the IoT technology is used for the optimal implementation of energy-saving technologies. At the same time, using BIM-modelling as the basis of the investment and construction project, all participants can have access to the full picture at each stage of the project, and refer to a single standard of digital interaction. Fig. 1 presents the model for the creation of a digital ecosystem in the field of construction.

It should be noted that this model could function only subject to certain conditions, including the developed norms and standards, an implemented mechanism of state control, and the availability of technical solutions and software as well as qualified specialists to all participants.

In the Report on the World Development 2016 "Digital Dividends", the World Bank observed that the digital revolution could generate new, consumer-friendly business models but not when established companies control the entry process; and technology can improve the productivity of workers but not when they lack the skills and knowledge to use it (World Development Report, 2016).

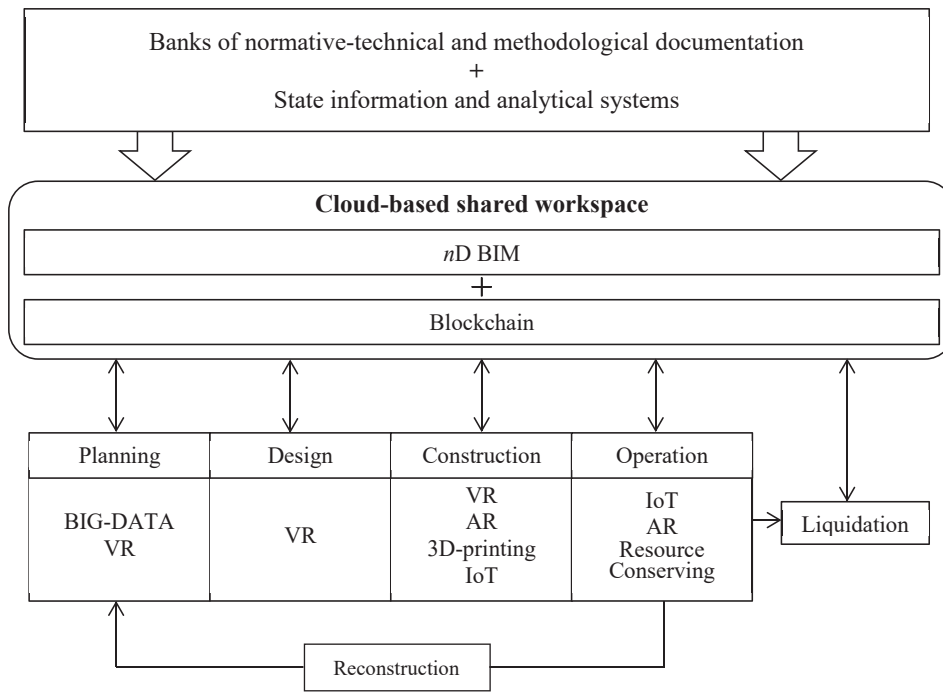

Fig. 1. Model for the creation of a digital ecosystem in the field of construction

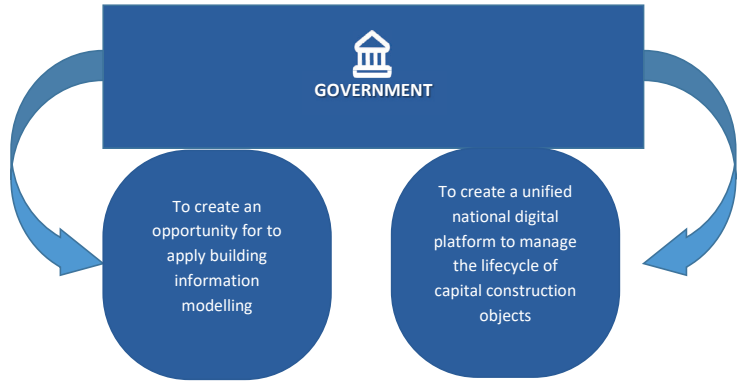

Fig. 2. Role of the government in the creation of a digital ecosystem in the field of Construction

The analysis of labour resources in the construction market of St. Petersburg and the Leningrad Oblast revealed that the greatest shortage of skilled workers was observed in the following positions: masons, concrete workers, installers of engineering networks, engineers of technical training, estimate and contract departments, and designers. In addition, there was a serious lack of construction line managers, primarily, skilled supervisors. These problems in the construction sector stemmed from the economic crisis of the 1990s when a significant outflow of qualified personnel occurred from the construction sector to other industries.

In addition, vacancies attract labour migrants from Central Asia, who do not have the necessary skills to build complex facilities. These circumstances result in high levels of manual labour. American architect Daniel Libeskind refused to hire the local labour force for the construction works of his buildings in China, basing the argument on the lack of skills required to master the complex innovations used in the construction sector.

With the view of the economic transformation, the most urgent priority for the development of the construction sector is the optimisation of labour resources in accordance with the changing conditions of the external and internal environments. The labour productivity of the Russian construction sector is low compared to other countries, which is largely due to the use of outdated management and production technologies that use high proportions of unskilled labour. The solution to this issue fundamentally requires to develop a system for the training of management personnel that meets the requirements of international and domestic professional standards.

The intensification of construction production requires the initiation and implementation of innovative processes and the structural adjustment for digitalisation on the scale of an organisation, the industry and the country. At the same time, the basis for the reorganisation of the construction sector should be a comprehensive programme aimed at the strategic planning and development of digital technologies that can ensure the coordination of undertaken tasks. Programme documents should aim to design and organise the mechanism for technological development of the construction sector. The mechanism should be based on the introduction of BIM technologies, which should aim to improve productivity. Ultimately, these efforts should contribute to the implementation of a governmental programme for the creation of high-performance jobs.

The role of the state as a framework for the digital economy is important.

The feasibility to integrate this model into real business life depends on a high level of collaboration between partners. All participants need to overcome barriers and become actively involved in the process of communication. The innovative actors need to develop "supportive structures" which would be helpful in the process of integration of BIM technologies. Once started, the process of collaborative innovations will transform business relationships.

4. Discussion of the results

The BIM model becomes an ideal candidate for the role of the root technology, into which other technical means are integrated. Combining of advanced digital technologies on the basis of BIM modelling into a single digital ecosystem will reduce fragmentation in the use of various technological solutions and create conditions for a coherent, uni-

fied and continuous investment as well as a construction process, which includes all participants at all stages of the object's lifecycle. In addition, the level of adaptability of the model to external changes increases, which leads to a reduction in the cost of the project.

The widespread use of the BIM technology for the entire lifecycle of a construction project entails the modernisation of the investment and construction process as a unit. This may lead to a change in the traditional disintegrated model of interaction between the participants of the investment and construction project to a partnership based on the information model of the facility, which allows concluding multilateral partnership agreements as opposed to bilateral contracts.

Conclusions

The implementation of digital technologies increases the speed of decision-making and improves the quality of management of main business processes. The integration of technologies — such as BIM, high-performance IT-systems, cloud platforms and IoT solutions, specialised mobile applications, robotic equipment, unmanned vehicles, additive technologies, Big-Data and blockchain — is the basis for the digitalisation of the investment and construction process. The digitalisation of this sector is undoubtedly objectively necessary. Digital technologies create an opportunity to develop a digital ecosystem in the field of construction, which leads to collaborative innovation in business relationships.

Literature

Ablyazov, T. H., & Petrov, I. S. (2017). Principles of Entrepreneurship in the Construction Sector in the Context of the Formation of the Digital Economy. *Ekonomika i Predprinimatel'stvo*, *12*(4), 712-717.

Analytical Report of J'son & Partners Consulting. (2019). Market analysis of cloud IoT-platforms and buildings and structures design and operation processes optimization applications in the world and its perspectives in Russia (including the 7D BIM support with integration in BMS/BAS). Retrieved from http://json.tv/ict_telecom_analytics_view/analiz-rynka-oblachnyh-iot-platform-i-prilojeniy-dlya-stroitelstva-s-podderjkoy-7d-bim-i-integratsiey-s-bmsbas-20181126070535

Analytical Report of J'son & Partners Consulting. (2019). The perspectives of the 3D-printing and Additive Manufacturing market in Russia Retrieved from http://json.tv/ict_telecom_analytics_view/rynok-3d-pechati-v-rossii-i-mire-additivnoe-proizvodstvo-ap-additive-manufacturing-am-2018-g-20190117060056

Audretsch, D. B., Cunningham, J. A., Kuratko, D. F., Lehmann, E. E., & Menter, M. (2018). Entrepreneurial ecosystems: economic, technological, and societal impacts. *The Journal of Technology Transfer*, *44*, 313-325. doi: 10.1007/s10961-018-9690-4

Churbanov, A. E., & Shamara, Yu, A. (2018). The impact of information modeling technology on the development of investment construction process. *Vestnik MGSU* [Proceedings of the Moscow State University of Civil Engineering], *13*(7-118), 824-835. doi: 10.22227/1997-0935.2018.7.824-835

Gama, F. (2018). Managing collaborative ideation: the role of formal and informal appropriability mechanisms. *International Entrepreneurship and Management Journal*, *15*, 97-118. doi: 10.1007/s11365-018-0544-1

Ginzburg, A.V. (2016). Building life cycle information modelling. *Promyshlennoe i Grazhdanskoe Stroitelstvo* [Industrial and Civil Engineering], *9*, 61-65.

Hsieh, W.-L., Ganotakis, P., Kafouros, M., & Wang, C. (2018). Foreign and Domestic Collaboration, Product Innovation Novelty, and Firm Growth. *The Authors Journal of Product Innovation Management*, *35*(4), 652-672. doi: 10/1111/jpim.12435

Ignatova, E. V., & Utkin, M. A. (2019). *BIM for building structures*. Construction Systems Engineering. Cyber-physical building systems: a collection of materials of the seminar held in the framework of the VI International Scientific Conference "Integration, partnership and innovation in building science and education". National Research University Moscow "State University of Civil Engineering (MGSU Press), 99-103. Retrieved from http://mgsu.ru/resources/izdatelskaya-deyatelnost/izdaniya/izdaniya-otkr-dostupa/

Kallaur, G. Y. (2018). Investment justification in information modelling technologies. *The Economics of Construction*, *1*(49), 27-38.

Kupriyanovsky, V., Sinyagov, S., & Dobrynin, A. (2016). BIM – Digital Economy. How to achieve the success? A practical approach to the theoretical concept. Part 1: Approaches and the main advantages of BIM. *International Journal of Open Information Technologies*, *3*, 1-8.

Mironov, V. (2018). *Big data in construction: how to reduce costs and increase sales*. Official site of ROSBUSINESSCONSULTING JSC. Retrieved from https://pro.rbc.ru/news/5aeb31c69a794795449a56b4#sixth

NBS BIM Object Standard. (2016). British standard PAS-1192-3:2013. Retrieved from https://www.nationalbimlibrary.com/en/nbs-bim-object-standard

Obodnikov, V. D., Alekseev, S., A. & Kagan, P. B. (2018). *Application of VR-technologies in BIM design*. Construction Systems Engineering. Cyber-physical building systems: a collection of materials of the seminar held in the framework of the VI International Scientific Conference "Integration, partnership and innovation in building science and education". National Research University Moscow "State University of Civil Engineering (MGSU press), 189-193. Retrieved from http://mgsu.ru/resources/izdatelskaya-deyatelnost/izdaniya/izdaniya-otkr-dostupa/

Oliver, C. (1990). Determinants of interorganizational relationship: integration and future directions. *Academy of Management Review*, *15*, 241-265.

Pilyay, A. I. (2017). Dimensions and levels of information modeling building design. *Online Journal "SCIENCE"*. Retrieved from https://naukovedenie.ru/PDF/18TVN617.pdf

Report of National Research University Moscow "State University of Civil Engineering (MGSU)" and LLC "Konkurator". (2016). The evaluation of the application of BIM technologies in construction. The results of a study of the effectiveness of the application of BIM technologies in Russian companies' investment and construction projects. Retrieved from http://nopriz.ru/upload/iblock/2cc/4.7_bim_rf_otchot.pdf

Talapov, V. V. (2015). *Basics of BIM: Introduction to Information Building Modeling*. Moscow, Russia: DMK Press.

The program "Digital Economy of the Russian Federation". (2017). Retrieved from http://static.government.ru/media/files/9gFM4FHj4PsB79I5v7yLVuPgu4bvR7M0.pdf

World Development Report 2016: Digital Dividends. (2016). Retrieved from https://www.worldbank.org/en/publication/wdr2016

Zieliński, M. (2013). *Supplier-Customer Relationship Performance in construction industry*. Retrieved from https://www.researchgate.net/publication/267208704_SupplierCustomer_Relationship_Performance_in_construction_industry

Volume 11 • Issue 3 • 2019

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 30 April 2019
accepted: 15 September 2019

pages: 48-59

"Appreciate me and I will be your good soldier". The exploration of antecedents to consumer citizenship

Anna Dewalska–Opitek, Maciej Mitręga

ABSTRACT

Customer citizenship behaviour (CCB) is an important consumer trend observed in the contemporary market. It may be described as an extra-role, voluntary behaviour performed in favour of other customers or companies. One of the CCB dimensions, namely, providing customer feedback to company offering, overlaps with value co-creation as a booming marketing concept. Our knowledge about factors determining this behaviour is relatively week. Trying to fill the gap, this paper discusses inclination for value co-creation among customers on the basis of literature review and explorative research. This explorative study aims to identify some company-related and customer-related antecedents to customer citizenship behaviour in the form of value co-creation in favour of companies. The theoretical deliberation is based on a critical literature review. The empirical part of the paper is based on explorative research in the form of a survey of 105 non-randomly selected customers. Aiming to identify the key drivers for customer inclination to participate in value co-creation, the exploratory factor analysis (EFA) was conducted; next, the quality of factor structure was assessed with the help of SmartPLS 3.0 using standard measures of validity; and finally, structural links between the inclination to co-create and distinct antecedents were estimated using the partial least square structural equitation modelling technique (PLS_SEM). The factor analysis suggested distinguishing two aspects of customer co-creation, i.e., either initiated by companies (Organised Co-Creation) or by customers (Spontaneous Co-creation). The estimated PLS structural model shows that only some casual paths were found statistically significant, i.e., the appreciation showed by companies towards customers engaging in the organised co-creation process (as extrinsic motivation) and customer innovativeness, as well as the fulfilment of the need for stability (as intrinsic motivation) with regards to spontaneous co-creation. The ex-post moderation analysis with the help of the PLS_MGA algorithm enabled to identify gender as the factor potentially explaining inter-group differences in the structural model.

KEY WORDS

customer citizenship behaviour, value co-creation, appreciation, gender

DOI: 10.2478/emj-2019-0020

Corresponding author:

Anna Dewalska–Opitek

Uniwersytet Ekonomiczny
w Katowicach, Poland
e-mail: a.dewalska-opitek@ue.katowice.pl

Maciej Mitręga

Uniwersytet Ekonomiczny
w Katowicach, Poland
e-mail: maciej.mitrega@uekat.pl

Introduction

Customer citizenship behaviour is among the most promising areas in marketing theory and practice. In marketing theory, customer citizenship behaviour (CCB) is perceived as non-obligatory consumer actions that create value for the company. It is addressed under various notions in several research streams, including service-dominant logic of market-

ing, customer engagement and customer prosumption (Dewalska and Mitręga, 2017). In business practice, companies welcome and encourage customers to engage in CCB. In turn, these customers are treated as value co-creators.

Although various factors are discussed in the literature as drivers of customer citizenship behaviour and value co-creation, the available knowledge about the mechanism that leads consumers to the engagement in these activities is still weak, especially on the empirical level (Alves at al., 2016; Roberts et al., 2014). The prior research on the antecedents of co-creation was in general unidimensional, i.e. focused on either consumer attributes (Huynh and Olsen, 2015; Xie et al., 2008) or the extrinsic factors that can be controlled by the companies or are context-specific (Haumann et al., 2015; Yi, Gong and Lee, 2013).

This paper presents the results of an empirical study conducted among Polish customers. The research was explorative in nature and conducted among 105 respondents. The study especially aimed to identify some consumer-related and company-related attributes that were hypothesised as drivers of customer citizenship behaviour. To identify the antecedents to customer value co-creation, the exploratory factor analysis (EFA) was conducted. Next, the multi-dimensional factor structure was assessed with SmartPLS 3.0 using standard measures of validity. Finally, the Heterotrait-Monotrait Ratio of Correlations (HTMT) was controlled as the latest validity test. Apart from research results, the paper also presents conclusions, points of some important limitations connected with the explorative character of the current research and indicates the possible future research areas.

1. Value co-creation and customer citizenship behaviour — a literature review

Recently, there has been a focus on customer behaviour in management and marketing literature (Bettencourt, 1997; Groth, 2005; Yi et al., 2013; Aggarwal, 2014). Prior studies allowed to recognise the role of customers who engage in various positive, discretionary behaviour with companies and other customers (Yi and Gong, 2006). Various terms have been used to describe this conduct, including customer voluntary behaviour (Bettencourt, 1997; Rosenbaum and Messiah, 2007; Balaij, 2014) or customer citizenship behaviour (Gruen, 2000; Groth, 2005; Bove et al., 2009), which is the subject matter of the general interest presented in the paper.

Customer citizenship behaviour (CCB) may be defined as "discretionary and pro-social actions displayed by customers, that bring benefits both to the companies and other customers" (Bettencourt, 1997; Bove et al., 2009). Other authors (Bettencourt, 1997; Bove et al., 2009) presented similar definitions of CCB. Citizenship behaviours are extra-role initiatives beyond the requirements of the usually performed customer roles. Hsieh, Yen and Chin (2004) referred to such helpful behaviours performed by customers as customer voluntary performance (CVP).

Literature suggests that customer citizenship behaviour is a multidimensional construct consisting of several forms (Soch and Aggarwal, 2013; Garma and Bove, 2009; Balaji, 2014; Bettencourt, 1997; Groth, 2005; Johnson and Rapp, 2010; Gruen, 1995; Bettencourt, 1997):

- customer behaviour that involves the provision of information and (positive or negative) opinions regarding companies, their goods and services, with the intention of improving the marketing activity (co-creation, voice, consultancy);
- customer behaviour that involves encouraging other customers (friends, family members, Internet users etc.) to use goods or services of a company, positive word-of-mouth (WOM) and recommendations (advocacy);
- customer behaviour that displays the commitment to a company, a favourable attitude towards its products, services and marketing activity by presenting a company's logotype (on clothes, bags etc.), presenting the involvement in marketing events provided by a company (displaying affiliation, social support);
- customer behaviour consisting of helping other customers when the use of a product or company processes may be troublesome and uneasy for other customers, benevolent acts of service facilitation towards other customers (helping other customers);
- customer behaviour that involves observing other customers aiming to eliminate inappropriate behaviour, e.g. not respecting the queue, misbehaving on the company's fan page, being rude to other customers (mitigating, policing).

Among various dimensions of CCB, there is an overlap with customer value co-creation as a booming concept of today's marketing (Alves at al., 2016;

Roberts et al., 2014). Traditionally, suppliers produced goods and services, which were purchased by customers. In the traditional conception of the process of value creation, consumers were "outside the firm." Value creation occurred inside the firm (through its activities) and outside markets. The concept of the "value chain" epitomised the unilateral role of the firm in creating value (Porter, 1980). The firm and the consumer had distinct roles of production and consumption, respectively. In this perspective, the market, viewed either as a locus of exchange or as an aggregation of consumers, was separate from the value creation process (Kotler, 2002). It had no role in value creation. Its role was the exchange and extraction of value (Prahalad and Ramaswamy, 2004).

Today, customers can engage in a dialogue with suppliers during each stage of product design and product delivery (Ballantyne, 2004). Due to the cooperation and mutual engagement, a supplier and a customer have the opportunity to create value through customised, co-produced offerings. The co-creation of value is a desirable goal as it assists firms in highlighting the customer's or consumer's point of view and in improving the front-end process of identifying customer needs and wants (Lusch and Vargo, 2006).

Prahalad and Ramaswamy (2004) presented the complex concept of co-creation, which is briefly summarised in Fig. 1.

Literature studies indicate a noticeable difference between two terms that are similar but not synonymous, namely, co-creation and co-production. According to Payne et al. (2008), "co-creation" presents the service-dominant (S-D) logic, according to which acting together, a supplier and a customer have the opportunity to create value. The term "co-production" is tainted with connotations of goods-dominant (G-D) logic, which involves a transfer of some activities to customers (for example IKEA involving customers in transportation and assembly of flat-pack furniture).

In their value co-creation conceptual framework, Tommasetti et al. (2017) presented co-production as a constituent of value co-creation behaviour, together with cerebral activities, cooperation, information research and collation, co-learning and connection. This was also described by Lush and Vargo (2006 and 2014). While co-production refers to customer participation in the realisation of value proposition, the co-creation is defined as the customer creation of value-in-use. It means that value for the user is created or emerges during the use, which is a process, in which the customer as a user is in charge (Grönroos, 2011). As Vargo and Akaka (2009) observed, there could be no value without the customer incorporating the firm offering into his or her life. Hence, value is created by the user, and moreover, also experienced by the user, who also uniquely determines what value is created (Vargo and Lusch, 2004).

Agrawal and Rahman (2015) believed that customers could play even more differentiated roles in the value co-creation process, which they called "customer-mix in value co-creation" (Fig. 2).

The classification of customer roles (Fig. 2) presents the eleven most popular and common roles. Although they are all distinct aspects, they are interrelated, and all play an important role for both companies and their customers.

The value obtained through co-creation may help satisfy customers and simultaneously benefit firms (Maglio et al., 2009; Edvardsson et al., 2011). Even in the case of a service failure, the involvement of customers in the recovery process could enhance customer satisfaction and encourage repeated purchases (Dong et al., 2008; Roggeveen, Tsiros and Grewal, 2008). Theoretically, better product quality (Füller, Hutter and Faullant, 2011), greater customer satisfaction (Nambisan and Baron, 2007) and reduced risk

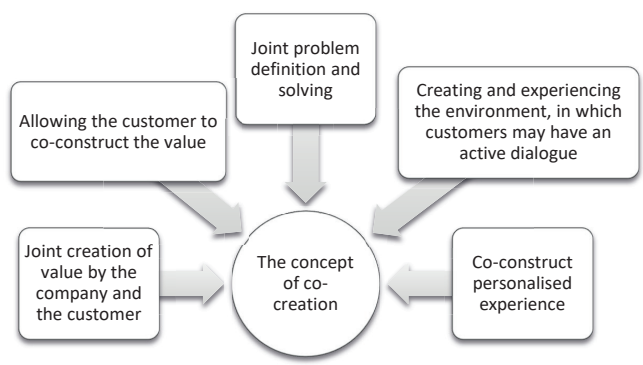

Fig. 1. Model for the creation of a digital ecosystem in the field of construction
Source: elaborated by the authors based on (Prahalad and Ramaswamy, 2004).

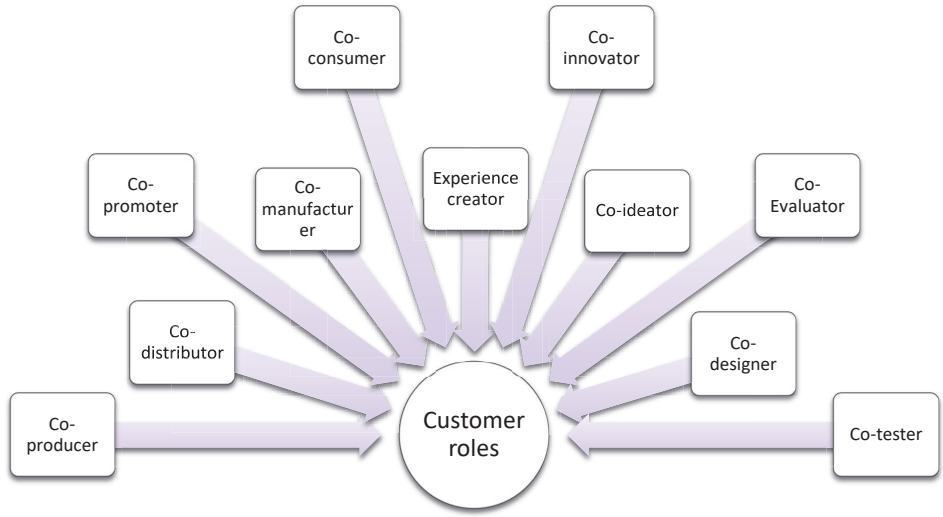

Fig. 2. Classification of customer roles in the value co-creation process
Source: elaborated by the authors based on (Agrawal and Rahman, 2015).

for the firm (Maklan, Knox and Ryals, 2008) are the key benefits of value co-created with the customer (Roser, DeFillippi and Samson, 2013).

It should be noted that value co-creation requires consumers to invest or sacrifice their resources (such as time and effort), which is sometimes described by as commitment or supportive behaviour (Wing Sung Tung et al., 2017). Since the behaviour is voluntary, it should be driven by specific motives. Therefore, it is only natural to ask: what antecedents of customer citizenship behaviours exist in general and for feedback in particular? To address this question, relevant concepts and theories should be considered.

According to Fowler (2013), the theory of motivation may suggest the answer to the question, with special regard to intrinsic and extrinsic motivations. The intrinsic motivation refers to doing something because it is inherently interesting, enjoyable or fits customer's values or attitudes. Elster (2006) pointed at altruism as motivation. Studies on human altruistic behaviours have shown that an extra role can make the value co-creator feel happy and satisfied. Once people experience that by doing a good thing, they do more of it to obtain inner happiness. The extrinsic motivation, however, refers to doing something because it leads to a separable outcome, for instance, may be appreciated and rewarded by a reference group or a company (Kotler, 1994; Ryan and Deci, 2000).

Fernandes and Remelhe (2016) proposed a model based on four specific motives as drivers for customer involvement in the co-creation process, i.e.: intrinsic motives (such as joy, curiosity, new experience), financial motives (such as expected monetary compensation or other rewards, e.g. special offers, prices), but also knowledge motives (improvement of skills, self-development) and social motives (the sense of belonging, the sense of community, communication), which may be referred to as an orientation towards Maslow's social and self-esteem needs. Hoyer et al. (2010) stressed that "consumer-level motivators" and "firm-level stimulators" are primarily responsible for the scope and intensity of value co-creation.

As far as the theory of motivation is concerned, to explain customer citizenship behaviour, the hierarchy of needs by Maslow may be useful. Cianci and Gambrel (2003) stated that Maslow's hierarchy of needs was the most referred to and discussed motivation theory. Maslow's theory posits that an individual will satisfy basic-level needs before modifying behaviour to higher-level needs, i.e., from physiological, safety and security to belonging (social needs), self-esteem, self-actualisation and transcendent needs (Urwiler and Frolick, 2008). This approach to the theory of needs gained both its adherents (Urwiler and Frolick, 2008; Rosenbaum and Messiah, 2007; Koltko-Rivera, 2006; Coy and Kovacs-Long, 2005) and opponents (Yang, 2003; Wahba and Bridwell, 1976; Payne, 1970; Alderfer, 1969). Some researchers created an interesting concept, according to which it is possible to aggregate all the needs into three main categories, i.e., basic needs, social needs and altruistic needs (Cao et al., 2012; Radic, 2011). Thus, it may be hypothesised that customers engage in citizenship behaviour to fulfil their needs, mainly those that

belong to higher levels in the hierarchy, such as self-esteem.

Value co-creation as a voluntary activity may also be explained by the social exchange theory in general, and the principle of reciprocity in particular. The core tenants of this framework are voluntary actions of an unspecified nature that extend beyond basic role obligations and suggest a personal commitment to others (Blau, 1964; Patterson and Smith, 2003). By participating in value co-creation, customers expect to be appreciated and helped in the future, and not necessarily by the same beneficiaries but while acting as the recipients of the support when needed (Falk and Fischbacher, 2006).

2. Research methods

The purpose of this study was to identify some correlates with the inclination of customers to engage in value co-creation in favour of companies, as a specific form of CCB. The research was conducted in 2017, in the form of a survey. It was a part of a survey on a broader spectrum of customer citizenship behaviour; nevertheless, the paper presents only selected results, i.e. research findings referring to customer value co-creation. The research was exploratory in nature, conducted aiming to determine the nature of the problem, and was not intended to provide conclusive evidence, but to have a better understanding of the problem (Henson and Roberts, 2006).

Data was collected from Polish customers only. The assumption of the sample selection was to find respondents, who declared they had engaged in value co-creation as a form of customer citizenship behaviour. Sampling was in the form of snowball sampling (a non-random technique). In total, 105 valid questionnaires were used in the analysis. Tab. 1 presents basic information about survey respondents.

The questionnaire was used as a research tool for data collection. It contained scales to measure the inclination to co-create value and its determinants. For the dependent variables (value co-creation through feedback), scales were adopted from studies by Soch and Aggarwal (2013), Groth (2005) and Johnson and Rapp (2010), while for independent variables (i.e. consumer innovativeness, fulfilment or the need for stability or the need for esteem, feedback appreciation), scales were generally adopted from studies by Kim et al. (2002), Cook and Wall (1980), Goldsmith and Hofacker (1991) and Gossling et al. (2003). The vast majority of constructs were measured with multi-item reflective measurement models using 5-point Likert scales ranging from (1) "strongly disagree" to (5) "strongly agree", except for "feedback appreciation" measured as a single item (i.e. "To what extent the company has shown appreciation for your activities? From 1 — "has not shown appreciation at all" to 5 — "has shown a lot of appreciation"). Some adaptation was also used when respondents were asked about the frequency of an activity, ranging from (1) "I definitely did not perform"/ "I will defi-

Tab. 1. Profile of survey respondents

Specification	Sample [%]
1. Gender	
a. Female	53.3
b. Male	46.7
2. Age	
a. 18 – 25 years	40.0
b. 26 – 35 years	11.4
c. 36 – 45 years	13.38
d. 46 – 55 years	15.2
e. 56 – 56 years	10.5
f. 66 years and more	9.5
3. Education	
a. Primary and junior high school	2.9
b. Vocational	14.3
c. Secondary general	33.3
d. Secondary technical	28.6
e. Higher	21.0

Tab. 2. Rotaded Component Matrix

Rotated Component Matrix[a]					
	Component				
	1	2	3	4	5
Providing information on customer satisfaction				0.791	
Providing feedback on the company's products, services and market activity (online and offline)				0.764	-0.340
Participating in customer surveys		0.404		0.516	
Self-fulfilment		0.916			
Self-development		0.913			
Competence development		0.853			
Always buys the latest models available in the market	0.760				
Willing to buy the latest technology	0.685				-0.556
Knows brand names and the latest products offered in the market	0.904				
Usually identifies the latest products faster than others	0.863				
Safety			0.941		
Stability			0.919		
Order			0.853		
Showing appreciation					0.884
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					

Tab. 3. Measurement validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Organised_CoCreate	N.A.	N.A.	N.A.	N.A.
Spontan_CoCreate	0.644	0.738	0.842	0.729
Esteem_need_fulfil	0.877	0.925	0.922	0.799
Innovativeness	0.863	0.869	0.916	0.785
Stability_need_fulfil	0.794	0.946	0.901	0.821

Source: elaborated by the authors based on SmartPLS 3.0.

nitely not perform" to (5) "I definitely performed"/ "I will definitely perform." To reduce the measurement error and not to bias the results, neutral wording was used, as well as the assurance of respondent anonymity and data confidentiality.

Before analysing the interrelations between independent variables and the inclination to co-create as the dependent variable, the quality of the measurement model was tested. Firstly, answers for 14 items were analysed using the Exploratory Factor Analysis. The EFA results suggested some important revision with regard to the hypothesised factor structure (Table 2). Specifically, the Inclination to Co-Create, that was originally treated as one latent construct, appeared to be loaded clearly by two first items, while the third item, i.e. "Participating in customers surveys" did not load at a commonly acceptable level (>0.6) in any of the distinguished latent factors. Thus, the decision was made to treat this item as reflecting a distinct aspect of customer co-creation. Namely, we made a distinction between "Spontaneous Co-Creation" (Spontan_CoCreate) and "Organised Co-Creation" (Organised_CoCreate).

Here, the first aspect of co-creation referred to situations when feedback provision by customers was conducted as a bottom-up process, i.e. the company did not organise formal customer surveys. The second aspect of co-creation referred more directly to the communication between companies and their customers initiated and organised by companies.

Additionally, as one of the items was originally associated with consumer innovativeness (i.e. "Willing to buy the latest technology") but received too strong cross-loading, this item was excluded.

Next, the quality of the revised 5-dimensional factor structure was assessed with the help of SmartPLS 3.0 using standard measures of validity and this structure appeared to meet all standard thresholds (Table 3) except for Cronbach's alpha for Spontan_CoCreat amounting to 0.64, which was acceptable concerning the exploratory character of this research project (Hair et al., 2013; Mitręga, 2014; Nunnally et al., 1967). Finally, the authors also controlled for heterotrait-monotrait ratio of correlations (HTMT) as the latest validity test suggested by Hair et al. (2017 for PLS-SEM and all HTMT was below the suggested (conservative) threshold value of 0.85.

3. PLS-SEM results

The authors of the article estimated structural links between the two-dimensional inclination to co-create and four distinct antecedents using the partial least square structural equation modelling technique (PLS-SEM). Also, the potential impact of some control variables was monitored, namely, customer age (Age), customer education (Education), the number of inhabitants at the place of residence (City size), the financial status perceived by a consumer (Econom status), and the frequency of the use of Internet (Internet use). Some advantages of PLS-SEM helped to decide against the use of CB-SEM (covariance-based SEM). PLS-SEM is a promising method that offers a vast potential for SEM research-

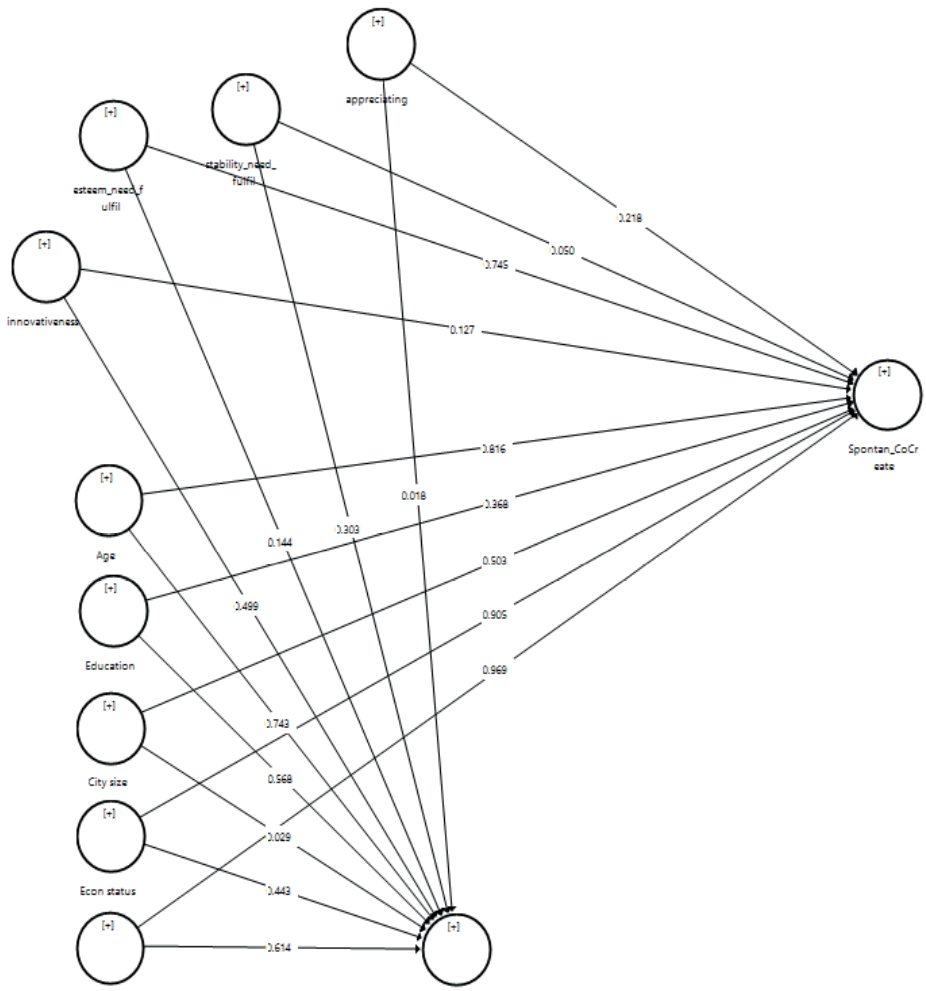

Fig. 3. Estimated PLS structural model

Source: elaborated by the authors based on SmartPLS 3.0 software.

ers, especially in the disciplines of marketing and management of information systems. Compared to CB-SEM, it is more robust with fewer identification issues. It works with much smaller as well as much larger samples, and readily incorporates formative as well as reflective constructs (Hair, Ringle and Sarstedt, 2011).

Specifically, it was considered that the main variables that were the focus of attention did not have a normal distribution, and PLS-SEM did not presume that the data were normally distributed (Hair et al., 2011). Also, PLS-SEM was preferred because SmartPLS 3.0 software allowed for direct ex-post testing moderation effects connected with potential multigroup differences with regard to the gender of the respondents (Ringle et al., 2018).

Fig. 3 presents the results of the PLS algorithm estimation for the structural model with all control variables. The variables from the baseline model are marked in the upper-left corner, while the control variables are presented in the lower-left corner. The numbers on the paths between the latent variables represent p values for particular path coefficients, where $p<0.05$ represents a statistically significant path.

Concerning the results for the baseline model, only some causal paths were found statistically significant, namely, the impact of appreciation on Organised CoCreate and the fulfilment of the need for stability need on Spontan CoCreate (conservative significance level, $p<0.05$).

Thus, our dataset provided partial support for our structural model, which is reasonable concerning the exploratory character of this study. However, we have also conducted an ex-post moderation analysis with the consumer gender as the factor potentially explaining inter-group differences in the structural model with the help of PLS-MGA algorithm proposed by Henseler et al. (2009) and available in SmartPLS 3.0 (Ringle et al., 2018).

The results of this algorithm for two causal paths which were significantly different in male vs female subsamples (in the case of significance test with $p<0.5$) are presented in Table 4.

These results suggest that in the case of surveyed women, there was a significant and positive connection between showed appreciation and Spontan_CoCreate, while this path was not statistically significant in the male sub-sample. In the similar spirit, the path between the fulfilment of the need for stability and Spontan_CoCreate was stronger in the women's sub-sample than in the general sample, while in the case of men, this path was statistically insignificant. Thus, the structural model appeared to work much better in the case of women as co-creators of a company offering than in the case of men as potential co-creators. This mechanism was observed in the case of both aspects of co-creation, namely, spontaneous co-creation and organised co-creation.

4. Discussion of the results

Customer citizenship behaviour, although a relatively new concept, has been a subject of interest among many researchers presenting its definitions and dimensions. Although various factors are discussed in the literature as drivers of customer citizenship behaviour and the inclination for value co-creation, the knowledge about the mechanism that leads customers to engage in these activities is weak, especially on the empirical level.

From a theoretical perspective, the paper integrates several approaches to customer citizenship behaviour, explaining the meaning and several dimension on the basis of literature studies. A focus is on value co-creation as one of the forms (dimensions) of customer citizenship behaviour, apart from advocacy, affiliation, helping other customers and mitigating them when inappropriate behaviour has been noticed. The paper also presents a conceptual framework of the possible motives to undertake an extra role.

Tab. 4. Bootstrapping results for PLS-MGA (female vs male)

	Path Coefficients Mean (female)	Path Coefficients Mean (male)	p-Values (female)	p-Values (male)
Appreciation -> Spontan_CoCreate	0.330	-0.194	0.003	0.107
stability_need_fulfil -> Spontan_CoCreate	0.550	0.042	0.004	0.515

Source: elaborated by the authors on the basis of SmartPLS 3.0 software.

The conducted research was exploratory in nature and aimed at identifying antecedents of a specific form of customer citizenship. The inclination to co-create was originally treated as one latent construct, but the hypothesised factor structure appeared to reflect distinct aspects of customer co-creation, i.e., spontaneous co-creation (fully initiated by customers, voluntary behaviour) and organised co-creation (customer contribution as a response to specific actions undertaken by a company). On the basis of the estimated PLS structural model, some casual paths were found as statistically significant, while other paths were not. There was a significant impact of appreciation on organised co-creation and the fulfilment of the need for stability on spontaneous co-creation. These factors can be interpreted within the theory of extrinsic and intrinsic motivation (Fernandes and Remelhe, 2016; Fowler, 2013; Elsver, 2006; Ryan and Deci, 2000). In the case of a company's planned actions aimed to engage customers in value co-creation, any appreciation expressed by a company in the form of compensation, rewards or bonuses (i.e. special offers, lower prices, letters of gratitude etc.) significantly enhances the customer's inclination for organised co-creation. Referring to Hoyer et al. (2010), "firm-level stimulators" are responsible for the scope and intensity of organised value co-creation.

Simultaneously, in terms of voluntary and discretionary value co-creation, intrinsic motives in the form of the fulfilment of the need for stability correlate with the inclination for spontaneous co-creation. The sense of satisfaction of needs or compulsion makes customers more eager to engage in the process of co-creation.

The results of the post-hoc analysis suggest that in the case of co-creation, the customer's gender is the factor explaining some inter-group differences within the structural model. It seems that women could be more motivated to act as co-creators in the aspects of both spontaneous and organised activity. It is an interesting finding, which may be explained using communication skills (Gustafsson et al., 2012) or social motivation (Fernades and Remelhe, 2016). A relatively small sample and exploratory nature of the study require a deeper insight to legitimatise this interpretation in further research, e.g. using a larger survey sample and an experimental approach.

From a managerial perspective, the paper provides intellectual input into attempts of companies to facilitate the turning of consumers into "good soldiers" (Groth, 2005) and to voluntarily provide strategic marketing resources. By successfully managing customer citizenship, companies may seek to maximise the lifetime value of desirable customer segments. Business entities may gain a competitive advantage by involving customers in the value-delivery process. However, customers may satisfy their needs not only by receiving co-created values but also by performing an extra role for the benefit of others, and their involvement would be reflected in the level of satisfaction received from contacts with companies in the cooperation.

Conclusions

In summary, customer citizenship behaviour may be perceived as a complex aspect of customer behaviour. The behaviour is driven by specific factors that encourage customers to undertake an extra role. This research suggests focusing on two dimensions of customer co-creation as a form of CCB, i.e., initiated by companies (Organised Co-Creation) and by customers (Spontaneous Co-Creation). The estimated PLS modelling identified some significant antecedents to customer citizenship, i.e., appreciation shown by companies towards customers who engage in the organised co-creation process (as extrinsic motivation) and customer innovativeness, as well as the fulfilment of the need for stability (as intrinsic motivation) in terms of spontaneous co-creation. The ex-post moderation analysis identified gender as the factor potentially explaining inter-group differences in the structural model, which is not conclusive but opens an interesting direction for further research.

This study may enrich the understanding of the inclination of customers for co-creation on both theoretical and empirical levels, indicating some drivers for customer propensity to undertake an extra role. The presented findings may be interesting for researchers and business practitioners.

Nevertheless, some limitations are worth addressing. Firstly, the research sample was somewhat small. Although results on customer co-creation were a part of a broader research, a more prolific sample may allow identifying new drivers for co-creating behaviours. Secondly, this research focused only on a very specific aspect of customer citizenship overlapping with value co-creation, namely customer feedback regarding the company's initiatives, so this study does not comprise the conceptual diversity of both CCB and VCC as described in the recent literature (Assiouras et al., 2019; Kim and Choi, 2016; Vargo and Lusch, 2016). Thirdly, the data collection

and analysis methods may be extended. Finally, research based on the perspective of companies may be conducted. This leaves some space for a future study.

Acknowledgment

The research presented in the paper was partially prepared by Maciej Mitręga and sponsored by the National Science Centre of Poland (Narodowe Centrum Nauki) under the project No. UMO-2017/25/B/HS4/01669.

Literature

Aggarwal, N. (2014). Investigating Moderating Role Of Customer Based Corporate Reputation And Customer Citizenship Behaviour. *Business Review*, *3*(3), 104-106.

Agrawal, A. K., & Rahman, Z. (2015). Roles and Resource Contributions of Customers in Value Co-creation. *International Strategic Management Review*, *3*, 144-160.

Alderfer, C. P. (1969). An Empirical Test of a New Theory of Human Needs. *Organizational Behaviour and Human Performance*, *3*, 142-175.

Assiouras, I. et al. (2019). Value co-creation and customer citizenship behavior. *Annals of Tourism Research*, *78*, 102742.

Balaji, M. S. (2014). Managing Customer Citizenship Behaviour: a relationship perspective. *Journal of Strategic Management*, *22*(3), 223-239.

Ballantyne, D. (2004). Dialogue and its role in the development of relationship specific knowledge. *Journal of Business & Industrial Marketing*, *19*(2), 114-123.

Bettencourt, L. A. (1997). Customer Voluntary Performance: As Partners In Service Delivery. *Journal of Retailing*, *73*(3), 384-386.

Blau, P. M. (1964), *Exchange and power in social life*. New York, United States: John Wiley.

Bove, L. L., Pervan, S. L., Beatty, S. E., & Shiu, E. (2009). Service Worker Role In Encouraging Customer Organizational Citizenship Behaviours. *Journal of Business Research*, *63*, 698-705.

Cao, H., Jiang, J., Oh, L. B., Li, H., Liao, X., & Chen, Z. (2013). A Maslow's hierarchy of needs analysis of social networking services continuance. *Journal of Service Management*, *24*(2), 170-190.

Cianci, R., & Gambrel, P. A. (2003). Maslow's Hierarchy of Needs: Does It Apply in a Collectivist Culture. *Journal of Applied Management and Entrepreneurship*, *8*, 143-161.

Coy, D. R., & Kovacs-Long, J. (2005). Maslow and Miller: An Exploration of Gender and Affiliation in the Journey of Competence. *Journal of Counselling*, *83*, 138-146.

Dewalska, A., & Mitręga, M. (2017). Zachowania obywatelskie konsumentów jako wyłaniający się obszar badawczy [Customer citizenship behaviour as an emerging research area]. *Marketing i Rynek*, *4*(CD), 40-48.

Dong, B., Evans, K. R., & Zou, S. (2008). The effects of customer participation in co-created service recovery. *Journal of the Academy of Marketing Science*, *36*(1), 123-137.

Edvardsson, B., Tronvoll, B., & Gruber, T. (2011). Expanding understanding of service exchange and value co-creation: a social construction approach. *Journal of the Academy of Marketing Science*, *39*(2), 327-339.

Elster, J. (2006). Altruistic Behavior and Altruistic Motivations. In S. Kolm & J. Mercier Ythier (Eds.). *Handbook on the Economics of Giving, Reciprocity and Altruism* (pp. 57-63). Elsevier.

Falk, A., & Fischbacher, U. (2006). A theory of reciprocity. *Games and Economic Behavior*, *54*, 293-315.

Fernandes, T., & Remelhe, P. (2016). How to engage customers in co-creation: customers motivation for collaborative innovations. *Journal of Strategic Management*, *24*(3-4), 311-323.

Fowler, J. G. (2013). Customer Citizenship Behaviour: An Expanded Theoretical Understanding. *International Journal of Business and Social Sciences*, *4*(5), 3-5.

Fuller, J., Muhlbacher, H., Matzler, K. & Jawecki, G. (2009). Consumer empowerment through internet-based co-creation. *Journal of Management Information Systems*, *26*(3), 71-102.

Garma, R., & Bove, L. L. (2009). *Customer Citizenship Behaviours Directed at Service Personnel: What The Experts Have to Say*. Australian and New Zeland Marketing Academy (ANZMAC), Conference Paper.

Grönroos, Ch. (2011). Value co-creation in service logic: a critical analysis. *Marketing Theory*, *11*(3), 271-301.

Groth, M. (2005). Customers As Good Soldiers: Examining Citizenship Behaviours In Internet Service Deliveries. *Journal of Management*, *31*(1), 7-27.

Gruen, T. W. (1995). The Outcome Set of Relationship Marketing in Consumer Markets. *International Business Review, 4*(4), 447-469.

Gruen, T. W., Summers, J. O., & Aciti, F. (2000). Relationship Marketing Activities, Commitment and membership Behaviours in Associations. *Journal of Marketing*, *64*, 34-49.

Gustafsson, A., Kristensson, P., & Witell, L. (2012). Customer co-creation in service innovation: a matter of communication? *Journal of Service Management*, *2*(3), 311-327.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis*. New Jersey, United States: Pearson Prentice Hall.

Hair, J. F., Ringle, Ch. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *The Journal of Marketing Theory and Practice*, *19*(2), 139-152.

Hair, J. F., et al. (2013). *A primer on partial least squares structural equation modeling (PLS-SEM)*. SAGE Publications, Incorporated.

Hair, J. F., et al. (2017). *Advanced Issues in Partial Least Squares Structural Equation Modeling.* SAGE Publications.

Haumann, T., Güntürkün, P., Schons, L. M., & Wieseke, J. (2015). Engaging customers in coproduction processes: How value-enhancing and intensity-reducing communication strategies mitigate the negative effects of coproduction intensity. *Journal of Marketing*, *79*, 17-33.

Henseler, J., Ringle, Ch. M, & Sinkovics, R. R. (2009). The use of partial least squares path modelling in international marketing. In R. R. Sinkovics & P. N. Ghauri (Eds.) *New challenges to international marketing* (pp. 277-319). Emerald Group Publishing Limited.

Henson, R. K., & Roberts, J. K. (2006). Use of Exploratory Factor Analysis in Published Research Common Errors and Some Comment on Improved Practice. *Educational and Psychological Measurement*, *66*(3), 393-416.

Hoyer, W. D., Chandy, R., Dorotic, M., Krafft, M., & Singh, S. S. (2010). Consumer co-creation in new product development. *Journal of Service Research*, *13*(3), 283-296.

Huynh, M. T. X., & Olsen, S. O. (2015). Consumer participation in virtual communities: The role of personal values and personality. *Journal of Marketing Communications*, *21*(2), 1-21.

Johnson, J. W., & Rapp, A. (2010). A more Comprehensive Understanding and Measure of Customer Helping Behaviour. *Journal of Business Research*, *63*, 787-792.

Kim, H. S., & Choi, B. (2016). The effects of three customer-to-customer interaction quality types on customer experience quality and citizenship behavior in mass service settings. *Journal of Services Marketing*, *30*(4), 384-397.

Koltko-Rivera, M. E. (2006). Rediscovering Later Version of Maslow's Hierarchy of Needs: Self-Transcendence and Opportunities for Theory, Research And Unification. *Review of General Psychology*, *10*(4), 302-317.

Kotler, Ph. (1994). *Marketing Management: Analysis, Planning, Implementation, and Control*. Prentice-Hall International.

Lusch, R. F., & Vargo, S. L. (2006). Service-dominant logic: reactions, reflections and refinements. *Marketing Theory*, *6*(3), 281-288.

Lusch, R. F., & Vargo, S. L. (2014). *Service-dominant logic: premises, perspectives, possibilities*. Cambridge University Press.

Maklan, S., Knox, S., & Ryals, L. (2008). New Trends in Innovation and Customer Relationship Management: A Challenge for Market Researchers. *International Journal of Market Research*, *50*(2), 221-240.

Maglio, P. P., Vargo, S. L., Caswell, N., & Spohrer, J. (2009). The service system is the basic abstraction of service science. *Information Systems & e-Business Management*, *7*(4), 104-106.

Mitręga, M. (2014). Pomiar w badaniach naukowych w marketingu-standardy w Polsce i za granicą okiem recenzenta [Measurement in marketing research. Polish and foreign standards - the reviewer's perspective]. *Marketing i Rynek, 8*(CD), 135-138.

Nambisan, S., & Baron, R. A. (2007). Interactions in virtual customer environments: implications for product support and customer relationship management. *Journal of Interactive Marketing*, *21*(2), 42-46.

Nunnally, J. C., Bernstein, I. H., & Berge, J. M. F. (1967). *Psychometric theory*. New York, United States: McGraw-Hill.

Patterson, P. G., & Smith, T. (2003). A cross-cultural study of switching barriers and propensity to stay with service providers. *Journal of Retailing*, *79*(2), 107-120.

Payne, A. F., Storbacka, K., & Frow, P. (2008). Managing the co-creation of value. *Journal of the Academy of Marketing Science*, *36*, 83-96.

Payne, R. (1970). Factors Analysis of a Maslow-type Need Satisfaction Questionnaire. *Personnel Psychology*, *23*, 251-268.

Porter, M. E. (1980). *Competitive Strategy: Techniques For Analysing Industries and Competitors*. The Free Press.

Prahalad, C. K., & Ramaswamy, V. (2004). Co-Creation Experience: The Next Practice In Value Creation. *Journal of Interactive Marketing*, *18*(3), 5-14.

Radic, S. (2011). The Hierarchy Of Needs For Social Media Evangelists. *Social Media Strategy.* Retrieved from www.goveloop.com/community/the-herarchy-of-needs-for-social-media-evangelists/

Ringle, Ch. M., Wende, S., & Becker, J. M. (2018). *SmartPLS 3*. Boenningstedt: SmartPLS GmbH.

Roberts, D., Hughes, M., & Kertbo, K. (2014). Exploring consumers' motivations to engage in innovation through co-creation activities. *European Journal of Marketing*, *48*, 147-169.

Roggeveen, A. L., Tsiros, M., & Grewal, D. (2008). The Effect of Compensation on Repurchase Intentions in Service Recovery. *Journal of Retailing*, *84*(4), 424-434.

Rosenbaum, M. S., & Messiah, C. A. (2007). When Customers Receive Support from Other Customers. *Journal of Service Research*, *9*(3), 261.

Roser, T., DeFillippi, R., & Samson, A. (2013). Managing Your Co-creation Mix: Co-creation Ventures in Distinctive Contexts. *European Business Review*, *25*(1), 20-41.

Ryan, R. M., & Deci, E. L. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *American Psychologist*, *55*(1), 68-78.

Soch, H., & Aggarwal, N. (2013). Influence of Commitment on Customer Discretionary Behaviour: A Survey in Retail Sector. *Universal Journal of Management*, *1*(2), 103-110.

Tommasetti, A., Troisi, O., & Vesci, M. (2017). Measuring customer value co-creation behaviour. *Journal of Service Theory and Practice*, *27*(5), 930-950.

Urwiler, R., & Frolick, M. N. (2008). The IT Value Hierarchy: Using Maslow's Hierarchy of Needs as a Metaphor for Gauging the Maturity Level of Information Technology Use within Competitive Organizations. The IT Value Hierarchy. *Information Systems Management*, *25*, 83-88.

Vargo, S. L., & Akaka, M. A. (2009). Service-dominant Logic as a Foundation for Service Science: Clarifications. *Service Science*, *1*(1), 32-41.

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing*, *68*(1), 1-17.

Vargo, S. L., & Lusch, R. F. (2016). Institutions and axioms: an extension and update of service-dominant logic.

Journal of the Academy of Marketing Science, *44*(1), 5-23.

Wahba, M. A., & Bridwell, L. G. (1976). Maslow Reconsidered: A Review of Research on the Need Hierarchy Theory. *Organizational Behaviour and Human Performance*, *15*, 212-230.

Wing Sun Tung, V., Chen, P. J., & Schuckert, M. (2017). Managing customer citizenship behaviour: the moderating roles of employee responsiveness and organizational reassurance. *Tourism Management*, *59*, 23-35.

Xie, C. Y., Bagozzi, R. P., & Troye, S. V. (2008). Trying to prosume: toward a theory of consumers as co-creators of value. *Journal of the Academy of Marketing Science*, *36*(1), 109-122.

Yang, K. S. (2003). Beyond Maslow's Culture-Bound Linear Theory: a Preliminary Statement of The Double-Y Model of Human Needs. In V. Murphy-Berman & J. J. Berman (Eds.), *Cross-Cultural Differences in Perspectives of the Self* (pp. 192-272). Lincoln, United States: University of Nebraska Press.

Yi, Y., & Gong, T. (2006). The ascendants and consequences of service and customer citizenship and badness behaviour. *Seoul Journal of Business*, *12*(2), 145-175.

Yi, Y., Gong, T., & Lee, H. (2013). The Impact of Other Customers on Customer Citizenship Behaviour. *Psychology and Marketing*, *30*(4), 341-356.

Volume 11 • Issue 3 • 2019

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 1 May 2019
accepted: 15 September 2019

pages: 60-68

Internet-based consumer co-creation experience of the new product development process

Viktoria Khrystoforova, Dariusz Siemeniako

ABSTRACT
The paper aims to explore consumer co-creation experience of new product development processes. Specifically, it is an attempt to determine the level of consumer engagement in an online co-creation process, identifying motives and reasons for the participation in new product development as well as understanding the types of Internet-based co-creation that are mostly preferred by consumers. The study used an online questionnaire and the CAWI method. The results of the research showed that consumers were interested in being involved in the co-creation of new product development. However, some consumers clearly expressed their reservations regarding participation because they felt lacking required knowledge.

KEY WORDS
consumer co-creation, new product development, open innovation, Internet-based co-creation, co-creation experience

DOI: 10.2478/emj-2019-0021

Corresponding author:

Viktoria Khrystoforova

National Aviation University, Ukraine
e-mail: khristoforovaviktoria@gmail.com

Dariusz Siemeniako

Bialystok University of Technology, Poland
e-mail: d.siemieniako@pb.edu.pl

INTRODUCTION

These days, nearly all organisations face challenges posed by the rapidly changing and dynamic environment, which requires them to cope and adapt. The evolvement of the Internet and the transformation of trends external to companies, such as globalisation or increased competition, have altered innovation processes that were traditionally used in organisations to achieve the open innovation approach, which puts some influence regarding the development of innovations in the hands of internal employees. Nevertheless, the concept of open innovation also implies a more active contribution of consumers to the new product development (NPD) processes (Chesbrough, 2003). Therefore, companies with an open innovation strategy view consumers as

a valuable resource for new product ideas (Geise, 2017), and the inclusion of consumers in NPD, which is becoming a trend for many organisations, is referred to as "consumer co-creation" (Hoyer et al., 2010). Consumer co-creation defines an active, creative and social collaboration process between producers and consumers, facilitated by the company (Piller et al., 2010). This concept has received increasing attention in the past few years, and nowadays, organisations are forced to find new ways to attract, gain and sustain loyal customers to remain competitive.

This paper aims to explore consumer co-creation experience of NPD processes in a company. Specifically, it is an attempt to determine the level of consumer engagement in an online co-creation process, identifying motives and reasons for participation in NPD as well as understanding the types of Internet-based co-creation that are mostly preferred by consumers.

Even though the questionnaire (CAWI) was conducted online, the research had a qualitative approach as the authors focused on the exploration of reasons, motives and expectations for the co-creation from the consumer perspective. The research provides an insight into the consumer experience in co-creation situations. Specifically, it focuses on determinants and motives in the cases where the co-creation experience depends on consumer characteristics, such as expected co-creation benefits (i.e., expectations of a consumer regarding benefits from co-creation situations; Fuller, 2010), consumer attitudes towards co-creation (considering the earlier mentioned benefits) and consumer reflection (how the attitudes are translated into actions) (Katz et al., 1974).

The theory presented in the article and the research findings can be used by managers and marketing specialists for insights into the key elements of co-creation and the most important consumer motivators to engage in co-creation activities.

The paper is organised as follows: first, the literature review presents the influence of open innovation on new product development, and the relation between the NPD process and consumer co-creation. The literature review also characterises the concept of consumer co-creation from the company's and consumer's perspectives, which reveals different motives of co-creation. The research findings present reasons, motives and expectations of co-creation from the consumer perspective. Finally, conclusions propose some practical implications based on the literature review and research results.

1. Literature review

The literature review was based on search key words, such as consumer co-creation, consumer motivation, new product development, and open innovation. The search was constrained to information regarding co-creation in the B2C sector only.

A constantly changing business environment, which is especially relevant nowadays, requires companies to compete by implementing new strategies while considering that product innovation development is used to satisfy consumer needs and wants. This is especially important in building customer loyalty (Siemieniako, 2011; Siemieniako and Urban, 2006). Therefore, open innovation has become a new paradigm and an integral part of innovation strategies (Inauen and Schenker-Wicki, 2011) in companies, including the involvement of consumers and producers simultaneously as co-producers. Zatwarnicka et al. (2019) describe the involvement of women in co-production in the handcraft industry of a developing country. A recent report showed that 61% of firms were growing or expanding their open innovation efforts with the focus on partner networks, ideation programmes, problem/solver networks and co-creation programmes (Griffin et al., 2014). The integration of open innovation in companies leads to the development of new products for the competitive marketplace. New product development is an important component in an organisation's enlargement and an increment of its future success (Durmaz et al., 2017). Regular development of new products can potentially ensure customer satisfaction, meet relentlessly changing needs and market requirements (Owens, 2004). Consequently, NPD is an important driver of corporate growth and profitability (O'Hern and Rindfleisch, 2010), with an emphasis on systems, which simultaneously provide quality, variety, frequency, speed of response and customisation (Bessant and Francis, 1994). This can be achieved using the NPD process and its stages. NPD processes involve a series of phases called the Stage-Gate process (Cooper, 2011) aimed at delivering a functional commercial benefit to consumers (Harmancioglu et al., 2007) and improving and controlling NPD (Sethi et al., 2012).

Typical Stage-Gate process design breaks the traditional NPD process into a set of discrete and identifiable stages, with each stage consisting of a set of prescribed activities (Tzokas et al., 2004), such as: the generation of new product ideas, the development

of an initial product concept, an assessment of its business attractiveness, the actual development of the product, testing it within the market, and the actual launch of the product on the marketplace. Alongside each of these stages, an evaluation takes place, basically, to determine whether the new product should advance further or be terminated (Tzokas et al., 2004).

By launching new products, companies try to deliver new product characteristics, such as new benefits, higher quality, correspondence to user needs, decreased time-to-market, and reduced development costs (Cooper, 2013). The NPD process aims to provide solutions that would satisfy consumer needs and wants (von Hippel, 2005). Hence, to perform this for creating and launching successful new products, an understanding of consumer preferences has to be essential and taken into consideration (Joshi and Sharma, 2004). This shift of consumer role during the NPD process leads to "co-creation". By relating the NPD and the co-creation process, O'Hern and Rindfleisch (2010, p. 83) discussed a definition of the co-creation as "a collaborative NPD activity in which customers actively contribute and/or select the content of a new product offering." Beside this, co-creation involves exchanging ideas, sharing knowledge, and working together (Akhilesh, 2017). Piller et al. (2010, p. 8) defined co-creation as "an active, creative, and social collaboration process linking producers and consumers, aided by the organization." This idea of co-creation is different from some other terms, such as mass collaboration, crowdsourcing, and mass customisation, which sometimes get confused with co-creation. As co-creation creates value for an individual as well as a group, it is different from mass customisation. Co-creation is different from crowdsourcing of ideas because it implies active intellectual participation in a process; and it is different from mass collaboration because of the two-way flow between the organisation and the participant (Ind et al., 2013). In addition, consumer involvement in the NPD process can improve product quality, reduce risk, and improve market acceptance (Hoyer et al., 2010).

The ability of consumers to take a more active role in NPD has been significantly enhanced by recent technological advances, most notably, the development and expansion of the Internet (O'Hern and Rindfleisch, 2010). Mitręga (2018) showed the value of online organisational routines for co-creation and their helpfulness in product innovation implementation on the market. The introduction of Web 2.0 and different social media platforms contributed to the development of a new era of consumer empowerment enabling consumers to interconnect worldwide and easily share and exchange personal, social and scientific knowledge with like-minded individuals (Lorenzo-Romeo et al., 2014) as well as share information, opinions and experiences as fast as never before (Smaliukiene et al., 2014). Thus, the web and social media enable companies to interact and share knowledge with consumers, and to co-create new products with them.

According to Hoyer (2010), the collaboration with consumers in all stages of the product development process concerns the scope of co-creation. Co-creation implies consumer engagement in phases of NPD (Verleye, 2015), namely, the creation of offerings through ideation (e.g., consumers generating new ideas in virtual environments of companies), design (e.g., consumers designing their own offerings using self-design tools provided by companies), and development (e.g., user communities testing offerings for defects). Some consumers only participate in the initial stages of the process; others partake in the final stages, and some cooperate continuously throughout the entire course of development (Largosen, 2005). However, consumer input at the early stages is more critical and useful than at the later stages (Kahn et al., 2005). For example: (i) the "Co-Creation Lab" of the BMW Group is a virtual meeting place for individuals interested in car-related topics and anxious to share their ideas and opinions on the automotive world of tomorrow; (ii) LEGO Ideas is an online community where members can discover cool creations by other fans and submit their own designs for new sets; (iii) Apache is open source web server software where consumers can test, provide feature enhancements, bug fixes, and support others in blogs and forums. Co-creation in NPD is an experience-oriented concept, which concentrates on the interaction between the company and the consumer. Therefore, co-creation has three important aspects, namely, the consumer, the company and the interaction between the consumer and the company. The co-creation process can be considered from different perspectives, i.e., the company perspective and the consumer perspective, highlighting benefits for both.

From the perspective of a company, the facilitation of the co-creation experience with consumers requires to create environments that promote co-creation. Firms need to create specific environments for employees to interact with consumers, provide information infrastructure and resources (Ter-

blanche, 2014). These capabilities and infrastructures that allow consumers to perform activities have to fulfil five basic requirements: provide user-friendly operation, offer module libraries, provide "trial and error" functionality, define a possible solution space and transfer user design (Gaubinger et al., 2015). Furthermore, these resources and infrastructures have to be built on the basis of three characteristics: "degrees of freedom" (the consumer's autonomy in the task), "degrees of collaboration" among consumers (the interaction between the firm and the consumer vs. communities) and the "stage of the innovation process" (front-end vs. back-end) (Piller et al., 2010). According to these three dimensions, eight ideal types of co-creation with consumers emerge: idea contests, idea screening, product-related discussion forums, communities of creation at front-end co-creation; and toolkits for user innovation, toolkits for customer co-design, communities of creation for problem-solving and virtual concept testing at back-end co-creation. All these methods of consumer co-creation follow a common principle, but despite this common ground, companies intending to profit from co-creation need to know which of the different methods are most suited for them and how to use these tools best (Piller et al., 2010). More detailed research is required to answer these questions.

From the consumer perspective, co-creation has been addressed in terms of stages experienced by consumers during participation, analysing their motivates to participate, their roles in co-creation and their participation styles (Terblanche, 2014). The level of consumer participation in co-creation depends on the technical ability of consumers, the information they possess and the costs of participation (Gurau, 2009). According to Fuchs and Schreier (2011), four levels of consumer involvement exist and relate to consumer empowerment in terms of two basic dimensions: creating ideas for new product designs (zero empowerment and empowerment to create) and selecting the product designs to be produced (empowerment to select and full empowerment). As a result, different levels of involvement will have different effects on the outcomes of co-creation. The higher the involvement of consumers in co-creation, the more positive the outcomes will be.

But the concept of co-creation is based on a voluntary basis, which implies that consumers have to be motivated to participate. Therefore, a key constraint of the concept is the consumer's willingness to exchange ideas and knowledge with organisations. It is vital for businesses to determine what enables consumers to actively share their ideas and what might inhibit their decision to cooperate.

Fuller (2010) analysed motives for co-creation. Multiple reasons drive consumers to engage in open innovation projects ranging from purely intrinsic motives (such as fun, kinship, and altruism) and internalised extrinsic motives (e.g., learning, reputation, and own use) to purely extrinsic motives (such as payment and career prospects) (von Krogh et al., 2008). As a result, ten categories of motives were identified: intrinsic playful task, curiosity, self-efficacy, skill development, information seeking, recognition (visibility), community support, friendships, personal need (dissatisfaction), and compensation (monetary reward) (Gaubinger et al., 2015). This motive structure served as the basis for the distinction of four consumer types: reward-oriented, intrinsically interested, curiosity-driven and need-driven consumers (Fuller, 2010). Reward-oriented customers are driven by monetary reward. Intrinsically interested customers are highly motivated by their interest in innovation activities, as they are very skilled novelty seekers, who like problem-solving. For them, monetary reward is not the first priority. Curiosity-driven customers are highly involved in co-creation, as they are curious about the process and its result. Need-driven customers participate in co-creation because they are not satisfied with the current products/services available on the market. They are highly demanding and very interested in adapting the existing offer to their own needs (Orcik et al., 2013). Ideally, a company should target all types of consumers with its Internet-based co-creation activities and meet their expectations.

In terms of customer motivation to participate in online co-creation, Katz et al. (1974) proposed uses and gratification (U&G) theory. This theory can be supplemented with Fuller's (2010) classification of benefits (which are economic, cognitive, hedonic, personal, social and pragmatic) and O'Hern's and Rindfleisch's (2010) co-creation typology classification, which includes co-designing, tinkering, collaborating and submitting.

2. Research method

The study was based on an online questionnaire and the CAWI method. Even though the tool was quantitative, the used approach was qualitative. The statistical analysis was not made as the research was

considered explorative and aimed at revealing consumer motives to participate in co-creation processes via Internet-based resources. Google Forms were chosen as an appropriate tool for the new era of consumer empowerment, enabling consumers to interconnect worldwide and helping them to gather data from various geographical locations.

Different types of questions were used in the questionnaire, including dichotomous, multiple-choice and ranking scale questions. Facebook was used as s social media platform for the distribution of the survey to reach respondents worldwide. The questionnaire was divided into two parts, with the first part capturing the motives and perception of involvement in the co-creation process, and the second part targeting demographic characteristics of respondents.

The research sample comprised of 126 respondents. The purposive method was used to gather respondents. The intent was to have male and female respondents of different age groups, specifically: 16–25 year-olds as the first group, 26–35 year-olds as the second group and those over 35 as the third group. It was also assumed that the respondents would represent a wide range of levels of education, occupations, different employment statuses and social groups, such as students and older adults.

Participation in this survey was voluntary, participants did not receive any financial/non-financial remuneration.

3. Findings

The group of respondents comprised of 38 (30%) males and 88 (70%) females. Respondents were distributed across three age categories, with 43% in the first group (16–25 y.o.), comprising between – 24% in the second group (26–35 y.o.) and 33% in the third group (over 35).

In terms of the level of education and the type of occupation, more than half of respondents were employed (52%), one-fifth were students (21%), 15% were self-employed, some were unemployed (10%) and retired (3%).

Most respondents (47%) spent 1 to 3 hours online on average per day, some (20%) spent 4 to 6 hours, and several people (11%) spent more than 6 hours. Only 10% of respondents had only 10–30 minutes to spend online on average per day, while 13% of respondents spent 30–60 minutes.

According to the results of the research, three-quarters of respondents had never participated in co-creation activities. Some reasons became apparent, with the majority (42%) of respondents indicating having had no knowledge of a possibility to take part. Despite the fact that consumer co-creation is not a new phenomenon, most people are still unfamiliar with this concept and the type of activities it entails. Consequently, aiming to attract more people, companies must provide more information about co-creation activities at their locations but also at more popular sites used by consumers, such as Facebook, Instagram and Twitter. The second most popular reason, which was indicated by a third of respondents, was the lack of knowledge of how to participate. This reason is interconnected with the first as without the awareness of the activity taking place, it is impossible to know how to participate. It is also an important factor as the lack of knowledge decreases customer motivation. To avoid this as well as to interest and motivate people to participate, companies must provide consumers with clear instructions and detailed explanation of the process. Yet another reason is the lack of thought about the possibility to take part in online co-creation activities, which was indicated by almost 13% of respondents. This reason can also be explained by the lack of motivation and understanding the purpose of the activity.

However, 81% of all respondents indicated their interest to participate in co-creation activities related to NPD processes in the future. The most popular reasons for such interest were enhanced knowledge of product trends, related products and technology (47% — strongly agree; 23% — agree), improved satisfaction of customer needs (57% — strongly agree; 29% — agree) and a possibility to spend some enjoyable and relaxing time (23% — strongly agree; 33% — agree; Fig. 1).

These reasons were related to cognitive, pragmatic and hedonic expected benefits, respectively. It should be noted that financial compensation or another type of reward was not a priority. Consequently, according to the expected benefits, the respondents can be attributed to the group of intrinsically interested, curiosity-driven and need-driven customers. Respondents who were uninterested in participating in co-creation in the near future once again mentioned the lack of time and interest.

To understand the respondent's intention to participate in future online co-creation activities, cluster analyses were used. The results showed that

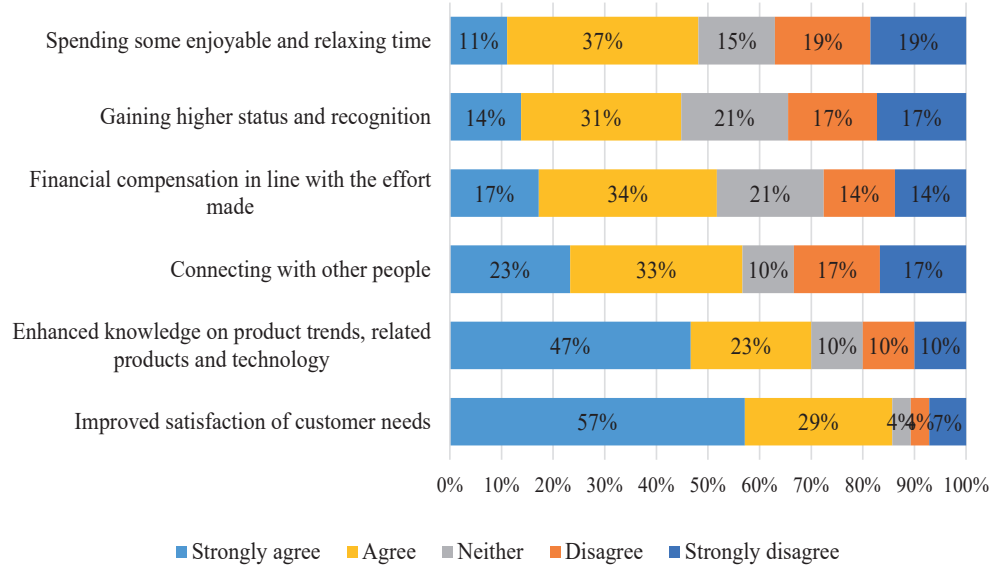

Fig. 1. Reasons of participating in online co-creation activities

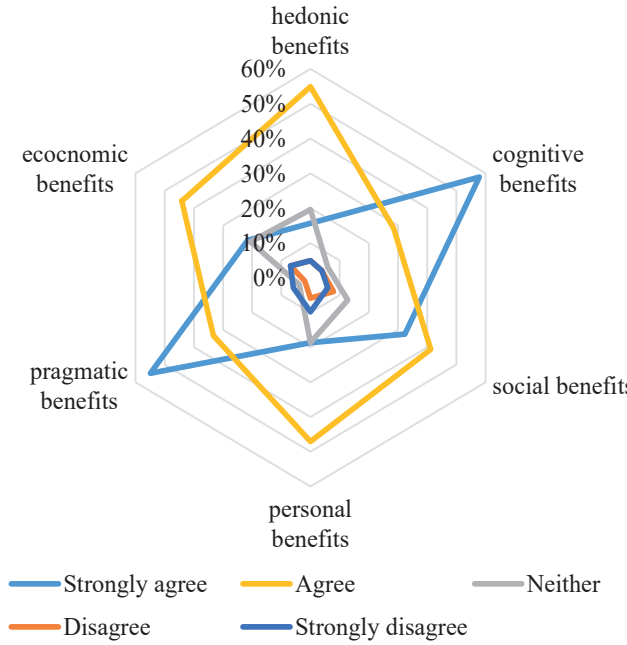

Fig. 2. Benefits expected from the participation in an online co-creation process

consumers engaged in online co-creation for several reasons, such as curiosity, dissatisfaction with existing products, intrinsic interest in innovation, enhanced knowledge, the chance to share ideas or to get monetary rewards. This analysis revealed the difference among consumers by their motive structure that drives them to participate in online co-creation and, therefore, expect different benefits (Fig. 2).

The most prevailing types of expected benefits among respondents were cognitive, which were related to acquiring new knowledge or skills, and pragmatic, which concerned better solutions for personal needs. This suggests that relationships exist between benefits and reasons for participation in online co-creation activities. As for the reasons related to benefits, enhanced knowledge of the products and their use as well as better solutions for personal needs were the most popular among respondents. However, respondents also indicated they would anticipate hedonic benefits in terms of spending some enjoyable and relaxing time, fun and pleasure, entertainment and stimulation of the mind,

enjoyment of problem-solving, idea generation etc. However, economic benefits were not important as they could be expected compared to other benefits. As it was mentioned above, all respondents indicated the importance of being rewarded and this reward did not automatically have to be money.

Considering the consumer attitude towards the co-creation process, it was observed that 57% of respondents strongly agreed with the fact that involvement of consumers in the online co-creation process would result in better products or services and co-creation activities could positively affect the relationship between customers and companies. However, 45% of respondents strongly agreed that users must be involved in the online co-creation process. Usually consumers want to be intrinsically motivated. Furthermore, consumers are more aware, more conscious about their needs and have a distinct conception of which products or services they are searching for. Consequently, they want to be engaged in co-creation process and actively participate in the creation of new products.

At the same time, however, the most preferred types of Internet-based co-creation activities were co-designing (helping to select the product design by voting), tinkering (adding additional features to the product) and collaborating (developing and improving core components and the underlying structure of a new product), which scored 31%, 27% and 26%, respectively. These results can be explained by the fact that submitting represents the lowest level of consumer empowerment, compared to other types of co-creation (as the company dictates the format that contributions must follow and also has full power to select which consumer contributions to adopt), while more consumers are seeking to receive a more active role in the creation of the products they consume. The almost equal distribution of opinions among these three types of co-creation can be explained by the fact that all these types provide customers with considerable autonomy in terms of the selection process in varying degrees, and co-designing involves a level of customer autonomy over content selection that falls somewhere between collaborating and tinkering.

Conclusions

Based on the literature review, it can be concluded that co-creation in the NPD process is an important aspect of the highly competitive market of today. With the advent of Internet and mobile technologies, consumer opinions and information can be easily obtained and cost less than ever before. Thus, co-creation with consumers is not only a means of gaining insight into the wants of consumers but also a marketing tool to show that the company invites its consumers to participate in the development of new products and company-wide innovation. Internet ensures effectiveness and efficiency of co-creation activities used for the NPD process by lowering the cost of interaction among participants, allowing a larger number of participants to contribute to a particular co-creation initiative as well as decreasing time-to-market and financial cost. In addition, consumer co-creation has substantial implications both for firms and consumers, where firm related outcomes of co-creation are efficiency, effectiveness and increased complexity, and the consumer-related outcomes fit consumer needs, build relationships, bring engagement and satisfaction.

The findings of this research showed that contemporary consumers, although not yet participating in co-creation activities within the NPD process, are very willing to be engaged in the future. The main reasons for participation in co-creation activities are enhanced knowledge on product trends, related products and technology, improved satisfaction of customer needs and spending some enjoyable and relaxing time. In the opinion of the respondents, the most important types of expected benefits from the participation in the co-creation of a company's NPD process are cognitive and pragmatic. Also, hedonic benefits were emphasised as important.

Based on the literature review and the results of the explorative research, the conceptual model (Fig. 3) was offered, which can be empirically tested using a quantitative survey in the future.

The proposed model consists of three variables, namely "antecedents", "attitudes", and "consequences". The first variable of the U&G theory (Katz et al., 1974), "antecedents", explains the motivations a customer could have to co-create on a voluntary basis. These motivations are based on Fuller's (2010) classification of benefits and, respectively, are economic, cognitive, hedonic, personal, social and pragmatic. These antecedents influence the attitudes of a user towards participants in co-creation and the subsequent actions. The variable "attitudes" describes what attitudes the customer has towards co-creation, considering previously mentioned benefits. The final variable "consequences" interprets how the attitudes are transferred into actions. These "consequences"

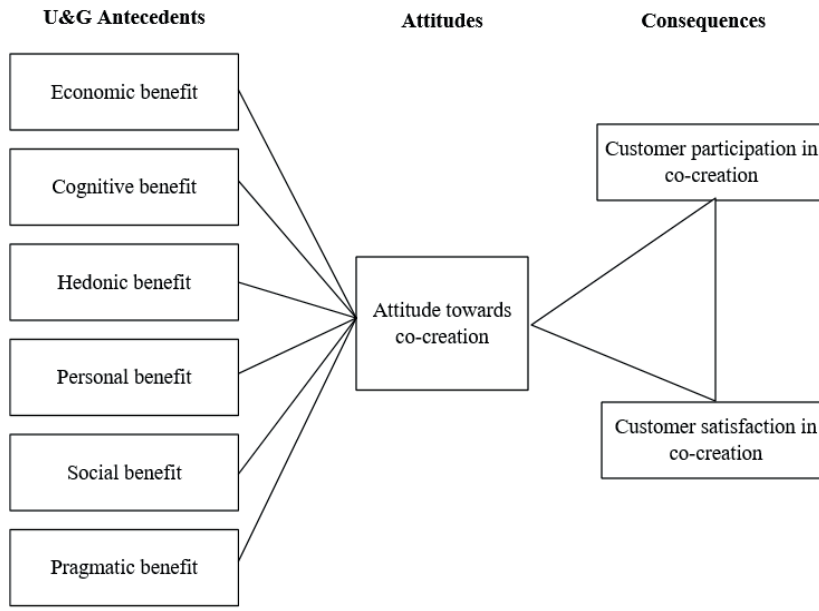

Fig. 3. Conceptual model

include "customer participation in co-creation", whether users have participated in any kind of customer involvement, which is based on typology of customer co-creation developed by O'Hern and Rindfleisch (2010) and includes codesigning, tinkering, collaborating and submitting; and "customer satisfaction in co-creation" which explains the benefits expected by the users to satisfy them sufficiently during co-creation.

The practical implications of these findings inform companies about a motivated co-creator and keys to the success of the co-creating activity. Motivation can be achieved by supporting and promoting the six perceived benefits, particularly those related to the social aspect, such as enjoyment and stimulation of the mind as well as benefits related to the pragmatic aspect, such as enhancing the knowledge of the product, technology or brands. Clearly, consumers would be willing participate more if the process offered enjoyment and entertainment as well as provided insights and knowledge of products and technologies.

Literature

Akhilesh, K. B. (2017). Co-Creation and Learning. In *Co-Creation and Learning* (pp. 45-54). New Delhi, India: Springer.

Bessant, J., & Francis, D. (1997). Implementing the new product development process. *Technovation*, *17*(4), 189-222.

Chesbrough, H. (2003). The era of open innovation. *MIT Sloan Management Review*, *44*(3), 35-41.

Cooper, R. G. (2011). Stage-Gate Idea to Launch System. In B. L. Bayus (Ed.), *Wiley International Encyclopedia of Marketing: Product Innovation & Management*. West Sussex, Great Britain: Wiley.

Cooper, R. G. (2013). New products: What separates the winners from the losers and what drives success. In B. Kahn, & G. Castellion (Eds.), *PDMA handbook of new product development* (pp. 3-34). New Jersey, United States: John Wiley & Sons, Inc.

Durmaz, Y., & Şirin, M. (2017). A Theoretical Approach to New Product Development Strategies. *International Journal of Academic Research in Management and Business*, *2*(1), 1-5.

Fuchs, C., & Schreier, M. (2011). Customer empowerment in new product development. *Journal of product innovation management*, *28*(1), 17-32.

Fuller, J. (2010). Refining virtual co-creation from a consumer perspective. *California Management Review*, *52*(2), 98-122.

Gaubinger, K., Rabl, M., Swan, S., & Werani, T. (2015). *Innovation and product management*. Berlin, Germany: Springer-Verlag Berlin Heidelberg.

Geise, F. A. (2017). Integration of Consumers into New Product Development by Social Media-Based Crowdsourcing–Findings from the Consumer Goods Industry in Germany. In G. Christodoulides, & A. Stathopoulou (Eds.), *Advances in Advertising Research* (pp. 15-27). Wiesbaden, Germany: Springer.

Gouillart, F., & Deck, M. (2011). The Craft of Co-Creation. *PRTM Insight*, 1-6.

Griffin, A., Noble, C. H., & Durmusoglu, S. S. (2014). *Open Innovation: New product development essentials from the PDMA*. New Jersey, United States: John Wiley & Sons.

Gurău, C. (2009). Marketing flexibility in the context of the service-dominant logic. *The Marketing Review*, *9*(3), 185-197.

Harmancioglu, N., McNally, R. C., Calantone, R. J., & Durmusoglu, S. S. (2007). Your new product development (NPD) is only as good as your process: an exploratory analysis of new NPD process design and implementation. *R&D Management*, *37*(5), 399-424.

von Hippel, E. (2005). Democratizing innovation: The evolving phenomenon of user innovation. *Journal für Betriebswirtschaft*, *55*(1), 63-78.

Hoyer, W. D., Chandy, R., Dorotic, M., Krafft, M., & Singh, S. S. (2010). Consumer cocreation in new product development. *Journal of Service Research*, *13*(3), 283-296.

Inauen, M., & Schenker-Wicki, A. (2011). The impact of outside-in open innovation on innovation performance. *European Journal of Innovation Management*, *14*(4), 496-520.

Ind, N., Iglesias, O., & Schultz, M. (2013). Building brands together: Emergence and outcomes of co-creation. *California Management Review*, *55*(3), 5-26.

Joshi, A. W., & Sharma, S. (2004). Customer knowledge development: antecedents and impact on new product performance. *Journal of Marketing*, *68*(4), 47-59.

Kahn, K. B., Castellion, G., & Griffin, A. (Eds.). (2005). *The PDMA handbook of new product development*. Hoboken, United States: Wiley.

Kärkkäinen, H., Jussila, J., & Janhonen, J. (2011). *Managing customer information and knowledge with social media in business-to-business companies*. Proceedings of the 11th International Conference on Knowledge Management and Knowledge Technologies, ACM.

Katz, E., Blumler, J. G., & Gurevitch, M. (1974). Utilization of Mass Communication by the Individual. In J. G. Blumler, & E. Katz (Eds.), *The Uses of Mass Communications: Current Perspectives on Gratifications Research* (pp. 19-31). Beverly Hills, United States: Sage Publications.

Khrystoforova, V. (2019). *Customer co-creation as open innovation process of New Product Development based on Internet solutions*. Master Thesis defended on June 2019, Faculty of Engineering Management, Bialystok University of Technology.

von Krogh, G., Spaeth, S., Haefliger, S., & Wallin, M. (2008). *Open Source software: what we know (and do not know) about motives to contribute*. DIME-DRUID Fundamental on Open and Proprietary Innovation Regimes, May 17th, Copenhagen, Denmark.

Lagrosen, S. (2005). Customer involvement in new product development: A relationship marketing perspective. *European Journal of Innovation Management*, *8*(4), 424-436.

Lorenzo-Romero, C., Constantinides, E., & Brünink, L. A. (2014). Co-creation: Customer integration in social media-based product and service development. *Procedia-Social and Behavioral Sciences*, *148*, 383-396.

Meuter, M. L., Bitner, M. J., Ostrom, A. L., & Brown, S. W. (2005). Choosing among alternative service delivery modes: An investigation of customer trial of self-service technologies. *Journal of Marketing*, *69*(2), 61-83.

Mitręga, M. (2018). *Dynamiczne zdolności marketingowe organizacji Koncepcja i wybrane obszary zastosowań* [*The organization's dynamic marketing abilities. Concept and selected areas of application*]. Katowice, Poland: Uniwersytet Ekonomiczny w Katowicach.

O'Hern, M. S., & Rindfleisch, A. (2010). Customer co-creation. In K. Naresh (Ed.), *Review of marketing research* (pp. 84-106). Emerald Group Publishing Limited.

Orcik, A., Stojanova, T., & Freund, R. (2013). *Co-creation: Examples and lessons learned from south-east Europe*. Proceedings of International Conference for Entrepreneurship, Innovation and Regional Development ICEIRD.

Owens, J. (2004). An evaluation of organisational groundwork and learning objectives for new product development. *Journal of Enterprising Culture*, *12*(04), 303-325.

Piller, F. T., Ihl, C., & Vossen, A. (2010). A typology of customer co-creation in the innovation process. *Innovation in a Modern Work Environment, 4*, 1-26.

Sethi, R., Iqbal, Z., & Sethi, A. (2012). Developing new-to-the-firm products: the role of micropolitical strategies. *Journal of Marketing*, *76*(2), 99-115.

Siemieniako, D. (2011). Lojalność relacyjna a zobowiązanie w złożonych związkach usługowych [Relational loyalty and commitment in complex service relationships]. *Marketing i Rynek*, *8*, 10-15.

Siemieniako, D., & Urban, W. (2006). Typy lojalnych klientów na podstawie cech więzi lojalności [Types of loyal customers based on the characteristics of a loyalty relationship]. *Marketing i Rynek*, *1*, 7-12.

Smaliukiene, R., Chi-Shiun, L., & Sizovaite, I. (2014). Consumer value co-creation in online business: the case of global travel services. *Journal of Business Economics and Management*, *16*(2), 325-339.

Terblanche, N. S. (2014). Some theoretical perspectives of co-creation and co-production of value by customer. *Professional Accountant*, *14*(2), 1-8.

Tzokas, N., Hultink, E. J., & Hart, S. (2004). Navigating the new product development process. *Industrial Marketing Management*, *33*(7), 619-626.

Verleye, K. (2015). The co-creation experience from the customer perspective: its measurement and determinants. *Journal of Service Management*, *26*(2), 321-342.

Zatwarnicka-Madura, B., Siemieniako, D., Glińska, E., & Sazonenka, Y. (2019). Strategic and Operational Levels of CSR Marketing Communication for Sustainable Orientation of a Company: A Case Study from Bangladesh. *Sustainability*, *11*(2), 555.

SPECIAL SECTION

Reengineering the way to do business: perspectives from standpoints of innovation, production and performance

GUEST EDITOR:

Włodzimierz Sroka

WSB University, Dąbrowa Górnicza, Poland
North-West University, South Africa
e-mail: wsroka@wsb.edu.pl

Natanya Meyer

North-West University, South Africa
e-mail: Natanya.Meyer@nwu.ac.za

Editorial – Włodzimierz Sroka, Natanya Meyer

DOI: 10.2478/emj-2019-0028

The current special section of Engineering Management in Production and Services consists of five articles devoted to topics of managerial reporting, open innovations, CRM and its influence on organisational performance, reengineering of production processes and comparison between governance mechanisms, and supply chain performance. These topics are undoubtedly important for countries in economic transition as well as for well-developed economies.

Authors of the first paper Open innovation in the context of organisational strategy analyse the relationship between different types of corporate strategy and open innovation in the contexts of the age, size and the operational range of enterprises. Traditional and electronic forms of a questionnaire were used to research a sample of 100 randomly selected companies in Poland. The level of "openness" of innovation processes in an enterprise was determined according to a 3-point scale, namely, a closed innovator, a hybrid or semi-open innovator, and an open innovator. Enterprise strategies were classed into three main types — cost leadership, differentiation or diversification — used to achieve a competitive advantage. The results showed a strong correlation between open innovations, the cost leadership strategy and the differentiation strategy (negative correlation). The relationship was also observed between the age, size and the range of a company and the opening of innovative processes. As stated by the authors, the research aimed to fill the knowledge gap regarding the links between a particular type of strategy and the opening of innovation processes.

The second paper Managerial reporting by food production companies in Slovakia in 2017 claims that corporate reporting on non-financial information has been currently gaining much more interest compared to the past. Most food enterprises believe that performing responsibly and showing an interest in society and the environment will result in some profit and will benefit them as well as society. Thus, the study focused on managerial reporting of 2017 regarding the social and environmental effects of food companies in Slovakia. The research covered all of the food enterprises operating in Slovakia that compiled annual reports for 2017. In total, 142 annual reports were collected on economic activities in 26 subclasses in the sector. The results present a current and comprehensive reporting overview of this industry in Slovakia and reveal several shortcomings in executive reporting.

The next paper Reengineering of production processes and its impact on the financial situation and business performance of the company highlights the importance of well-planned and implemented processes in the improvement of the financial position of the business. The authors believe that the current body of knowledge is yet to provide business managers with an effective solution to monitor the impact made by reengineering on corporate financial results. Therefore, the contribution this paper makes is significant as it provides a practical application of reengineering based on the analysis, implementation and evaluation to assess the impact on the financial situation and performance of the business. The main findings of this study support the initial view that reengineering of production processes could most probably lead to increased performance and value to a company, specifically with regards to its financial situation.

The fourth paper CRM influence on organisational performance — the moderating role of IT reliability aims to verify the role of IT reliability as the factor potentially strengthening the CRM influence on organisational performance and conclude whether the IT reliability is indeed an important factor shaping the CRM ability to generate value for an organisation. The research was carried out based on a survey of 558 entities in Poland and 564 in Switzerland. The research clearly showed that IT reliability is a moderator of the relation between CRM time-of-use and the organisational performance. The existing IT solutions should support CRM, and with such support, this management method will positively impact organisational performance. This conclusion seems to be an important contribution to the studied field, filling the research gap concerning the mechanism of IT support for CRM.

The final paper Examining the link between the governance mechanisms and supply chain performance — an empirical study within the triadic context focuses on the importance of governance in the supply chain process. The study showed that the triadic supply chains significantly differentiate in terms of the modes of governance. In addition, findings also indicated that the triadic supply chains that follow the network governance mode consider their performance to be significantly higher in comparison to the supply chains that do not run this type of governance mechanism. It is important to highlight that the mechanism of governance is inseparable from a certain dyadic relationship established between two actors in the broader structure of supply chains. The study also showed that incorporating a clan as a social mechanism of governance together with good market environment and hierarchy results in increasing the relational benefits and overall performance for both dyads in the triadic supply chains.

The articles in this special section of Engineering Management in Production and Services provide valuable new insights into analysed topics. We believe that this issue contributes to the development of theory and provides relevant insight for scholars, policymakers and practitioners.

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 1 May 2019
accepted: 15 September 2019

pages: 71-85

Managerial reporting by food production companies in Slovakia in 2017

Renáta Pakšiová, Kornélia Lovciová

ABSTRACT

Corporate reporting on non-financial information has been currently gaining much more interest compared to the past. Most food enterprises believe that performing responsibly and showing an interest in society and the environment will produce a profit and benefit them as well as society. Such cases, in which enterprises report on non-financial information, were the subject of this research. The study aims to discover the managerial reporting of 2017 on the social and environmental effects of food companies in Slovakia to better understand problems in this regard. 2017 was the first year when enterprises were required to draft annual reports containing non-financial information following the amendment to the Slovak law that resulted from the European Union requirements. Across the world, reporting on non-financial information is regulated by voluntary guidelines. The paper presents conclusions of a content analysis of annual food business reports in the Slovak Republic in the context of G4 (GRI) directives from social and environmental points of view as key elements in social responsibility reporting. Individual social and environmental aspects of the research are disclosed by an enterprise if the information in its annual report conforms to defined G4 activities (GRI). All the food enterprises operating in Slovakia that compiled annual reports for 2017 were included in the research. Therefore, 142 annual reports with economic activities in 26 subclasses in the food industry sector were selected. The results present a current and comprehensive (full) reporting overview of this industry in Slovakia and reveal several shortcomings in executive reporting. The analysis of the environmental information in the annual reports shows that food enterprises reporting on environmental protection mainly focus on waste, product services, wastewater, materials and energy, evidenced by information about ongoing monitoring of the environmental impacts of production. In the social category, the G4 (GRI) directive defines four main aspects: (i) labour relations and the environment, (ii) human rights, (iii) society and (iv) liability for products.

KEY WORDS

disclosure, food enterprises, Slovakia, non-financial information, CSR reporting

DOI: 10.2478/emj-2019-0022

Corresponding author:

Renáta Pakšiová

University of Economics in Bratislava, Slovakia
e-mail: renata.paksiova@euba.sk

Kornélia Lovciová

University of Economics in Bratislava, Slovakia
e-mail: lovciova@gmail.com

Introduction

In the Slovak Republic, the food industry is closely linked to primary agricultural production and, therefore, holds an important position in the economy. It has a significant impact on employment and health of the population as well as the development of individual areas and regions of Slovakia. Nevima and Kiszová (2013) reached similar conclusions concerning the Czech Republic. The Food Industry Development Concept 2014–2020 of the Slovak Republic considers the food industry a strategic branch that ensures the country's food sovereignty having the further developmental potential to the level of 80% by 2020. The Concept aims to meet the following strategic objectives (The Food Industry Development Concept, 2014):

- Improve the food sovereignty to 80% of the current consumption of the Slovak population;
- Strengthen the position of the Slovak food industry on the market;
- Increase the food industry's competitiveness.

In April 2018, the Food Chamber of Slovakia (FChS) indicated the declining trend in all indicators of the food industry, which was a consequence of the onset of low-cost trade systems and restrictions in Slovakia. Large stores significantly contributed to the decline in the proportion of domestic food on the domestic market. In other words, Slovak food has been pushed out of the market by cheaper imported food (Teraz.sk, 2018).

The food industry plays an important role in the Slovak Republic; however, it is characterised by an insufficient and low degree of food security (Kollár, 2015; Vaqué, 2017). The plan to combine the development of the food industry with the concept of corporate social responsibility (CSR) is a suitable tool for meeting the strategic objectives of food enterprises that are associated with those of the government. Nowadays, the interest of the public in the information related to the food industry is on the rise. Annual reports, which are the basic source of information on business activities, are regulated by the Accounting Act in Slovakia. The obligation to compile an annual report concerns companies that are required to audit the financial statements by an external auditor and the Accounting Act also sets out the basic requirements for the content of the annual report. However, it does not specify the exact information to be included or its structure, especially in the field of CSR. In terms of sustainability reporting, particularly CSR, the EU member states follow the current key legal act, which in is Directive 2013/34/EU of the European Parliament and of the Council on the annual financial statements, consolidated financial statements and related reports of certain types of enterprises, amending Directive 2006/43/EC and 83/349/EEC as amended. More detailed reporting in the field of CSR was prescribed by Directive 2014/95EU of the European Parliament and of the Council of 22 October 2014 amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large enterprises and groups. Member states of the EU can choose a way to apply the requirements for enterprises. They have more possibilities to report non-financial information (CSR information): to compile it as a part of a managerial report (this option is available in Slovakia, where an Annual Report is a fusion of financial and non-financial information), to compile a standalone sustainability report, or to compile several reports containing different types of information.

Information about business activities published in annual reports is only important when it can be used by people to make decisions. Different than reporting financial information, there is no uniform approach to reporting non-financial information, which makes itis difficult to compare. Annual reports contain information that varies in scope, is placed in different locations, has numerous wordings and interpretations. Consequently, it becomes questionable whether businesses are reporting anything at all. The current CSR reporting issues are also relevant to industrial sectors.

Authors of several major publications have been investigating CSR reporting in several countries and industries (e.g. Gray et al., 1995; KPMG, 2017; Habek, 2017; Horvath et al., 2017a; Horvath et al., 2017b; Wagner et al., 2018; Tetrevova, 2018); however, no comparable research for the food industry in terms of extended annual reporting requirements in the Slovak Republic has been published yet.

Despite efforts to reconcile and compare non-financial information in the Member States of the European Union, for example, by issuing a Guide to Disclosure of Non-Financial Information (the methodology for disclosure of non-financial information), obstacles arise from differences in legislation, terminology or information presentation (Guidelines on non-financial reporting, 2017).

Given the above-mentioned facts and importance of the food industry, research was concentrated on determining the scope of reporting on key aspects of social and environmental issues for the accounting period 2017, in which the requirements for reporting on non-financial information in accordance with the transposed EU directives in Slovak legislation were stipulated for the first time.

The study aimed to discover the managerial reporting in 2017 on the social and environmental effects of food enterprises in Slovakia to better understand problems in this regard. 2017 was the first year when enterprises were required to draft annual reports containing non-financial information following the amendment to the Slovak law that resulted from the European Union requirements. Across the world, reporting on non-financial information is regulated by voluntary guidelines. The paper presents conclusions of an analysis of Slovak annual food-business reports in the context of G4 (GRI) directives in social and environmental fields as key elements of

social responsibility reporting and the use of the most refined reporting guide to aid such task.

The paper offers a literature review focusing on the theoretical background of food enterprise specificities, corporate social responsibility and their reporting behaviour from theoretical and practical points of view. The practical research into the content of annual reports focused on the conditions in Slovakia, and the results were structured according to the main aspects of social and environmental categories presented in the G4 (GRI) directives. The discussion section compares the results to those obtained by authors in other contemporary researches. The conclusions section identifies the most important weaknesses in and directions for improving executive reporting on non-financial information and information about the social and environmental activities of enterprises.

1. Literature review

Globalisation, accompanied by rapid technological changes, has given rise to a completely new business environment. Under these new circumstances, the development of a modern company is determined not only by the effective use of resources and the application of appropriate strategies but also by taking into account the concept of corporate social responsibility (Sroka and Szántó, 2018). In other words, if a company wishes to be perceived as a reliable partner in business, it should implement elements of this concept (Stonkute, Vveinhardt and Sroka, 2018). Terms "sustainability" and "permanent sustainable development" date back to the 1970s. Originally, they were used in the sense that the uncontrolled growth of anything (population, production, consumption, pollution, etc.) is not sustainable when resources are limited (Petera and Wagner, 2015). Sustainable development has famously been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Zhang, Morse and Kambhampati, 2018 or Turečková et al., 2018). In the last decade, an increasing number of companies have been involved in the preparation and disclosure of sustainability reports, which include information on economic, social and environmental dimensions as the major measures of the corporate sustainability quality the so-called "triple bottom line" (Elkington, 1998). Sustainable development is a broader category than CSR. The CSR concept is an implementation of sustainable development at the enterprise level. CSR is considered important for the existence of companies in numerous countries and regions (Lőrinczy and Sroka, 2015).

Since the enforcement of obligations to publish reports on corporate social responsibility (CSR) in the European Union in 2018, an increasing number of companies have introduced the CSR policy into their everyday business practices, and as a result, started disclosing the related information in CSR reports or within annual reports (Strouhal et al., 2015). Corporate social responsibility has become significant in contemporary theory as well as professional practice (Grmelová and Zahradníková, 2019).

The commitment to act responsibly for sustainable development of the society is mandatory for companies that aim to create a strong corporate image as the society becomes more and more concerned about ethical, social (Mallin, 2004) and environmental (Krause, 2015) challenges. In most countries, CSR reporting is voluntary; therefore, companies choose various means to disclose CSR-related information, either in the form of standalone CSR reports or within annual financial reports (Strouhal et al., 2015). As business sustainability is a highly complex issue, mainly containing non-financial data, reporting is not easy, so, several initiatives provide frameworks for sustainability reporting (Budinská, 2016).

In many countries, politicians wish to proliferate the number of new firms and improve their performance by improving sustainable activities (Solesvik, 2019). Depending on a country, different frameworks and standards can be used, such as UN Global Compact Principles, OECD Guidelines for Multinational Enterprises, GRI guideline, ISO 26000, AA1000 and SA8000 (Aureli, 2017). The GRI Sustainability Reporting Guidelines (Guidelines) offer Reporting Principles, Standard Disclosures and an Implementation Manual for the preparation of sustainability reports by organisations, regardless of their size, sector or location (G4 (GRI) Sustainability reporting guidelines, 2016). The main benefit of the directive is a list of quantitative and qualitative performance indicators, through which the company describes its socially responsible performance (Chomová, 2009).

At present, many standards regulate CSR. This diversity is mainly supported by increased interest and the inconsistency in the theoretical anchoring of the CSR concept. Studying the literature, however, most frequently results in a conclusion that usually, the basic division, according to Leipziger (2010), is

applied, which divides standards into the process- and performance-oriented. Performance standards are concentrated on the formulation of measures for social responsibility, while process standards also focus on defining areas, e.g., reporting or communicating with stakeholders (Kutlák and Procházková, 2017). According to the concept of CSR as a strategic decision, the management plays a fundamental role in determining responsible behaviour of an organisation and its accountability to different interest groups (Hill and Jones, 1992; Rupley et al., 2012; Ferrero-Ferrero et al., 2013). Stakeholder involvement is seen as a key process to align enterprise and stakeholder interests and to identify material content for sustainability reports (Moratis and Brandt, 2017). Typical users often willingly engage with organisations, in which they have an interest (Li et al., 2014). The legislature does not explicitly classify tasks related to creating conditions for business development among the tasks of communes as local government units and important stakeholders. However, it indicates the need to satisfy the collective needs of the community (Pierzyna, 2019). The broad diversity of information exchange practices has been found in the network of "policy stakeholders" (Dvorak and Civinskas, 2018). It is not only financial health indicators that provide information on an enterprise (Šebestová et al., 2018). Together, non-financial and financial reporting provides stakeholders with meaningful, comprehensive insights into the position and performance of companies and groups in the past, present and predictable future, which is why they are so strongly regulated.

As an alternative to sustainability reports, companies may divulge information about their social and environmental goals, actions and related consequences through other documents, such as the integrated report, citizenship report, social report or even the annual report (Aureli, 2017; MacGregor Pelikánová, 2019). Today, reporting the sustainability of a business is not just a voluntary matter (Budinská, 2016). Many Slovak companies provide brief information in their annual reports to meet legal requirements. However, some companies consider the annual report an important and effective document for the transparency of their business and, therefore, already meet the criteria of a high-quality annual report (Okruhlica et al., 2018).

Corporate social responsibility can be seen as an attribute to helping meet the goals of enterprises in the food industry. It is increasingly recognised as a critical tool for companies seeking to integrate CSR into day-to-day operations and strategies (Chandler, 2017a). When looking at the legal viability, there has been a trend towards allowing organisations some additional flexibility in the dissemination of their financial statements (Boylan and Boylan, 2017). CSR or, as some call it, corporate conscience, citizenship, social performance or sustainable corporate responsibility is a form of enterprise self-regulation integrated into a business model (Wood, 1991).

Strategic CSR represents the intersection of the CSR and strategy; thus, to implement a strategic CSR perspective throughout operations, it is essential that executives understand the interdependent relationships between the firm, its strategy, and its stakeholders that define the firm's environment and contain its capacity to act (Chandler, 2017b). CSR management across all dimensions becomes the core of sustainable strategic management of a company, the most important component of which is people. The staffing of the company is considered to be the most valuable source of prosperity, and often, personnel management as a priority (Loučanová and Parobek, 2014). Demographic changes caused by the ageing of the population have an impact on organisations and the age structure of their employees; organisations face new challenges in the field of human resources management since employees belonging to different age groups also perceive their working environment differently and react differently (Rožman et al., 2019). However, recent studies have found that a salary is not the most important factor in the context of employee job satisfaction as other factors, such as work-life balance and health awareness, have special significance (Schiller, 2019). The utilisation of the company strategies in CSR must have a significant impact on the work motivation of employees (Zatrochová, 2015). Human resource management contributes greatly to attracting talented individuals to an organisation even in the face of increasing competition due to the global and knowledge economies (Al-Tal and Emeagwali, 2019). A new research method may emerge to address the problem (Ribeiro-Soriano et al., 2018; Melecký and Staníčková, 2017).

Environmental sustainability can help a company make a positive contribution to society and the natural environment (Nagyová et al., 2016). The environment has become a part of a company's responsible approach to business activity and, at the same time, an opportunity for entrepreneurial growth (Carroll, 1999). Environmental activities in the framework of the enterprise strategy development gave rise to the EU Green Paper, in which CSR defines the voluntary integration of social and environmental aspects into

day-to-day business activities and interactions with stakeholders (Moravcikova et al., 2017). The nature of social responsibility, as a starting point for sustainability, expresses the company's focus on goals and strives to meet the economic, social and environmental goals of activities, in which the company manages responsibly beyond legal standards (Németh, 2016). This definition is based on the so-called principle of triple bottom line (people, profit, planet) (Kunz, 2012), that is, the measurement of positive and negative impacts of the enterprise on the social, economic and environmental spheres of society as a whole, considering other CSR principles, such as sustainable development and volunteering (Jankalova and Vartiak, 2017). Environmental Operational Accounting monitors and evaluates value-based financial accounting information and data on material and energy flows in a mutually related manner to improve the efficiency of material and energy use, mitigate environmental impacts of business activities, products and services (Majerník et al., 2017). Energy efficiency and renewable energy have a great potential for economic development in Europe's regions by boosting energy security, creating jobs and increasing regional autonomy as well as helping to fight climate change (Hunkin et al., 2014). The European Union has contributed greatly to the growth of these sectors in Europe, with the Europe 20/20/20 targets setting the mid-term policy framework (MacGregor Pelikánová, 2019), and a variety of programmes and tools providing finance and support for regional development (Zimmermannová et al., 2019).

Orientation on products or employees and other social aspects are currently becoming a significant dilemma in most industries, not only in Slovakia, which brings a new understanding of stakeholders (Krejčí and Šebestová, 2018). The product (service) offered to the customer is one of the factors enabling the company to achieve a competitive advantage (Sroka, Jablonski A. and Jablonski M., 2013). Firms find it increasingly desirable to advocate for environmental protection in the promotion of their corporate image and products (Keller, 1998). One such direction that could help in the reduction of negative development is a systematic and well-planned policy (Martinat et al., 2016). The term "innovation" is a common word used in the scientific communities as well as businesses (Shpak et al., 2017). One of the most important steps in managing the public sector innovation is having an appropriate definition for it (Wipulanusat et al., 2019). Product innovations resulting in general improvements in product quality parameters, such as reliability and durability, can be classified as sustainability-oriented since they extend the lifespan of the products. Process improvements that reduce waste and enhance the efficiency of the use of energy or resources will obviously boost competitiveness and will also contribute to greening. Investment in new production equipment, replacing the outdated, low-efficiency machines, may not only increase productivity and quality but also ensure more energy-efficient processes, hence reducing the firms' energy consumption per unit (Szalavetz, 2017).

In developed countries, consumer protection is an integral part of the market economy. In the European Union, the concept is in place, focusing on accessibility and security and protecting consumers against serious risks and threats to health (Lacková and Faith, 2015) as well as generally contributing to the modern European integration (MacGregor Pelikánová, 2019). According to Directive 2001/95/EU of the European Parliament and of the Council of 3 December 2001 on general product safety, it is important to take measures aimed at improving the functioning of the internal market, which is the area having no internal borders where the free movement of goods is ensured. In the absence of Community provisions, horizontal safety legislation of Member States imposing economic operators, in particular, a general obligation to market only safe products could be achieved at the level of the consumer that is provided to consumers (Directive 2001/95/EU, 2001).

2. Research methods

As a method, this research mostly used content analysis of annual reports by enterprises, filtering main topics from social and environmental categories of information. As the analysis focused on reports within the food industry, enterprises were selected checking their classification according to SK NACE — the Slovak statistical classification of economic activities — and their obligation to compile and publish annual reports as specified under financial requirements of the Act on Accounting of Slovakia for audited financial statements. Food industry enterprises from the SK NACE classification were selected using the service of a private company FINSTAT, which allowed to choose enterprises based on different criteria (Finstat, 2019).

The Register of Financial Statements (Register of Financial Statements, 2019) administered by the Ministry of Finance of the Slovak Republic was the

primary source of annual reports for analysis. Since 2014, enterprises are obligated to publish financial statements and annual reports in the Register. The research focused on all published annual reports of enterprises that operated in the Slovak food industry in 2017.

Out of the total number of 1577 food enterprises, 142 were selected into the sample of a more detailed analysis. On the date of issue of the financial statement, the enterprises had to meet the following two conditions:

- operate in the food industry. The sample of food enterprises was determined based on the SK NACE classification, section C — Industrial Production, Food Processing sector, divisions 10 — Food Production, 11 — Beverage Production, and 12 — Production of Tobacco Products;
- obligated to audit their financial statements and annual reports and, therefore, obliged to draft the annual report.

The qualitative analysis of the information published in annual reports of 2017 submitted by Slovak food industry enterprises listed as such in SK NACE aims to reveal the specifics of reporting particular to this industrial segment. The content analysis was based on keywords contained in annual reports regarding CSR-specific areas. The keywords mainly focused on terms typical of the food industry and supported by general and specific aspects of GRI standards (G4 directive) from the main topics of social and environmental categories. The result of this applied research is an overview of the most important information that should be provided in annual reports by Slovak food industry enterprises in terms of current legislation in the context of sustainable development and also the extent of their actual publication.

3. Research results

The content analysis was based on the information contained in annual reports, under the parts on social and environmental issues, i.e., areas related to CSR. The analysis followed the structure of general and specific aspects of the Global Reporting Initiative (GRI) standards, which proved to be helpful. When choosing the appropriate keywords, researchers mainly focused on terms typical of the food industry. Within the individual categories of the GRI general guidelines, researchers analysed non-financial information that was disclosed in annual food enterprise reports. The food industry is categorised according to SK NACE — the Slovak statistical classification of economic activities —Section C — Manufacturing, which is based on the NACE EU Regulation referred to in the Regulation (EC) No 1893/2006 of the European Parliament and of the Council (Regulation (EC), 2006).

From the total number of 1577 food enterprises established in Slovakia, 142 were obligated to submit annual reports for 2017 (representing only 9% of all enterprises) in 26 subclasses of economic activities under the Section C. All 142 enterprises were obligated to audit their financial statements and draft annual reports for the year 2017, and as they had fulfilled their obligation up to February 2019, when the research started, their reports were selected for the detailed textual analysis (Table 1). In Slovakia, enterprises listed under seven subclasses out of the 33 of the Section C applicable to the food sector's economic activities are not obligated to audit their financial statements or submit annual reports (representing 21% from all active subclasses in Slovakia).

According to the analysis of environmental information provided in the annual reports, food enterprises engage in environmental protection, which is evidenced by an abundance of information regarding the monitoring of environmental impacts of production. In their annual reports for 2017, several food enterprises also commented on the draft of the Act on Depositing of Plastic Bottles and Cans. The reports also contained information on the use of water in several production stages, e.g. the production and use of water vapour in food manufacturing. Almost every sector had at least one food business that expressed a statement regarding the use and protection of water as an essential part of the food manufacturing process. Such statements were expressed by 21 or 14.79% of enterprises. 25 enterprises (17.61%) addressed the issues of waste and wastewater. Waste is a diverse issue as, for example, enterprises engaged in animal production cooperate with certified partners for transportation, loading and disposal or further processing of animal waste based on a contractual relationship. Similarly, different waste, such as paper, glass, cardboard, plastic and rubber packaging, is transported by subcontractors authorised to process, recycle and recover such waste. The enterprises conformed to the waste policy by implementing waste management systems that focused on correct sorting and high level of waste recovery. Sugar factories classified in SK NACE under 10810 — "Manufacture of sugar", can be taken as an example of waste recovery, which is used

Tab. 1. Analysis of information submitted in annual repor by enterprises operating in the food industry

Food industry sector	SK NACE	Enterprises in the food industry for 2017		Enterprises obligated to disclose the annual report for 2017 (all disclosed it)	
		Number of enterprises	Percentage of the total number of enterprises	Number of enterprises	Percentage of the total number of enterprises
Processing and preserving of meat	10110	71	4.50	11	7.75
Processing and preserving of poultry meat	10120	9	0.57	3	2.11
Production of meat and poultry meat products	10130	56	3.55	8	5.63
Processing and preserving of fish, crustaceans and molluscs	10200	8	0.51	1	0.70
Manufacture of fruit and vegetable juice	10320	8	0.51	1	0.70
Other processing and preserving of fruit and vegetables	10390	72	4.57	5	3.52
Manufacture of oils and fats	10410	28	1.78	4	2.82
Operation of dairies and cheese making	10510	37	2.35	14	9.86
Manufacture of grain mill products	10610	57	3.61	12	8.45
Manufacture of starches and starch products	10620	4	0.25	2	1.41
Manufacture of bread; manufacture of fresh pastry goods and cakes	10710	50	3.17	25	17.62
Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	10720	76	4.82	6	4.23
Manufacture of sugar	10810	3	0.19	2	1.41
Manufacture of cocoa, chocolate and sugar confectionery	10820	64	4.06	3	2.11
Processing of tea and coffee	10830	63	3.99	1	0.70
Manufacture of condiments and seasonings	10840	19	1.20	6	4.23
Manufacture of prepared meals and dishes	10850	75	4.76	1	0.70
Manufacture of homogenised food preparations and dietetic food	10860	7	0.44	1	0.70
Manufacture of other food products	10890	217	13.76	9	6.34
Manufacture of prepared feeds for farm animals	10910	69	4.38	5	3.52
Manufacture of prepared pet foods	10920	11	0.70	1	0.70
Distilling, rectifying and blending of spirits	11010	111	7.04	7	4.93
Manufacture of wine from grapes	11020	146	9.26	7	4.93
Manufacture of beer	11050	50	3.17	3	2.11
Manufacture of malt	11060	7	0.44	2	1.41
Manufacture of soft drinks; products of mineral waters and other bottled waters	11070	132	8.37	2	1.41
Processing and preserving of potatoes	10310	17	1.08	0	0.00
Manufacture of margarine and similar edible fats	10420	1	0.06	0	0.00
Manufacture of ice cream	10520	59	3.74	0	0.00
Manufacture of macaroni, noodles, couscous and similar farinaceous products	10730	23	1.46	0	0.00
Manufacture of cider and other fruit wines	11030	10	0.63	0	0.00
Manufacture of other non-distilled fermented beverages	11040	11	0.70	0	0.00
Manufacture of tobacco products	12000	6	0.38	0	0.00
Total		**1 577**	**100%**	**142**	**100%**

Source: compiled by the author based on the data available in the Register of Financial Statements of Slovakia.

by a biogas plant. Some enterprises classified in SK NACE under 10710 — "Manufacture of bread, manufacture of fresh pastry goods and cakes", generate waste from post-harvest processing of crops. The choice of materials used in production was emphasised by 18 (1.68%) enterprises. Construction of a photovoltaic power plant or its implementation in next years was disclosed by 16 enterprises. The analysis suggests that socially responsible enterprises are not worried about investing resources in new production facilities, upgrading of technologies, safety and energy savings that have positive environmental impacts. Expenses on environmental protection have been confirmed by 14 business from among the analysed enterprises, most of them classified in SK NACE under 10510 — "Operation of dairies and cheese making", five of which mentioned their investments having an impact on environmental protection (Tab. 2).

Tab. 2. Analysis of information in the environmental category

Category ENVIRONMENTAL	Number of enterprises that disclosed the information	Percentage share of the total number of enterprises	Number of enterprises that did not disclose the information	Percentage share of the total number of enterprises	Total	Percentage share of the total number of enterprises
Material	18	12.68	124	87.32	142	100.00
Energy	16	11.27	126	88.73	142	100.00
Water	21	14.79	121	85.21	142	100.00
Biodiversity	9	6.34	133	93.66	142	100.00
Emissions	18	12.68	124	87.32	142	100.00
Waste and wastewater	25	17.61	117	82.39	142	100.00
Products and services	26	18.31	116	81.69	142	100.00
Compliance with legislation	1	0.70	141	99.30	142	100.00
Transport	1	0.70	141	99.30	142	100.00
Investments to the environmental protection in total	14	9.86	128	90.14	142	100.00
Environmental evaluation of suppliers	7	4.93	135	95.07	142	100.00
Mechanism of environmental complaints	0	0.00	142	100.00	142	100.00

Source: compiled by the author based on the data available in the Register of Financial Statements of Slovakia.

Tab. 3. Analysis of information in the social category (labour relations and environment)

Category SOCIAL Labour relations and environment	Number of enterprises that disclosed the information	Percentage share of the total number of enterprises	Number of enterprises that did not disclose the information	Percentage share of the total number of enterprises	Total	Percentage share of the total number of enterprises
Employment	59	41.55	83	58.45	142	100.00
Personnel management	19	13.38	123	86.62	142	100.00
Health and safety	24	16.90	118	83.10	142	100.00
Training and education	21	14.79	121	85.21	142	100.00
Diversity and equal opportunities	3	2.11	139	97.89	142	100.00

Source: compiled by the author based on the data available in the Register of Financial Statements of Slovakia.

According to G4 (GRI) directive, the social category is divided into four main aspects: labour relations and environment, human rights, society, and liability for products. Following this division, the qualitative analysis was classified into the following four main aspects. Pursuant to G4 (GRI) directive, the aspect of employment includes information on the number and structure of employees according to their age, gender and region, the total number of original employees and newly recruited staff or the turnover rate. With regard to information for the aspect "Employment" specified in Table 3, almost 59 selected enterprises disclosed this information, representing the largest share of 41.55%. This information was not disclosed by 83 or 58.45% of enterprises. Despite the fact that food enterprises train their employees in the field of occupational safety and health to prevent workplace risks and manage them efficiently to minimise possible occupational injuries to employees, the level of disclosure in terms of this aspect was low since only 16.90% of enterprises published safety and occupational safety information. Only one food enterprise published information on the implementation of OHSAS 18001 — Occupational Health and Safety Assessment Specification. More detailed results of the content analysis in the social category of labour relations and environment are shown in Tab. 3.

The annual reports of the analysed food enterprises did not contain information from the aspect of human rights, as this category includes information of non-standard nature or is rather unique, for example, on banning of discrimination, child labour, forced or obligatory labour, freedom of association and collective bargaining, which is not considered a problematic area in the Slovak Republic.

The social category of the social environment) within the analysed item of local communities included information on development programmes for local communities based on their needs. The essence of such programme is, e.g., the grant project Saris to People whose contributions were focused on the revitalisation of monuments and other symbols of the Presov region. These projects were supported by enterprises classified in SK NACE under 10130, 10610, 10720, 11020, and 11050. More information from the content analysis of the annual reports in this field is presented in Tab. 4.

Slovak food enterprises should put the quality and safety of food in the first place. They often base their business policy on food quality and safety. In 2017, 23 enterprises (16.20%) out of 142 disclosed the information regarding their interest in health and safety of customers, while 119 enterprises (83.80%) did not disclose such information, which is surprising in this context. In general, information on the quality and safety of food was disclosed only by several enterprises. Results of the analysis related to other important topics within this category can be found in Tab. 5.

Reporting is the next step after taking action to protect nature and the social aspects of working in

Tab. 4. Analysis of information in the social category (social environment)

Category SOCIAL Social Environment	Number of enterprises that disclosed the information	Percentage share of the total number of enterprises	Number of enterprises that did not disclose the information	Percentage share of the total number of enterprises	In total	Percentage share of the total number of enterprises
Local communities	6	4.23	136	95.77	142	100.00
Corruption	0	0.00	142	100.00	142	100.00
Public policy	4	2.82	138	97.18	142	100.00
Behaviour against competition	0	0.00	142	100.00	142	100.00
Compliance with legislation	0	0.00	142	100.00	142	100.00
Assessment of suppliers from the perspective of impact on society	1	0.70	141	99.30	142	100.00
Mechanism for filing of complaints within impact on society	0	0.00	142	100.00	142	100.00

Source: compiled by the author based on the data available in the Register of Financial Statements of Slovakia.

society. The research shows that businesses generally engage in these activities, but they frequently incorrectly classify and report such information to meet the needs of all users.

4. Discussion of the results

Long-term research conducted by KPMG, including its latest report (KPMG, 2017), confirmed that regulations stipulated by governments and stock exchanges are the main drivers of environmental, social and governance reporting. In various regions and countries, reporting still differs significantly. Research by Horvath et al. (2017b) identified an existing gap between Eastern Europe with a relatively low degree of reporting and Western Europe with a higher degree of reporting. The Czech Republic and the Slovak Republic are countries with a lower rate of reporting, which is at the level of the global average (Wagner et al., 2018) and which was also confirmed by the research. The degree of analysed topics of information shared by enterprises in investigated annual reports was mostly lower than 20%.

The amount of research into CSR reporting in Central and Eastern Europe is growing. Nevertheless, it remains an under-researched area, especially compared to Western Europe. This mostly concerns research published exclusively in journals indexed in Scopus or the Web of Science databases. The differences exist also at the level of individual countries and industry sectors. In the food industry sector, no research is yet available about Slovakia. However, this sector generates low research interest in other countries as well. In this context, the research was aimed at analysing the content of CSR reporting in annual reports of Slovak food companies.

Guthrie, Petty, Yongvanich and Ricceri (2004) determined that the analysis of annual reports is a good indication of the degree of reporting. Gray, Kouhy and Lavers (1995) regarded annual reports as regularly produced statutory documents of the highest importance to users.

In Central and Eastern Europe, only a few up-to-date English language papers about CSR have been published in high-quality journals. In terms of the studied countries, none of these papers discussed the Slovak Republic or Slovak food companies. Only some analyses targeted CSR reporting in the Czech Republic, mainly studying corporate websites. Also, Tetrevova (2018) concluded that the degree of CSR reporting by chemical companies is low.

The results of the published studies are difficult to generalise because they applied diverse methods and analysed different types of reports (sustainability reports, annual reports, website reports, etc.). With some simplification, it can be generally summarised that most reports concluded that the majority of companies in Central and Eastern Europe only reported some information concerning CSR topics. This conclusion is also confirmed by the results of the research in Slovak food enterprises. The research results show that environmental and social information is scarce, and reporting is mostly unsystematic. Habek (2017) reported similar findings from investigating individual sustainability reports prepared in accordance with GRI standards in four countries (the Czech Republic, Hungary, Poland and Slovakia). He concluded that CSR reporting was not widespread in these countries. Attempts to measure the sustainability of farms were usually based on the indicators of a set of sustainability factors. According to the literature, analyses should (however, frequently do not) cover the level as well as the relationship between

Tab. 5. Analysis of information in the social category

Category SOCIAL Liability for Products	Number of enterprises that disclosed the information	Percentage share of the total number of enterprises	Number of enterprises that did not disclose t he information	Percentage share of the total number of enterprises	In total	Percentage share of the total number of enterprises
Health and safety of customers	23	16.20	119	83.80	142	100.00
Labelling of products and services	17	11.97	125	88.03	142	100.00
Marketing communication	25	17.61	117	82.39	142	100.00

Source: compiled by the author based on the data available in the Register of Financial Statements of Slovakia.

sustainability factors, because complementary, synergies or competition between sustainability goals can be expected (Sulewski et al., 2018). This is also confirmed by the results, which suggest that in practice, it is difficult to achieve a sustainable development paradigm in all factors at once, even though it is desirable to do so. Today, this is one of the biggest challenges of the common food and agricultural policy (Sulewski et al., 2018). Thus, the support can be expressed to conclusions by Shpak et al. (2018) stating that the development of reproducible potential has current opportunities and that the level of development of achieved potential shows efficient use of social and labour resources.

Conclusions

Nowadays, reporting on non-financial information by companies is gaining more interest compared to the past. Consequently, more attention is given to companies reporting this information. This could have good marketing effect with an aspect of growing business potential. The food industry is no exception, and most food enterprises believe that showing interest in society and the environment will produce a profit, benefiting the businesses as well as society. To better understand the issue, the research focused on non-financial reporting activities by enterprises.

Despite its significant position, the food industry of the Slovak Republic is currently in decline. The Food Industry Development Concept of Slovakia aims to ensure the most efficient national food industry. Thus, the food industry must be viewed as a strategic industry that implements the principles of social responsibility in food enterprise strategy and, thereby, fulfils the strategic plans of society as a whole.

2017 was the first year when enterprises were required to prepare annual reports with non-financial information according to the amended Slovak law that transposed the European Union requirements. Consequently, all the food enterprises operating in Slovakia that compiled annual reports for 2017 were included in the research. Across the world, reporting on non-financial information is regulated by voluntary guidelines.

The paper presents conclusions of content analysis of annual food business reports in the Slovak Republic in the context of G4 (GRI) directives from social and environmental points of view as key elements in social responsibility reporting. The research covered all food businesses operating in Slovakia that prepared an annual report for 2017. The results present a current and comprehensive (full) reporting overview of this industry in Slovakia and reveal several shortcomings in the executive reporting and related engineering processes.

The analysis of the content of annual reports prepared by food enterprises suggests a rise in the interest to submit non-financial information as a part of CSR and sustainable management. Nevertheless, it is still low compared to other industry segments or Western Europe, and it will be important to concentrate on the characteristics of information disclosed by food enterprises from social, environmental and economic points of view.

A contextual analysis of the environmental information in the studied annual reports showed that food enterprises reported on environmental protection mainly focusing on topics of waste, product services, wastewater, materials and energy, and provided information about the ongoing monitoring of the environmental impacts of production.

The G4 (GRI) directive defines four main aspects in the social category: (i) labour relations and the environment, (ii) human rights, (iii) society, and (iv) liability for products. This division was used in the research to categorise the content analysis. In annual reports, the most frequently disclosed social information concerned employment, which covered topics about employee numbers and structures according to age, gender and region, the total number of original employees, newly recruited staff and the turnover rate. A contextual analysis of information provided in the annual reports showed that 59 or 41.55% of enterprises disclosed such employment information. This information was not disclosed by 83 enterprises, representing 58.45%. Information about employee education, including occupational safety and health, was disclosed only by a few enterprises, which was not an encouraging finding. However, it is highly probable that the non-disclosure of this information did not mean that those enterprises did not conduct the activity.

The particulars of reporting by food enterprises relate to compliance with food quality assurance standards. Although food quality and safety are of the highest priority to food enterprises, most enterprises did not disclose such information.

Reporting is the next step after taking action to protect nature and the social aspects of working in society. They are primarily prevented from doing so. The analysis shows that businesses generally engage

in these activities, but the problem is often the correct classification and reporting to meet the needs of all users. Transparency, as well as faithful and true images, are the basic requirements for a well-constructed report. However, to achieve this, there must be tools and business processes that enable not only financial but also non-financial information to be collected and processed throughout the reporting period and not only at the end (or after). To easily prepare a high-quality annual report, is especially important to have a good information system tailored to information flows, types and forms of information as well as selection ports for each reporting area. Support system for the collection of information is the first aspect of reporting processes.

In general, annual reports provide enterprises with the communication potential for presenting and establishing positive activities in society. In Slovakia, this potential has not yet been utilised by food enterprises. This paper identified areas, in which reporting by food business requires improvement as well as important social and environmental topics that are important in this respect. The findings show that enterprises could benefit from the design and provision of a tool that would facilitate and consolidate non-financial reporting as well as collect, sort and disseminate information using information technologies that communicate with accounting software. Information for both financial and non-financial reporting should be provided by a single software package that would make it easier to refer to and calculate financial indicators related to the social and environmental activities of enterprises. At present, most managerial software is available for consolidating different types of information on enterprise activities. The software could be updated, providing tools for easier and improved financial and non-financial reporting. The G4 (GRI) could be redesigned to structure this type of information and adapt to specific conditions of the state, and, eventually, the segment. Aiming to improve management reporting, it is important and helpful to set up a usable electronic form or a standard for easily applicable processes required to compile an annual report or a standalone sustainability report using the information from the managerial information system. This approach would ensure easily accessible, comparative and understandable information for users. Later, report compilation could become more automated. This future vision of high-quality reporting would have a positive impact on businesses and society.

Acknowledgements

This research was supported by the APVV [grant number APVV-16-0602].

Literature

Act No 431/2002 Coll. on Accounting, as amended.

Al-Tal, M. J. Y., & Emeagwali, O. L. (2019). Knowledge-based HR Practices and Innovation in SMEs. *Journal of Management*, *52*(1), 6-21. doi: 10.2478/orga-2019-0002

Aureli, S. (2017). A comparison of content analysis usage and text mining in CSR corporate disclosure. *The International Journal of Digital Accounting Research*, *17*, 1-32. doi: 10.4192/1577-8517-v17_1

Boylan, D. H., & Boylan, C. L. (2017). Technology in Accounting: Social Media as Effective Platform for Financial Disclosures. *The International Journal of Digital Accounting Research*, *17*, 93-109. doi: 10.4192/1577-8517-v17_4

Budinská, L. (2016). Reporting udržateľnosti podnikania podľa GRI [Business sustainability reporting by GRI]. In *Podnikové financie vo vede a praxi - 2016: zborník vedeckých statí Katedry podnikových financií* [*Business Finance in Science and Practice - 2016: Proceedings of Scientific Papers of the Department of Corporate Finance*] (pp. 120-129). Bratislava, Slovakia: EKONÓM.

Carroll, B. B. (1999). Corporate Social Responsibility – Evolution of a Definitional Construct. *Business & Society*, *38*(3), 268-295.

Chandler, B. D. (2017a). Accountability. In *Strategic Corporate Social Responsibility: Sustainable Value Creation* (pp. 180-198). United States: SAGE Publications.

Chandler, B. D. (2017b). Accountability. In *Strategic Corporate Social Responsibility: Sustainable Value Creation* (pp. 237-240). United States: SAGE Publications.

Chomová, K. (2009). Reportovanie správ o udržateľnom rozvoji – Smernice GRI – Global Reporting Initiative [Reporting on Sustainable Development Reports - GRI Guidelines - Global Reporting Initiative]. In *Inovácie marketingových a obchodných* činností *(2): vedecký monografický zborník* [*Marketing and Business Innovation (2): Scientific Monograph Proceedings*] (pp. 38-44). Bratislava, Slovakia: EKONÓM.

Directive 2001/95/EU of the European Parliament and of the council of 3 December 2001 on general product safety.

Directive 2013/34/EU of the European Parliament and of the Council on the annual financial statements, consolidated financial statements and related reports of certain types of enterprises, amending Directive 2006/43/EC and 83/349/EEC as amended.

Directive 2014/95/EU of the European Parliament and of the council of 22 October 2014 amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large enterprises and groups.

Dvorak, J., & Civinskas, R. (2018). The determinants of cooperation and the need for better communication between stakeholders in EU countries: The case of posted workers. *Polish Journal of Management Studies, 18*(1), 94-106. doi: 10.17512/pjms.2018.18.1.08

Elkington, J. (1998). *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*. New Society Publishers: Stony Creek.emyslu%202014-2020.pdf

Ferreto-Ferrero, I., Fernández-Izquierdo, M. Á., & Munoz-Torres, M. J. (2013). Integrating sustainability into corporate governance: an empirical study on board diversity. *Corporate Social Responsibility and Environmental Management*, *22*, 193-207. doi: 10.1002/csr.1333

Finstat. (2019). Retrieved from: www.finstat.sk

G4 (GRI) Sustainability reporting guidelines. (2016). Retrieved from https://www2.globalreporting.org/standards/G4 (GRI)/Pages/default.aspx

Gray, R., Kouhy, R., & Lavers, S. (1995). Constructing a research database of social and environmental reporting by UK companies. *Accounting, Auditing & Accountability Journal, 8*(2), 78-101. doi:10.22164/isea.v1i2.13

Grmelová, N., & Zahradníková, R. (2019). Czech Republic. Corporate Social Responsibility of Five Leading Food Retailers Operating in the Czech Republic. *European Food and Feed Law Review*, *14*(2), 180-186.

Guidelines on non-financial reporting (methodology for reporting non-financial information) (2017/C 215/01).

Guthrie, J., Petty, R., Yongvanich, K., & Ricceri, F. (2004). Using content analysis as a research method to inquire into intellectual capital reporting. *Journal of Intellectual Capital*, *5*(2), 282-293. doi: 10.1108/14691930410533704

Habek, P. (2017). CSR Reporting Practices in Visegrad Group Countries and the Quality of Disclosure. *Sustainability, 9*(12), 1-18. doi: 10.3390/su9122322

Hill, C. W. L., & Jones, T. M. (1992). Stakeholder-agency theory. *Journal of Management Studies*, *29*(2), 131-154. doi: 10.1111/j.1467-6486.1992.tb00657.x

Horvath, P., Putter, J. M., Dagiliene, L., Dimante, D., Haldma, T., Kochalski, C., Král, B.,Labaš, D., Lääts, K.,Bedenik, N. O., Pakšiová, R., Petera, P., Ratajczak, P., Buhovac, A. R., Sava, A., Sucala, V., Tirnitz, T. J., & Wagner, J. (2017a). Status quo and future development of sustainability reporting in Central and Eastern Europe. *Journal of East European Management Studies, 22*(2), 221-243. doi: 10.5771/0949-6181-2017-2-221

Horvath, P., Putter, J. M., Dagiliene, L., Dimante, D., Haldma, T., Kochalski, C., Král, B., Labaš, D., Lääts, K., Bedenik, N. O., Pakšiová, R., Petera, P., Ratajczak, P., Buhovac, A. R., Sava, A., Sucala, V., Tirnitz, T. J., & Wagner, J. (2017b). *Sustainability reporting in Central and Eastern European companies: international empirical insights.* Cham, Germany: Springer.

Hunkin, S., Barsoumian, S., Krell, K., Severin, A., & Corradino, G. (2014). *Thematic Study on Energy Efficiency and Renewable Energies, CENTRAL EUROPE Programme*. Retrieved from https://www.interreg-central.eu/Content.Node/Thematic-Study-EE-and-RES-April-2014.pdf

Jankalova, M., & Vartiak, L. (2017). Identification of bases for evaluation of the business excellence status in relation to the CSR concept. *International Journal for Quality Research*, *11*(2), 315-330. doi: 10.18421/IJQR11.02-05

Keller, K. (1998). *Strategic brand management: Building, measuring, and managing bran equity.* Upper Saddle River, United States: Prentice Hall.

Kollár, V. (2015). Bezpečnosť a kvalita potravín. In *Zborník z XV. Medzinárodnej vedeckej konferencie "Manažérstvo* životného *prostredia"* (pp. 132-134).

Koncepcia potravinárskeho priemyslu 2014-2020 [The Food Industry Development Concept]. (2018). Retrieved from http://www.pdbela.sk/DOQ/2.2%20Koncepcia%20rozvoja%20potravin%C3%A1rskeho%20pri

KPMG. (2017). *The road ahead: The KPMG Survey of Corporate Responsibility Reporting 2017*. Retrieved from https://assets.kpmg/content/dam/kpmg/xx/pdf/2017/10/kpmg-survey-of-corporate-responsibility-reporting-2017.pdf

Krause, J. (2015). The Potential of an Environmentally Friendly Business Strategy – Research from the Czech Republic. *International Journal of Engineering Business Management*, *7*, 1-6. doi: 10.5772/60064

Krejčí, P., & Šebestová, J. (2018). Social innovation ties: A dilemma of product and employee orientation. *Polish Journal of Management Studies*, *17*(2), 123-133. doi: 10.17512/pjms.2018.17.2.11

Kutlák, J., & Procházková, P. T. (2015). Communication about corporate social responsibility (CSR): CSR reporting. *Business Trends*, *7*(2), 63-74. doi: 10.22495/cbv14i1art3

Lacková, A., & Faith, L. (2015). Product safety within the European union, Sustainability - Environment - Safety 2015. In *Sustainability - Environment - Safety 2015: recenzovanýzborníkpríspevkov z medzinárodnejvedeckejkonferenciekonanej 4. decembra 2015 v Bratislave* [*International Scientific Conference. Sustainability - Environment - Safety 2015: reviewed Proceedings from International Scientific Conference on December 4, 2015 in Bratislava*] (pp. 105-111). Žilina, Slovakia: STRIX.

Leipziger, D. (2010). *The corporate responsibility code book*. Sheffield, Great Britain: Greenleaf.

Li, X., Xie, H., Chen, L., Wang, J., & Deng, X. (2014). News impact on stock price return via sentiment analysis. *Knowledge-Based Systems*, *69*, 14-23. doi: 10.1016/j.knosys.2014.04.022

Lőrinczy, M., & Sroka, W. (2015). The perception of ethics in business: analysis of research results. *Procedia Economics and Finance*, *34*, 156-163. doi: 10.1016/S2212-5671(15)01614-7

Loučanová, E., & Parobek, J. (2014). Spoločensky zodpovedné podnikanie prostredníctvom retroinovácií [Corporate social responsibility through retro-innovation]. *Výkonnosť podniku: vedecký* časopis *Výskumného* ústavu *ekonomiky a manažmentu* [*Business performance: scientific journal of the Research Institute of Economics and Management*], *4*(1), 69-79.

MacGregor Pelikánová, R. (2019). Corporate Social Responsibility Information in Annual Reports in the

EU – Czech Case Study. *Sustainability*, *11*(1), 237. doi: 10.3390/su11010237

Majerník, M., Andrejovský, P., Daneshjo, N., & Sančiová, G. (2017). *Environmentálna podniková ekonomika*. Košice, Slovakia: Typopress s.r.o.

Mallin, C. (2004). *Corporate Governance*. Oxford, Great Britain: Oxford University Press.

Martinat, S., Dvorak, P., Frantal, B., Klusacek, P., Kunc, J., Turečková, K., & Reed, M. (2016). Sustainable urban development in a city affected by heavy industry and mining? Case study of brownfields in Karvina, Czech Republic. *Journal of Cleaner Production*, *118*(1), 78-87. doi: 10.1016/j.jclepro.2016.01.029

Melecký, L., & Staničková, M. (2017). Cost Efficiency of EU Funded Projects: Case of Selected SMEs in the Moravian-Silesian Region. In *Proceedings of the 12th International Conference on Strategic Management and its Support by Information* (pp. 293-303). Ostrava, Czech Republic: VŠB-TUO.

Moratis, L., & Brandt, S. (2017). Corporate stakeholder responsiveness? Exploring the state and quality of GRI-based stakeholder engagement disclosures of European firms. *Corporate Social Responsibility and Environmental Management*, *24*(4), 312-325. doi: 10.1002/csr.1408

Moravcikova, D., Krizanova, A., Kliestikova, J., & Rypakova, M. (2017). Green Marketing as the Source of the Competitive Advantage of the Business. *Sustainability*, *9*(12), 2218-2231. doi: 10.3390/su9122218

Nagyová, Ľ., Košičiarová, I., Holienčinová, M., & Holota, T. (2016). Corporate Social Responsibility in Food Manufacturing Companies – Environmental Dimensions. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *64*(3), 1037-1043. doi: 10.11118/actaun201664031037

Németh, H. (2016). Spoločenskou zodpovednosťou ku konkurencieschopnejšej firme [Social responsibility for a more competitive business]. *Kvalita a spoločenská zodpovednosť* [*Quality and Corporate Responsibility*], *24*(4), 22-27.

Nevima, J., & Kiszová, Z. (2013). Multiplicative and Additive Approach in Analytic Hierarchy Process – Case Study of Competitiveness Evaluation of Czech and Slovak Regions. *International Journal of Mathematical Models and Methods in Applied Sciences*, *7*(5), 490-499.

Okruhlica, F., Šebejová, K., & Debnár, M. (2018). *Výročná správa* [*Annual report*]. Prague, Czech Republic: Wolters Kluwer.

Petera, P., & Wagner, J. (2015). Understanding Sustainability by Large Czech Companies. In *Idimt-2015: Information Technology and Society Interaction and Interdependence* (pp. 357-366). Prague, Czech Republic: University of Economics in Czech Republic.

Pierzyna, J. (2019). The use of EU funding in the development of local economic activity zones. *Forum Scientiae Oeconomia, 7*(1), 85-102. doi: 10.23762/FSO_VOL7_NO1_6

Register účtovných závierok [Register of Financial Statements]. (2019). Retrieved from http://www.registeruz.sk

Regulation (EC) No 1893/2006 of the European Parliament and of the Council of 20 December 2006 establishing the statistical classification of economic activities NACE Revision 2 and amending Council Regulation (EE) No 3037/90 as well as Regulations on specific statistical domains.

Ribeiro-Soriano, D. E., Donthu, N., & Val Nunez, M. T. (2018). An overview of research methods in international management: an introduction. *European J. International Management*, *12*(5-6), 501-509.

Rokovanie vlády Slovenskej republiky [Negotiations of the Government of the Slovak Republic]. (2018). *Predkladacia správa* [*Presentation report*]. Retrieved from http://www.rokovania.sk/File.aspx/ViewDocumentHtml/Mater-Dokum-168517?prefixFile=m_

Rožman, M., Grinkevich, A., & Tominc, P. (2019). Occupational Stress, Symptoms of Burnout in the Workplace and Work Satisfaction of the Age-diverse Employees. *Journal of Management*, *52*(1), 46-60. doi: 10.2478/orga-2019-0005

Rupley, K. H., Brown, D., & Marshall, R. S. (2012). Governance, media and the quality of environmental disclosure. *Journal of Accounting and Public Policy*, *31*(6), 610-640. doi: 10.1016/j.jaccpubpol.2012.09.002

Schiller, T. (2019). Is the mandatory implementation of workplace health management systems harmful to the competitiveness of European employers or an obstacle to economic growth? *Central European Business Review*, *8*(1), 50-63. doi: 10.18267/j.cebr.211

Šebestová, J., Majerová, I., & Szarowská, I. (2018). Transparency in the municipality spending: Financial health index. In *International conference on European in financial regulation (EUFIRE), Romania, Alexandru Ioan Cuza Uni Iasi, Fac Econom. & Business Adm., Iasi 2018* (pp. 177-189). Iasi, Romania: Editua Universitari Alexandru Ioan Cuz.

Shpak, N. O., Satalkina, L., Sroka, W., & Hittmar, S. (2017). The social direction of enterprises innovation activity. *Polish Journal of Management Studies, 16*(1), 187-200. doi:10.17512/pjms.2017.16.1.16

Shpak, N. O., Stanasiuk, N. S., Hlushko, O. V., & Sroka, W. (2018). Assessment of the social and labor components of industrial potential in the context of corporate social responsibility. *Polish Journal of Management Studies*, *17*(1), 209-220. doi: 10.17512/pjms.2018.17.1.17

Solesvik, M. Z. (2019). Entrepreneurial competencies and intentions: The role of higher education. *Forum Scientiae Oeconomia*, *7*(1), 9-23. doi: 10.23762/FSO_VOL7_NO1_1

Sroka, W., Jablonski, A., & Janblonski, M. (2013). Cooperative business models in steel enterprises in Poland. *Metalurgija, 52*(4), 565-568. doi: 669.013.003:65.01:669.013.003:658.5:658.8

Stonkuté, É., Vveinhardt, J., & Sroka, W. (2018). Training the CSR Sensitive Mind-Set: The Integration of CSR into the Training of Business Administration Professionals. *Sustainability, 10*(3), 1-14. doi: 10.3390/su10030754

Strouhal, J., Gurvitš, N., Nikitina-Kalamäe, M., & Startseva, E. (2015). Finding the link between CSR reporting

and Corporate Financial Performance: Evidence on Czech and Estonian listed companies. *Central European Business Review*, *4*(3), 48-59. doi: 10.18267/j.cebr.132

Sulewski, P., Kloczko-Gajewska, A., & Sroka, W. (2018). Relations between Agri-Environmental, Economic and Social Dimensions of Farms' Sustainability. *Sustainability*, *10*(12), 4629. doi: 10.3390/su10124629

Szalavetz, A. (2017). The environmental impact of advanced manufacturing technologies: examples from Hungary. *Central European Business Review*, *6*(2), 18-29. doi: 10.18267/j.cebr.177

Szántó, R., & Sroka, W. (2018). Corporate Social Responsibility and Business Ethics in Controversial Sectors: Analysis of Research Results. *Journal of Entrepreneurship, Management and Innovation, 14*(3), 111-126. doi: 10.7341/20181435

Teraz.sk. (2018). *Potravinári: Potravinársky priemysel na Slovensku sa prepadá* [*Food producers: The food industry in Slovakia is falling*]. Retrieved from https://www.teraz.sk/ekonomika/potravinársky-priemysel-na-Slovensku-sa/321189-clanok.html

Tetrevova, L. (2018). Communicating CSR in High Profile Industries: Case Study of Czech Chemical Industry. *Inzinerine Ekonomika - Engineering Economics, 29*(4), 478-487. doi: 10.5755/j01.ee.29.4.19199

Turečková, K., Nevima, J., Škrabal, J., & Martinát, S. (2018). Uncovering patterns of location of brownfields to facilitate their regeneration: Some remarks from the Czech Republic. *Sustainability*, *10*(6), 224-234. doi: 10.3390/su10061984

Vaqué, L. G. (2017). Possible Unfair Practices in the Marketing of Differentiated Food Products in the Single Market. The Concept of the „Legitimate Expectations" of Consumers. *European Food and Feed Law Review*, *12*(6), 482-490.

Wagner, J. (2017). Status Quo and Future Development of Sustainability Reporting in Central and Eastern Europe. *Journal of East European Management Studies*, *22*(2), 221-243. doi: 10.5771/0949-6181-2017-2-221

Wagner, J., Petera, P., Krehnacova, A., & Paksiova,, R. (2018). Content Analysis of Information on Sustainability in Annual Reports of the Largest Czech and Slovak Companies. In *Vision 2020: sustainable economic development and application of innovation management from regional expansion to global growth: proceedings of the 32th International Business Information Management Association Conference* (pp. 5286-5291). Seville, Spain: IBIMA.

Wipulanusat, W., Panuwatwanich, K., Stewart, R. A., & Sunkpho, J. (2019). Drivers and barriers to innovation in the Australian public service: a qualitative thematic analysis. *Engineering Management in Production and Services, 11*(1), 7-22. doi: 10.2478/emj-2019-0001

Wood, D. (1991). Corporate Social Performance Revisited. *The Academy of Management Review*, *16*(4), 691-718. doi: 10.2307/258977

Zatrochová, M. (2015). Utilization of the company strategies and their influence on the labour motivation. In *Significance of human resources and strategy in organization improvement*: *monography*. 1st ed. (pp. 37-48). Zagreb, Croatia: Croatian Quality Managers Society.

Zhang, D., Morse S., & Kambhampati, U. (2018). *Sustainable development and Corporate Social Responsibility*. New York, United States: Routledge.

Zimmermannová, J., Pawliczek, A., & Čermák, P. (2019). Public Support of Solar Electricity and its Impact on Households – Prosumers. *Journal of Management*, *52*(1), 4-19. doi: 10.2478/orga-2018-0001

Volume 11 • Issue 3 • 2019

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 30 April 2019
accepted: 20 August 2019

pages: 86-95

Open innovation in the context of organisational strategy

Katarzyna Walecka-Jankowska, Joanna Zimmer

ABSTRACT
The paper aims to analyse the relationship between different types of corporate strategy and open innovation in the contexts of the age, size and the operational range of enterprises. The research targeted companies in Poland that were surveyed from January to April, using traditional and electronic forms of a questionnaire. The questionnaire was developed based on a 5-point Likert scale. The level of "openness" of innovation processes in an enterprise was determined according to a 3-point scale, namely, a closed innovator, a hybrid or semi-open innovator, and an open innovator. The strategy implemented by an enterprise was classed into main three types used to achieve a competitive advantage, i.e. cost leadership, differentiation or diversification. There is a strong correlation between open innovations, the cost leadership strategy and the differentiation strategy (negative correlation). The relationship between the age, size and the range of a company and the opening of innovative processes was also observed. The research aims to fill the knowledge gap existing in the literature regarding the links between a particular type of strategy and the opening of innovation processes.

KEY WORDS
open innovations, diversification, differentiation, cost leadership

DOI: 10.2478/emj-2019-0023

Corresponding author:

Katarzyna Walecka-Jankowska

Wroclaw University of Science and Technology, Poland
e-mail: katarzyna.walecka-jankowska@pwr.edu.pl

Joanna Zimmer

Wroclaw University of Science and Technology, Poland
e-mail: joanna.zimmer@pwr.edu.pl

Introduction

The innovativeness of enterprises is considered one of the main determinants giving them competitive advantage in an increasingly complex environment (Romão and Nijkamp, 2019; García-Sánchez et al., 2019; Bogers et al., 2018; Nada et al., 2011; Chesbrough 2003; Chesbrough and Crowther, 2006; Gassmann and Enkel, 2004). Possibilities to internalise required data, knowledge or competencies are limited (Michelino et al., 2014); therefore, a specific approach to innovation of an enterprise is included in its business strategy. Moreover, the turbulent nature of the environment means changes in circumstances that are favourable to innovation, especially in terms of technological innovation, which is now becoming greatly dependent on outsourcing and external

knowledge. Using the technology and ideas to generate innovation, enterprises can maximise the efficiency of their innovation processes, which indicates the tendency towards the open innovation model. The topic is also extensively discussed in the literature.

The popularity of the open innovation concept around the world (Chesbrough and Crowther, 2006; Gassmann and Enkel, 2004; Michelino et al., 2014; Cassiman and Valentini 2016; Tafti et al., 2019) gives rise to a question regarding the determinants required to open the innovation process. Authors focus on the strategy of an enterprise aimed to establish whether the opening of the innovation processes depends on the type of strategy employed by the enterprise. Furthermore, authors considered the age, size and the operational range of enterprises to analyse the phenomenon of opening the innovation process. In light of such considerations, the paper aims to analyse the relationship between different types of corporate strategy and open innovation in the contexts of age, size and the operational range of enterprises.

1. Concept of open innovation — the theoretical perspective

The definition of open innovation was proposed by Chesbrough and Bogers in 2014 as "a distributed innovation process based on purposively managed knowledge flows across organisational boundaries." The main objective is to improve the innovativeness of an enterprise and to search for outlet markets for technologies and ideas, which do not fit in the current business concept. In this regard, the concept comes down to three basic dimensions (Chesbrough, 2003): the inflow of knowledge, the outflow of knowledge and the business model. The dispersion of the innovation process through the inflow and outflow of knowledge occurs with the use of both monetary and non-monetary mechanisms, in accordance with the corporate business model. This facilitates collaboration with various external entities and specialists (customers, suppliers, R&D units, scientific institutions) in the scope of generating innovation. It means that the boundaries of an enterprise become an adopted barrier, which facilitates the improvement of innovation at virtually any stage of the development process. Ideas unused by the enterprise are made available on the market free of charge, on the basis of licensing or other similar agreements.

The scale of this continuum also includes innovation generated in a traditional manner, through closed processes (based on internal corporate R&D activities, which are strictly controlled to prevent the competitors from gaining an advantage). To save time and reduce costs, only the ideas with the greatest potential are developed further. This approach requires a high level of autonomy, extensive investment in R&D departments and appropriate procedures to protect the know-how of the company.

According to the open innovation model, enterprises are able to acquire additional sources of income by selling ideas with a lower potential for development. Moreover, they can broadly access knowledge and external experts, which reduces the time required to develop innovation. Sharing know-how is the basic element which differentiates the two models. In the closed model, organisations often conduct long-term research on innovation, incurring high costs, with no guarantee of success. A return on long-term investments could be achieved by selling them. However, Chesbrough (2003) stressed that the basic factor in the development of open innovation was a significant increase in the number and level of mobility of knowledge workers. This, in turn, makes it more difficult to control their knowledge and ideas (Chesbrough, 2003).

Research on open innovation (e.g. Chesbrough and Crowther, 2006; Gassmann and Enkel, 2006) shows that enterprises often focus only on one of the first two dimensions of this concept, i.e. the inflow or outflow of technology, ideas and knowledge. In addition, each of the streams is used with a varying degree of openness (Cheng et al., 2014). To a great extent, this approach depends on the age of a company and the sector, in which it operates. Mature businesses and those operating in low-tech sectors mainly focus on sharing their knowledge and ideas, and only secondly on acquiring knowledge from the market. Whereas organisations linked to high-tech sectors are much more dedicated to gaining external knowledge than making it available to others (Gassmann and Enkel, 2006).

2. Measurement of the openness of innovation processes

The opening of innovation processes is related to the ability of an enterprise to absorb knowledge from its surroundings. However, the ability to absorb

Tab. 1. Openness of business innovation processes

Type of innovation	Sources of knowledge
Closed innovators: enterprises with innovations developed mainly through their own efforts (they have neither cooperated nor bought external R&D)	Internal knowledge is the most important source
Hybrid innovators: enterprises with innovations developed mainly through research and development activities, but having cooperated or bought external R&D	Both internal and external knowledge is just as important
Open innovators: enterprises with innovations developed mainly through cooperation with other entities or by other entities	At least one external source is more important than internal knowledge

Source: (Barge-Gil, 2010).

knowledge can become an obstacle to seeking and acquiring knowledge (Cohen-Levinthal, 1990; Faludi, 2014; Matricano et al., 2019). Large businesses have a better knowledge-absorption ability and often a lower demand for external sources, and it is the other way around for smaller enterprises (i.e. higher demand for external knowledge, but a much poorer absorption ability; Barge-Gil, 2010; Faludi, 2014; Matricano et al., 2019). The levels of "openness" of innovation processes in an enterprise are presented in Tab. 1.

Generally, enterprises can be divided into closed and open innovators. Unlike open businesses, closed enterprises do not share their knowledge-based resources nor ideas developed by internal R&D departments in the outlet market. Rather often, they also do not seek such knowledge from their surroundings; therefore, the main source of innovation for them remains the internally developed knowledge. Whereas in enterprises dedicated to open innovations, external knowledge is often more important than internal knowledge. Such enterprises share their resources with other entities and freely use ideas and sources of inspiration for innovation. Whereas hybrid enterprises are those that consider external knowledge complementary to internal knowledge.

The literature specifies no uniform method for measuring the openness of enterprises in terms of innovation (Bianchi et al., 2011; Michelino et al., 2014). Moreover, multiple studies in this field often present contradictory results.

The size of an enterprise, as the determinant influencing its effective use of open innovations, is considered in many studies (Laursen and Salter, 2006; Keupp and Gassmann, 2009; Michelino et al., 2014; Schroll and Mild, 2011). The publications by Chesbrough (2003) and Chesbrough and Crowther (2006) indicate that openness to innovation is mainly characteristic for large enterprises from high-tech sectors. This view was also shared by Bianchi (2011), who claimed that large enterprises implemented this concept on average 1.5 times more frequently than SMEs. Furthermore, Sandulli (2012) pointed out that larger enterprises were often more willing to collaborate with others in the scope of innovation compared to smaller businesses. However, a contradictory view was presented by Barge-Gil (2010), who believed that open innovators were enterprises whose employment rates were lower than for hybrid innovators. A lack of a correlation between the size of the business and the level of openness of its innovation processes was stressed by Podmetina et al. (2011). Christensen et al. (2005) observed that apart from the size of an enterprise, a major determinant was the phase in the life cycle of the used technology and the sector of business operation.

Another factor often referred to in studies, which influences the openness of businesses in terms of innovation, is their age (Teirlinck and Poelmans, 2012; Michelino et al., 2014; Acha, 2006). Teirlinck and Poelmans (2012) and Acha (2006) claimed that the differences in the relationship between age and openness of innovation processes arise from the sector in which the enterprise operates. No correlation between the age and openness of business innovation processes was reported by Keupp and Gassmann (2009) and Schroll and Mild (2011).

The operational range of enterprises was also analysed in terms of innovation (Meyer-Krahmer and Gundrum, 1995; Nowakowska, 2011; Stenberg and Arndt, 2015). The market opportunities of enterprises and the development opportunities of regions increasingly depend on their capacity to continuously generate innovative products and processes. The innovation environment will have a positive impact on enterprises operating in it. Therefore, enterprises operating locally or regionally may open innovation processes through participation in innovation networks or clusters (Meyer-Krahmer and Gundrum, 1995; Nowakowska, 2011). On the other hand, enterprises operating at national and international level have even wider access to sources of innovation, among other things due to the opportunity to coop-

erate with entities in countries with the highest level of innovation (Niedzielski and Rychlik, 2007).

3. Enterprise strategy and open innovation

The effective opening of business innovation processes requires an innovative approach to be included in the overall business strategy. This helps to create an organisational culture, which is open to generating innovation and providing clear guidelines necessary to fulfil strategic objectives (Nada et al., 2011). An innovative approach embedded in the strategy of an enterprise should allow it to (Nada et al., 2011):

- establish the strategic arena for innovation;
- determine the objectives and expectations for the results of innovation;
- determine the desired level of innovativeness;
- manage risk associated with innovation;
- allocate appropriate staff and financial outlays.

Activities in the scope of opening the innovation processes constitute a part of the overall business strategy, as they determine the future, survival and development of the enterprise, especially in the context of the unstable and turbulent nature of its surroundings. Therefore, modern management should be focused on the provision of the capital, infrastructure and human resources necessary to support business innovation processes (Nada et al., 2011).

The concept of open innovation assumes the ability of an enterprise to continuously seek competitive advantage by making use of the opportunities and threats in its surroundings. Therefore, formal boundaries of an enterprise constitute an adopted barrier to the flow of information, ideas and technologies (Tylżanowski, 2015). These are the strategies formulated on the level of a business unit and allow enterprises to gain and maintain a competitive advantage in their sector (Crema et al., 2014).

According to Porter (1985), an enterprise can employ three strategies to allow it to gain competitive advantage: cost leadership, differentiation and focus. However, the focus strategy refers to costs or differentiation within a given sector of the industry (Porter, 1985); therefore, it is not discussed in this article. Moreover, Porter (1985) talked about the necessity to develop a horizontal strategy that connected the actions of business units to facilitate the efficient use of its internal links (the flow of know-how, joint investments, independent decision-making of the units; Porter, 1985). The horizontal strategy includes the diversification of the enterprise's operation.

The cost leadership strategy involves establishing business costs at a slightly lower level compared to that of sector competitors. A significant advantage in this regard is often achieved by using economies of scale, serving several market sectors, utilising modern and innovative technologies as well as cheaper access to resources (Porter, 1985). The impact of open innovation on the costs incurred by enterprises has not been clearly determined. Razak et al. (2014) stressed that the opening of business innovation processes enables enterprises to achieve economic benefits related to the reduction of their total costs and increase the market appeal of their products (Razak et al., 2014). Moreover, the implementation of the concept of open innovation contributes to the reduction of R&D costs incurred by the enterprise (Ades et al., 2013). On the other hand, it may result in increased costs related to the management of complex external relations (Michelino et al., 2014). This view was also shared by Laursen and Salter (2006), who observed that seeking and verifying relevant external knowledge may be cost-, labour- and time-intensive. Whereas Chesbrough and Crowther believed that enterprises that focused on the fast development of products treated costs as a secondary issue.

On the basis of literature findings, the following hypothesis was established:

H1 — The more a strategy is concentrated on cost leadership, the more open is the innovation process.

The strategy based on differentiation enables enterprises to offer products considered unique by the recipients at a higher price (Porter, 1985). Following the same reasoning, it can be assumed that enterprises implement this strategy through the use of innovation (Crema et al., 2014). In Published open innovation studies make references to the effect of this concept on the ability of enterprises to generate radical and incremental innovation. Studies by Chesbrough and Crowther indicate that by opening their innovation processes, enterprises are able to monitor the market in search of breakthrough technologies, which may pose a threat. Moreover, many researchers (Huizing, 2011; Pariada et al., 2012; Gassmann, 2006; Cheng, 2016; van de Vrande et al., 2011) believe that the concept of open innovation is favourable to the development of radical innovations. This is because opening business innovation processes to knowledge, technologies and ideas facilitates radical development of innovation (Gassmann, 2006; Parida et al., 2012;

Cheng, 2016). Knowledge-sharing positively impacts on the organisational learning processes as well as knowledge updating and stimulates new ideas (van de Vrande et al., 2011; Cheng, 2016). Laursen and Salter (2006) believed that enterprises which developed radical innovations required significant investment outlays for their research and development activities, but their chances of success were slim. Incremental innovation requires less effort; however, its impact on efficiency is also smaller.

On the basis of literature findings, the following hypothesis was established:
H2 — The more a strategy is concentrated on differentiation, the more open is the innovation process.

The diversification strategy assumes gaining competitive advantage by expanding the activity to a new market sector or area of production (Crema et al., 2014). Analysing the impact of diversification on open innovation is not an easy task due to the multitude of its forms. Crema et al. (2014) believed that a product diversification strategy influenced the level of openness of business innovation processes (Crema et al., 2014). This belief was also shared by Lichtenthaler (2008), who stressed that enterprises with a varied technological portfolio purchased external technologies more frequently than enterprises specialising in one type of technology.

On the basis of literature findings, the following hypothesis was established:
H3 — The more a strategy is concentrated on diversification, the more open is the innovation process.

The decision whether an enterprise should generate innovation solely through its internal R&D departments or through collaboration with external partners depends on its skills and abilities, and the desire to control innovation processes (Crema et al., 2014).

As mentioned before, to generate innovation, modern enterprises usually focus on both (the traditional — closed and open) models. It is because an extreme desire to generate only one of those types of innovation can have negative effects on the strategy implemented by the enterprise (Ades et al., 2013). This view is shared by Crema et al. (2014) who believed that excessive opening of innovation processes might have a negative influence on the long-term success of innovations due to the loss of control and native competences. Whereas completely closed innovation processes may increase the time required to bring innovations to the market and create a desire to extend their life cycles. This necessitates enterprises to establish the openness of their innovation processes at such a level as to enable them to develop their products quickly, to build key competences and to ensure the protection of their intellectual property (Gassmann et al., 2010).

4. Research methodology

Based on the literature, the authors of the paper established the following research objectives:

- to analyse the scale of the phenomenon related to the adoption of the open innovation model in enterprises considering their age and size;
- to determine the type of strategy conducive to the implementation of open innovation activities in the surveyed enterprises.

The research targeted companies in Poland that were surveyed from January to April, using traditional and electronic forms of a questionnaire. The questionnaire was developed based on a 5-point Likert scale. The level of "openness" of innovation processes in an enterprise was determined according to a 3-point scale used in Barge-Gil (2010) and Celadon (2014) studies, namely, a closed innovator, a hybrid or semi-open innovator, and an open innovator. The strategy implemented by the enterprise was classed into main three types, used to achieve a competitive advantage, i.e. cost leadership, differentiation or diversification (Porter, 1985; Crema et al., 2014).

The study examined 100 randomly selected enterprises of various sizes, operating in different business sectors. The selection was made from the mailing list available from the Eniro online database of 3,000,000 entities. The questionnaire consisted of three parts, plus the section regarding respondent particulars.

The degree of application of the open innovation model was determined by two factors — streams of "input" and "output" of knowledge, ideas and innovations in enterprises, which were analysed using specific parts of the questionnaire. The first part of the questionnaire determined the input factor and referred to the inflow/acquisition of knowledge from the external market and long-term plans of enterprises in terms of obtaining external knowledge. It covered six research areas, 24 components in total. The analysis included sources of external knowledge acquisition by the enterprises. The focus was on entities from the micro-environment of the enterprise (competitors, suppliers, customers, various enterprises from the industry and outside the industry as well as R&D units). Acquisition of knowledge through

participation in fairs, exhibitions, training and the purchase of licenses was also included.

The second part of the survey was dedicated to the output factor and included questions related to the outflow/sale of knowledge unused by the enterprises. This factor considered two aspects — the paid transfer of knowledge and knowledge-sharing in cooperation with external entities. Here, the focus was also on entities from the micro-environment. Also, entities from the international environment of the surveyed enterprises were considered when analysing the "input" and "output" factors of knowledge. The dependent variable was defined as open innovation, considering the "input" and "output" factors. Independent variables were age (length of operation on the market) and size (determined by the number of employees) as well as the extent of enterprise operation (from local to international). Individual strategies, i.e. cost leadership, differentiation and diversification, constituted an independent variable as well. However, the assessment of the type of strategy used by the surveyed entities was left to the respondents.

Statistical analysis of data was performed using IBM SPSS Statistics software, ver. 20. The results of Cronbach's α coefficient measurements indicate rather high internal consistency of the scale and reliability of the measurement of particular variables (between 0.799 – 0.955).

Next, linear regression and correlation analyses were carried out. Due to the size of the test sample, the results of the study should be treated as a pilot study. The level of openness of business innovation processes and the strategy implemented were measured on the basis of subjective opinions of employees. The randomness and representativeness of the sample were verified with the use of the $\chi 2$ test (significance $p<0.05$ for size, age and the operational range distribution of enterprises with open innovations and $p<0.001$ for the distribution of selected strategies with open innovations).

5. Study results

The survey was intended for all organisations regardless of their size, activity profile or affiliation to a branch of the economy. As a result, 118 respondents were obtained, and 18 were removed due to irregularities. The respective data is present in Figures 1, 2 and 3.

The conducted study shows that 16% of enterprises from the test sample are open innovators. More than half of the enterprises surveyed can be classed as hybrid innovators (55%), which base their innovation on both external and internal knowledge. Whereas as many as 29% are closed innovators that generate innovation independently. The operational range of the surveyed enterprises was primarily national (39% responses) and international (40%).

First, the correlation analysis was performed examining the impact of independent variables — the size, age and the operational range — and three types of strategy on the dependent variable — the level of openness of innovation processes. Results showed a statistically significant (0.001) correlation between open innovation and the size (0.437), age (0.317) and the operational range (0.309) of enterprises. Interesting results were found in the case of strategy types: only cost leadership had a positive correlation with the open innovation process, while the other two types were negative. All correlations were statistically significant, but only cost leadership and differentiation had high scores (0.560 for cost leadership; and -0.571 for differentiation), while the strategy of diversification had a low score (-0.12).

The regression analysis was performed as a main statistical analysis. Coefficients are presented in Tab. 2.

Six verified variables were responsible for almost 16% of dependent variable variations, which means that strategy and control variables (the size, age and the operational range) determine only 15.9% of the

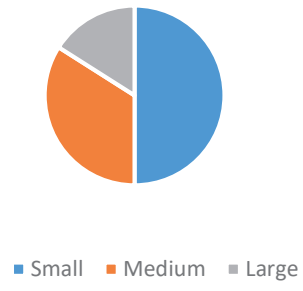

Fig. 1. Size of the enterprise

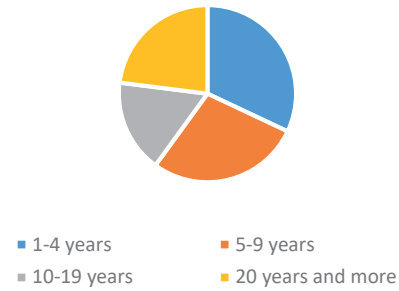

Fig. 2. Age of the enterprise

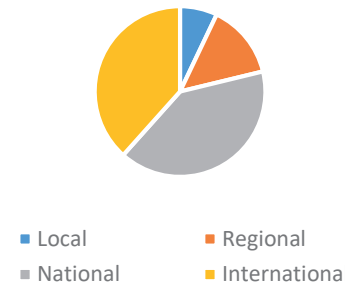

Fig. 3. Operational range of the enterprise

Tab. 2. Coefficients of the Anova regression analysis (with Open_Innovation as dependent variable)

Model B		Non-standardised coefficient		Standardised coefficient	t	Significance
		standard error	Beta			
1	(Constant)	2.819	1.304		2.161	0.033
	Size	0.099	0.056	0.162	1.766	0.081
	Age	0.084	0.058	0.137	1.459	0.148
	Operational range	0.134	0.060	0.178	2.239	0.028
	Cost leadership	0.238	0.265	0.169	0.899	0.371
	Differentiation	-0.656	0.278	-0.431	-2.357	0.021
	Diversification	-0.174	0.262	-0.120	-0.665	0.508

tendency to open innovation processes. The value of F statistics for the model equals $F(1.98) = 15.909$; $p<0.0001$. Moreover, the study shows that small enterprises have a higher tendency to open their processes to innovation (average 3.00 out of 5 points) than large enterprises (average 2.35 out of 5 points). As results suggest, only the operational range and the strategy of differentiation are significant.

Conclusions

Literature still lacks research on open innovation regarding the relationship between the strategy followed by enterprises and the possibility of implementing open innovation activities. The concept itself, despite the high popularity globally, is still relatively unknown in Poland; thus, only a small number of organisations apply the concept to its fullest extent. Only 16% of the surveyed enterprises were open innovators, whereas more than half were classed as hybrid innovators. The existing knowledge gap necessitates the analysis of the concept of open innovation in the context of enterprise strategy.

Opening innovative processes to external knowledge is associated with many aspects of the functioning of enterprises in the environment, including finding the right knowledge or partner for exchange, securing know-how against the leakage during the cooperation or the possibility of knowledge absorption. The absorption ability grows with the size of an enterprise. However, open innovations can also bring many benefits to small enterprises (reducing R&D costs, modernising production processes, reducing the risk of implementing innovations). Research shows that the size and age of enterprises has an impact on their tendency to use open innovation. From among the respondents, 48% were small and micro enterprises, of which 1/3 were open innovators. In terms of the entire test sample, open innovators were enterprises present on the market for less than ten years. In addition, the analysed enterprises were more willing to absorb knowledge and ideas from external sources than to share their knowledge with other entities in their surroundings. The average value established for the inflow of knowledge to studied enterprises was 3.0 out of 5.0 points, whereas for the outflow of knowledge — 2.5 points. Aiming to validate the findings, research should be carried out on the revenue and costs related to the inflow and outflow of knowledge in enterprises.

The study showed that the type of strategy employed by enterprise influences the level of openness of its innovation processes. Based on the correlation analysis, hypotheses H1, H2 and H3 hypotheses regarding the relationship between the cost leadership strategy, differentiation strategy, diversification and open innovation could not be rejected. Based on the regression analysis, only the hypothesis H2 could not be rejected.

Strategies of differentiation or qualitative leadership enable enterprises to diversify a product by improving its quality, modifying its appearance or use. It is extremely difficult to maintain the uniqueness and originality of the product in the era of rapidly changing market and customer expectations (especially for smaller enterprises). One of the ways to keep up with the market is to open innovation processes to external knowledge. Opening innovative processes can bring small and micro organisations many unique benefits, e.g. reducing the risk and costs arising from the implementation of innovative ideas, knowledge acquisition from the best specialists in the industry and implementing large projects in cooperation with R&D institutions. However, research has shown a negative correlation between a differentiation strategy and the opening of innovation processes by enterprises. This may be due to the fact that

enterprises using the product differentiation strategy focus primarily on innovations developed by their own R&D departments. The ability to maintain the uniqueness of the offer and customer loyalty is connected with the need to protect the knowledge and technology of an enterprise from competitors. Strong protection of know-how and control of own innovation processes is the domain of innovations understood traditionally (closed innovations).

Cost leadership strategy enables production at a lower cost compared to the competition while maintaining the quality. This is possible because of experience. Cost leadership is, therefore, possible mainly when enterprises are efficiently managed (which allows to avoid waste and reduce costs with increasing volume) and have a sufficiently large market share. The reduction of production costs is often associated with the implementation of technological or organisational innovations. Such enterprises primarily focus on developing internal knowledge and R&D departments with the help of external entities. The strategy of cost leadership is chosen by large enterprises, which, as previously noted, have greater opportunities to absorb technology and external knowledge. Establishing a new partnership to exchange knowledge and technology can reduce the risk, time and cost of developing and implementing innovations. In addition, following the market in terms of technology helps to find new development opportunities.

The study also considered the strategy of diversification; however, no linear relationship was observed between the variables. This result is surprising because the diversification strategy enables the enterprise to enter new areas of activity thanks to its own resources or the acquisition of external resources. Therefore, it seems that this strategy should be most closely linked to open innovations. The existing research efforts do not provide a clear answer on how to link diversification strategies with open innovations (or with innovations in general; e.g. Orlando et al., 2017). Some scholars even argue that diversification and innovation are almost in opposition (Palepu 1986; Hoskisson et al., 1993 for Orlando et al., 2017). This aspect definitely requires further research.

Limitations of the presented research were mainly the size of the test sample and difficulties with reaching respondents having the appropriate knowledge and position. Moreover, the superficiality of the questionnaire prevented a deeper analysis of the complex processes related to the generation of innovation. Research on the subject should be extended through interviews.

In the future, studies on the intent of businesses to use open innovations should also include three additional aspects proposed by Acha (2006):

- Breadth expressed as the number of sources used;
- Depth of cooperation;
- Cooperation patterns (models).

In addition, issues related to the inflow and outflow of knowledge should be analysed by examining the expenditure on such activities. In contrast, the strategy itself should be explored through the performance of the enterprise and its relationship with the environment.

Literature

Acha, V. (2008). *Open by design: the role of design in open innovation*. The Department for Innovation, Universities and Skills, DIUS Research Report *8*(10). doi: 10.5465/ambpp.2008.33653210

Ades, C., Figlioli, A., Sbragia, R., Porto, G., Plonski, G., & Celadon, K. (2013). Implementing Open Innovation: The Case of Natura, IBM and Siemens. *Journal of Technology Management & Innovation, 8*(1), 12-25. doi: 10.4067/S0718-27242013000300057

Arndt, O., & Sternberg, R. (2000). Do manufacturing firms profit from intraregional innovation linkages? An empirical based answer. *European Planning Studies*, *8*, 465-486.

Barge-Gil, A. (2010). Open, Semi-Open and Closed innovators. Towards an Explanation of Degree of Openness. *Industry and Innovation*, *17*(6), 577-607. doi: 10.1080/13662716.2010.530839

Bianchi, M., Cavaliere, A., Chiaroni, D., Frattini, F., & Chiesa, V. (2011). Organisational models for open innovation in the bio-pharmaceutical industry: an exploratory analysis. *Technovation*, *31*(1), 22-33. doi: 10.1016/j.technovation.2010.03.002

Bogers M., Chesbrough, H., & Moedas, C. (2018). Open innovation: research, practices, and policies. *California Management Review*, *60*(2), 5-16. doi: 10.1177/0008125617745086

Cassiman B., & Valentini, G. (2016). Open Innovation: Are Inbound and Outbound Knowledge Flows Really Complementary? *Strategic Management Journal*, 37(6). 1034-1046. doi: 10.1002/smj.2375

Celadon, K. L. (2014). Knowledge Integration and Open Innovation in the Brazilian Cosmetics Industry. *Journal of Technology Management & Innovation*, *6*(3), 34-50. doi: 10.4067/S0718-27242014000300003

Cheng, C., & Huizingh, E. (2014). When Is Open Innovation Beneficial? The Role of Strategic Orientation. *Journal of Product Innovation Management*, *31*(6), 1235-1253. doi:10.1111/jpim.12148

Cheng, C., Yang, Ch., & Sheu, Ch. (2016). Effects of open innovation and knowledge-based dynamic capabilities on radical innovation: An empirical study. *Jour-*

nal of Engineering and Technology Management, *41*, 79-91. doi:10.1016/j.jengtecman.2016.07.002

Chesbrough, H. (2003). The era of open innovation. *MIT Sloan Management Review*, *44*(3), 35-41. doi: 10.2307/41166416

Chesbrough, H., & Bogers, M. (2014). Explicating open innovation: Clarifying an emerging paradigm for understanding innovation. *New Frontiers in Open Innovation*. Oxford, Great Britain: Oxford University Press, Forthcoming. doi: 10.1093/acprof:oso/9780199682461.001.0001

Chesbrough, H., & Crowther, A. K. (2006). Beyond high-tech: early adopters of open innovation in other industries. *R&D Management*, 36(3), 229-236. doi: 10.1111/j.1467-9310.2006.00428.x

Christensen, J. F., Olesen, M. H., & Kjaer, J. S. (2005). The industrial dynamics of open innovation – evidence from the transformation of consumer electronics. *Research Policy*, *34*, 1533-1549. doi: 10.1016/j.respol.2005.07.002

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity. A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, *35*(1), 128-152. doi: 10.2307/2393553

Crema, M., Verbano, Ch., & Venturini, K. (2014), Linking strategy with open innovation and performance in SMEs. *Measuring Business Excellence*, *18*(2), 14-27. doi: 10.1108/MBE-07-2013-0042

Faludi, J. *(2014)*. Fifty shades of innovation – from open toward user, and open collaborative forms of innovation - an overview. *Vezetéstudomány*, *XLV*(11), 33-43.

Gassmann, O. (2006). Opening up the innovation process: towards an agenda. *R&D Management*, *36*(3), 223-228. doi:10.1111/j.1467-9310.2006.00437.x

Gassmann, O., & Enkel, E. (2004). *Towards a theory of open innovation: three core process archetypes.* R&D Management Conference (RADMA). doi: 10.1111/j.1467-9310.2010.00605.x

Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. *R&D Management*, *40*(3), 213-221. doi: 10.1080/08956308.2017.1255054

Huizingh, E. (2011). Open innovation: state of the art and future perspectives. *Technovation*, *31*, 2-9. doi:10.1016/j.technovation.2010.10.002

João, R., & Nijkamp, P. (2019). Impacts of innovation, productivity and specialization on tourism competitiveness–a spatial econometric analysis on European regions. *Current Issues in Tourism*, *22*(10), 1150-1169. doi:10.1080/13683500.2017.1366434

Keupp, M. M., & Gassmann, O. (2009). Determinants and archetype users of open innovation. *R&D Management*, *39*(4), 331-341. doi: 10.1111/j.1467-9310.2009.00563.x

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, *27*(2), 131-150. doi: 10.1002/smj.50

Lichtenthalter, U., & Ernst, H. (2008). Opening up the innovation process: the role of technology aggressiveness. *R&D Management*, *39*, 38-55. doi: 10.1111/j.1467-9310.2008.00522.x

Matricano, D., Candelo, E., Sorrentino, M., & Martinez-Martinez, A. (2019). Absorbing in-bound knowledge within open innovation processes. The case of Fiat Chrysler Automobiles. *Journal of Knowledge Management*, *23*(4), 786-807. doi:10.1108/JKM-10-2018-0625

Meyer-Krahmer, F., & Gundrum, U. (1995). Innovationsförderung im ländlichen Raum. *Innovation Policy in Rural Areas. Raumforschung und Raumordnung*, *53*, 177-185.

Michelino, F., Caputo, M., Cammarano, A., & Lamberti, E. (2014). Inbound and Outbound Open Innovation. Organization and Performances. *Journal of Technology Management & Innovation*, *9*(3), 65-82. doi: 10.4067/S0718-27242014000300005

Nada, N., Turkyilmaz, A., & El-Badawy, A. (2011). *SMEs Innovation Management Framework*. Istanbul, Turkey: Fatih University.

Niedzielski, P., & Rychlik, K. (2007). Innowacje w sektorze produkcyjnym i usługowym – odmienność czy podobieństwo? [innovations in service sector and industry – differences and similarities]. *Zeszyty Naukowe Uniwersytetu Szczecińskiego*, *453*(8), 177-186.

Nowakowska, A. (2011). *Regionalny wymiar procesów innowacji* [*The regional dimension of innovation processes*]. Łódź, Poland: Wydawnictwo Uniwersytetu Łódzkiego.

Orlando, B., Reniz, A., Sancetta, G., & Cucari, N. (2017). How does firm diversification impact innovation? *Technology Analysis & Strategic Management*, *30*(4), 391-404. doi: 10.1080/09537325.2017.1313405

Parida, V., Westerberg, M., & Frishammar, J. (2012). Inbound open innovation activities in high-tech SMEs: the impact on innovation performance. *Journal of Small Business Management*, *50*(2), 283-309. doi: 10.1111/j.1540-627X.2012.00354.x

Podmetina, D., Väätänen, J., Torkkeli, M. T., & Smirnova, M. M. (2011). Open innovation in Russian firms: an empirical investigation of technology commercialisation and acquisition. *International Journal of Business Innovation and Research*, *5*(3), 298-317. doi: 10.1504/IJBIR.2011.040100

Porter, M. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. New York, United States: The Free Press.

Rauter, R., Globocnik, D., Perl-Vorbach, E., & Baumgartner, R. J. (2018). Open innovation and its effects on economic and sustainability innovation performance. *Journal of Innovation & Knowledge*, *XXX*, 1-8. doi:10.1016/j.jik.2018.03.004

Razak, A., Murray, P., & Roberts, D. (2018). Open innovation in universities: the relationship between innovation and commercialization. *Knowledge and Process Management*, *21*(4), 260-269. doi: 10.1002/kpm.1444

Sandulli, F., Fernandez-Menendez, J., Rodriguez-Duarte, A., & Lopez-Sanchez, J. (2012). Testing the Schumpeterian hypotheses on an open innovation framework. *Management Decision*, *50*(7), 1222-1232. doi: 10.2139/ssrn.1978403

Schroll, A., & Mild, A. (2011). Open innovation modes and the role of internal R&D: An empirical study on open innovation adoption in Europe. *European*

Journal of Innovation Management, 14(4), 475-495. doi:10.1108/14601061111174925

Tafti, F. F., Abdolvand, N., & Harandi, S. R. (2019). A strategic alignment model for collaborative open innovation networks. *International Journal of Business Innovation and Research*, *19*(1), 1-28. doi: 10.1504/IJBIR.2019.099751

Teirlinck, P., & Poelmans, E. (2012). Open innovation and firm performance in small-sized R&D active companies in the chemical industry: the case of Belgium. *Journal of Business Chemistry, 9*(3), 117-131. doi: 10.1504/IJBIR.2011.040100

Tylżanowski, R. (2015). Koncepcja Open Innovation jako źródło przewagi konkurencyjnej przedsiębiorstwa [The open innovation concept as a source of enterprise's competitive advantage]. *Handel Wewnętrzny*, *4*(357), 16-25.

van de Vrande, V., Vanhaverbeke, W., & Duysters, G. (2011). Technology In-Sourcing and the Creation of Pioneering Technologies. *Journal of Product Innovation Management*, *28*, 974-987. doi: 10.1111/j.1540-5885.2011.00853.x

Volume 11 • Issue 3 • 2019

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 30 April 2019
accepted: 20 August 2019

pages: 96-105

CRM influence on organisational performance — the moderating role of IT reliability

Katarzyna Tworek, Anna Sałamacha

ABSTRACT
Purpose. This article mainly aims to verify the role of IT reliability as the factor potentially strengthening the CRM influence on organisational performance and conclude whether the IT reliability is indeed an important factor shaping the CRM ability to generate value for an organisation. Methodology. The empirical research was conducted to verify the existence of such a relation. The research was carried out based on the survey performed among organisations, and the sample included 558 entities from Poland and 564 from Switzerland. The statistical analysis of the obtained results was carried out using regression analysis with the moderator. Results. The obtained models clearly show that IT reliability is a moderator of the relation between CRM time-of-use and the organisational performance. The theoretical contribution. The obtained results clearly confirm that the existing IT solutions should support CRM, and with such support, this management method is positively influencing the organisational performance. Such a conclusion seems to be an important contribution to the studied field of research, filling the research gap concerning the mechanism of IT support for CRM. It remains consistent with the views from the literature and contributes to their extension.

KEY WORDS
management, Customer Relationship Management, IT in an organisation, IT reliability, organisational performance

DOI: 10.2478/emj-2019-0024

Corresponding author:

Katarzyna Tworek

Wrocław University of Science and Technology, Poland
e-mail: katarzyna.tworek@pwr.edu.pl

Anna Sałamacha

Wrocław University of Science and Technology, Poland
e-mail: anna.salamacha@pwr.edu.pl

Introduction

Conditions of the contemporary market economy, i.e. the high variability of an organisation's environment, the progressing globalisation in the trade field as well as the intensification of competition require organisations to create strong and long-term consumer relations (Tsou and Huang, 2018; Dubey and Sangle, 2019; Santouridis and Tsachtani, 2015). It seems that the best response to this challenge is the concept of Customer Relationship Management (CRM), which began in the 1990s (Ngai, 2005) and became an important tool in the area of marketing management in the last two decades (Waseem, 2019). Within those frames, organisations transferred their interest from products or services to the customer, i.e. the centric approach (Santouridis and Tsachtani, 2015).

Usually, CRM is perceived as a combination of people, processes and technology that seeks to understand a company's customers (Chen and Popovich, 2003; Dwiastuti et al., 2018) in general and has a special emphasis on key customers (Akroush et al., 2011). It can be analysed from two perspectives: strategic and technological (Santouridis and Tsachtani, 2015). The literature suggests approaches focused either on the consumer and the strategic relationship management (Light, 2001) or on the technology (Peppard, 2000). Nowadays, it seems that those aspects should be perceived together as a complex combination of business and technological factors building the CRM as management methods used in an organisation in a broader sense of organisational strategy (Keramati et al., 2010; Bull, 2003; Chen and Popovich, 2003).

There is no doubt that properly implemented CRM might bring a lot of benefits both from the point of view of the client and the organisation, such as customer acquisition, customer retention, financial benefits, customer loyalty, cross-selling, customer profitability, value creation for the customer, customisation of products and services (Sivaraks et al., 2011; Kim and Kim, 2009; Richards and Jones, 2008; Kim et at., 2003). However, despite its popularity, the CRM concept has been repeatedly criticised for unsatisfactory results that organisations achieve (Richards and Jones, 2008; Bull, 2003). Therefore, it seems reasonable to research the effects of the CRM on organisational performance, using a new approach that considers the role of IT reliability.

However, it seems that a solid relationship exists between the implementation of the CRM management method and the use of IT solutions supporting this method. Clearly, the ability of CRM to influence the organisational performance should not be perceived as only related to the implementation of IT solution support as this approach seems inadequate (Chen and Popovich, 2003). IT solutions may be very useful in the support and integration of processes that provide customer satisfaction (Ngai, 2005; Ryals and Payne, 2001), with a broader view on organisation (Akroush et al., 2011). However, the outcome seems only possible if the IT solutions used for CRM support are reliable. Therefore, this article mainly focuses on verifying the role of IT reliability as the factor potentially strengthening the CRM influence on the organisational performance. The theoretical background is presented in the first part of the article. The second part continues the topic and connects it to the development of hypotheses, further describing research methods. The third part presents results of the empirical research, conducted to verify the existence of the assumed relation. Finally, the conclusions confirm that IT reliability is indeed an important factor shaping the ability of CRM to generate value for an organisation.

1. Literature review

1.1. Role of IT in supporting modern management methods — IT reliability

Various management methods differ depending on their need for IT support in the phase of implementation and operation in an organisation (Rosemann and Brocke, 2015; Al-Mashari et al., 2003; Ngai et al., 2009; Wan, 2009; Lira et al., 2012; Tworek, 2019). Different management methods demonstrate different sensitivity to IT support and a different level of standardisation and alignment of existing IT solutions available for every organisation to choose from and implement. Moreover, it is crucial to underline that with changes in the internal and external conditions of the organisation's functioning (changes in size or configuration of the organisation, information technology development, emergence of new markets etc.), existing IT aimed at supporting various management methods must be improved and transformed to ensure the continued alignment between IT solutions and current needs, otherwise they will lose the ability to perform the functions for which they were created, and the organisation will cease to benefit from the implementation of those management methods (Tworek, 2019).

Since the relevance and the need for the use of IT in an organisation seems to finally be indisputable, there is a need for the analysis and evaluation of its use in organisations. The concept of 3R (reliability, resilience and robustness) emerged in the literature a few years ago (Little, 2003). It underlines that the key factor influencing the ability to profit from the use of IT is its appropriate functioning in the organisation (Tworek, 2018a).

The reliability of IT in an organisation is understood as a measurable property of IT, useful for its control and management, identifying its quality level and indicating potential problems (Zahedi, 1987). It is directly linked to the efficiency of IT components, especially those critical to its proper operations. The reliability of IT in an organisation is a notion build by factors connected to 3 different IT theories: the suc-

cess model by DeLone and McLean (2003), four types of IS failure by Lyytinen (1987), and the TAM model by Davis (1985). Based on that, the model of IT reliability in an organisation has been developed by Tworek (2016, 2018a) and verified in various business contexts (Tworek 2018a, 2018b, 2019). It consists of three factors: the reliability of the information included in IT in the organisation, the reliability of support services offered for IS in the organisation, and the reliability of the system itself (including the usability of the system). Each factor consists of a series of items, listed in Fig. 1.

Bieńkowska et al. (2018) performed a preliminary study concerning the influence of IT reliability (measured using an IT reliability framework) on results of controlling, and Tworek and Zabłocka-Kluczka (2018) did the same for Business Continuity Management. Both cases revealed the existence of a strong possibility that IT reliability could have a significant influence on other management methods as well and simultaneously verified the use of the IT reliability framework for this type of analysis of IT solutions in an organisation.

Requirements of CRM implementation and operation in an organisation evolve in time. Also, they require changes in the area of IT solutions that support CRM. IT reliability might be perceived by the users of the CRM system (employees of the organisation). The perception of IT reliability by the user may be subjective due to individual experience with the system and the degree of matching the system to the tasks to be supported (Bieńkowska et al., 2019). Despite this subjectivity, it can be assumed that the long-term use of the CRM system can have a positive relationship with IT reliability as, over time, the CRM concept evolves to meet the needs of a specific organ-

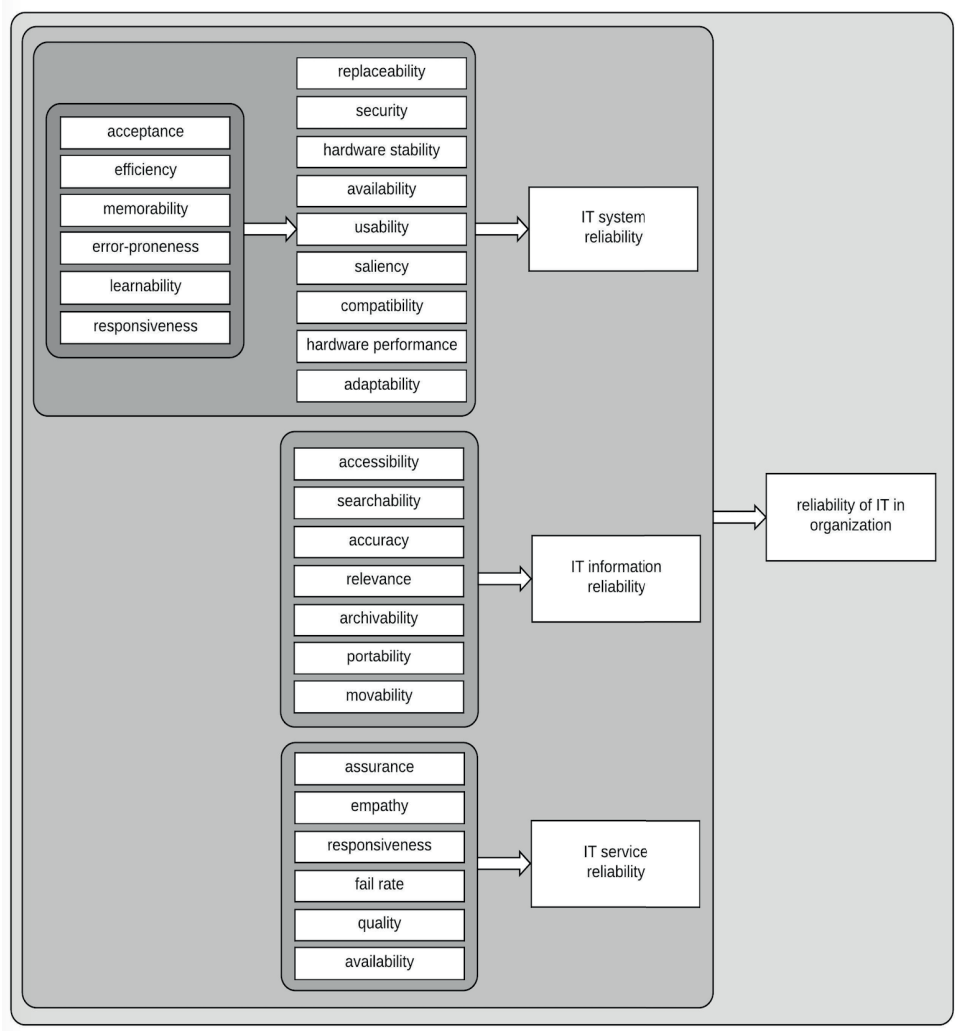

Fig. 1. Verified IT reliability model
Source: (Tworek, 2019).

isation. The detailed theoretical considerations concerning this subject aimed at hypothesis development are presented next.

2. Research methodology

2.1. CRM and IT reliability — the development of hypotheses

Without a doubt, IT solutions existing in the organisation should be aimed at supporting CRM, and without them, it is impossible to efficiently use this management method (Ngai et al., 2009; Payne and Frow, 2005). This notation CRM is also commonly used in IT development to describe IT solutions dedicated to the support of this method (Payne and Frow, 2005). Hence, there are standardised and well-known IT solutions aligned with the needs of CRM available for every organisation to make a choice. However, each organisation is different, and employee requirements in the case of IT solution support for their activities concerning CRM also differ. Therefore, in time, the IT solutions should become more and more aligned with those requirements due to continuous changes and improvements implemented to facilitate specific requirements of an organisation. As stated by Tworek (2019), alignment is directly linked to IT reliability. The more aligned are the solutions with actual needs, the higher is the IT reliability (which may be considered an indicator of the alignment maturity). Therefore, it seems that IT reliability might be correlated with CRM time-of-use. A higher IT reliability, indicating a higher alignment (which can be obtained only in time), should cooccur with a longer period of the CRM use. Based on that reasoning, the following hypothesis was formulated: H1: There is a positive relationship between IT reliability (and all of its components) and the CRM-time of-use.

Existing studies concerning CRM and organisational performance capture various issues, but the results are not conclusive (Keramati et al., 2010). For instance, the studies by Soltani et al. (2018) indicate a positive correlation between the success of CRM and organisational performance, indicating factors that impact on the success of CRM: customer orientation, organisation's capability, information technology, and customer knowledge management. In turn, studies by Josiassen et al. (2014) showed that CRM affects organisational performance but not in all dimensions. However, Bull's (2003) research showed that only in the case of 30 percent of organisations that implemented the CRM concept, it had a positive impact on their organisational performance (Bull, 2003). These inconsistencies indicate the necessity to indicate factors that can affect organisational performance (Chang et al., 2010). Therefore, considering the previously discussed aspects, it seems important to examine the relationship between the CRM time-of-use and the organisational performance in the light of IT reliability as factors potentially enabling and strengthening this relationship. IT reliability may assume the role of a moderator between the CRM time-of-use and the organisational performance. That is mainly because the alignment between business requirements (and employee requirements in the case of IT solution support) has an indirect influence on the organisational performance through the positive impact on the quality of any management method, which is highly sensitive for IT solution support (Tworek, 2019). CRM is definitely a highly sensitive method. Therefore, it seems that the alignment obtained in time (with the increase in the CRM time-of-use) may be a source of strengthening the influence of the CRM time-of-use on the organisational performance due to the increase of the CRM quality (and its more efficient use in the organisation due to greater IT reliability). Moreover, according to Park and Kim (2003), the role of information reliability seems to be of particular importance. They linked CRM with information strategy of the organisation, stating that there are three types of information: generated of-the-customer, for-the-customer, and by-the-customer. The reliability of all these types is not only a prerequisite for the efficient use of CRM but also seems to be an enabler for generating the value for the organisation from using this management method and translating it into improved organisational performance. This view is also supported by other researchers, e.g., Liao et al. (2010) underlining the role of information trust, or Liu et al. (2006) expressing the need for information quality boost for CRM. Therefore, the additional hypothesis should be formulated: H2: CRM time-of-use has a positive influence on organisational performance.

And, what's more important: H2a: The higher IT reliability, the stronger the influence of the CRM time-of-use on organisational performance.

In light of the above, the following research hypotheses can be formulated (Fig. 2).

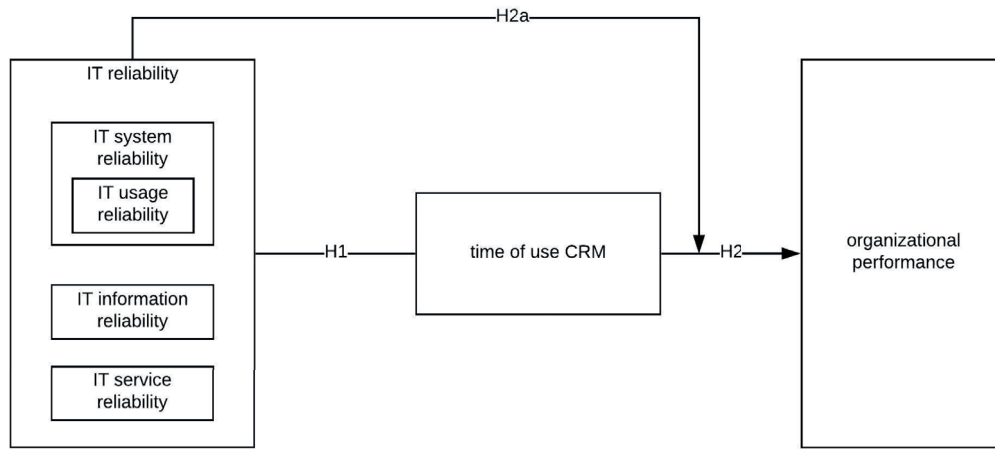

Fig. 2. Developed hypotheses

2.2. Research method and sample

The survey was conducted to verify the proposed hypotheses and identify the level of IT reliability, the CRM time-of-use and organisational performance in two business contexts. The main survey was preceded by the pilot survey conducted in early 2018 in a group of 50 organisations to explain the issues concerning the ambiguity of several questions. According to obtained results, the ambiguous questions were rewritten to obtain more informed responses from organisations participating in the main survey. The main research was conducted as a part of the research project "The IT reliability influence on the quality of management methods and techniques" No. 2017/01/X/HS4/01967 funded by the National Science Centre in Poland. The main survey was conducted in March 2018, with organisations located in Poland and Switzerland, which was the only condition limiting the sample (organisations were surveyed regardless of their size, industry or a type of business etc.), using online survey service: SurveyMonkey. Only one survey was carried out anonymously in one organisation, and it was completed by employees who had a broad view of the entire organisation.

The research sample contains organisations operating in Poland and Switzerland. 558 valid responses were collected from Poland, and 564 valid responses were collected from Switzerland. The sample cannot be considered representative since the population of organisations operating in those two countries was finite but very large, and the method of including an organisation in the sample did not support its representativeness. However, it is sufficiently diversified to be a basis for overall conclusions concerning the topic. Sample characteristics are presented in Tab. 1; the sample covers organisations of all sizes and types.

2.3. Measurement of variables

To examine the proposed hypotheses, key variables were defined: IT reliability, the CRM time-of-use and organisational performance. Respondents evaluated all variables basing on the list of factors and using the Likert scale (for IT reliability, the scale from "very poor" to "very good" with the middle point "fair"; for other variables, the scale from "I strongly agree" to "I strongly disagree" with the middle point "I do not have an opinion").

Tab. 1. Research sample characteristics

Organisation's size	Manufacturing organisations	Service organisations	Trade organisations	Total
Micro (below 10 people)	130	64	27	221
Small (11-50 people)	87	144	43	274
Medium (51-250 people)	63	112	73	248
Large (above 250 people)	120	184	75	379
Total	400	504	218	1122

IT reliability was measured considering all IT solutions used in the organisation (IT solutions for CRM were one of those) using the Likert scale, which seems to be an appropriate choice (for IT reliability, the scale from "very poor" to "very good" with the middle point "fair"; for other variables, the scale from "I strongly agree" to "I strongly disagree" with the middle point "I do not have an opinion"). First of all, the reliability of IT in an organisation is a subjective notion. Employees' perspective and opinion concerning the aspects of IT reliability are the best sources of knowledge since their perception matters the most. IT influences the organisation mainly through its potential to influence every-day work of the employees. Quantitative methods are commonly used to assess the software and hardware features linked to reliability. However, they do not give information concerning the actual perception of this notion within the organisation (Tworek, 2018). Based on that assessment, one key variable was defined: IT reliability (consisting of the reliability of the IT system, the reliability of the IT information, and the reliability of the IT service).

The CRM time-of-use in an organisation was based on a single question. Respondents were asked to indicate the time taken by controlling that operates in the organisation in the specified intervals ("not used", "recently implemented", "used for more than a year", "used for more than 5 years", "used for more than 10 years").

The organisational performance was measured on a 4-item scale, including the return on investment (ROI), the sales growth, the profit growth and productivity improvement (Maletic et al., 2015). The evolution of the performance during the previous three years was conducted. In line with literature, subjective measures of organisational performance were used (Bansal 2005; Maletic et al., 2015). On the one hand, the objective performance measures (such as financial) are difficult to obtain due to confidentiality or unavailability. On the other, a subjective examination, although always exposed to errors, facilitates the comparison of many different organisations due to the studied aspects. Finally, there is evidence that subjective and objective performance measures are strongly correlated (Dawes, 1999; Dess and Robinson, 1984). Due to different industries, sizes and strategic priorities of investigated organisations, performance data needed to be adjusted to evaluate each organisation. For this purpose, respondents were asked to answer the questions by comparison to expectations. The organisational performance was rated on the Likert scale (from "well below expectations" to "well above expectations" with the middle point "as expected").

3. Research results

3.1. Descriptive statistics and the reliability analysis of scales

As the first step in the research process, the reliability of scales of each variable was verified. The results received from the analysis of the reliability of the measurement scales are presented in Tab. 2. It is worth underlining that Cronbach's α was high for every variable, which indicates a high internal reliability of the scales and measurements.

3.2. Relationships between IT reliability, the CRM time-of-use and organisational performance

To verify hypotheses H1 and H2, the correlation between IT reliability, the CRM time-of-use and organisational performance was calculated as the first part of the study. The correlation between IT reliability and the CRM time-of-use was analysed with the help of Pearson's correlation to verify the hypothesis H1. The results are presented in Tab. 3. The results showed that IT reliability was statistically significantly correlated with the CRM times-of-use. Moreover, the value of the Pearson's coefficient was much higher in the case of IT system reliability (□r = 0.406) suggesting that it was the most important component of IT reliability from the point of view of CRM. Therefore, the hypothesis H1 could be accepted: as there was a significant relationship between the CRM time-of-use and IT reliability.

Tab. 2. Defined variables together with the results of the reliability analysis of scales

No.	Variable	No. of scales	Cronbach's α
1	IT reliability	28	0.953
2	CRM time-of-use	1	--
3	Organisational performance	4	0.911

The correlation between the CRM time-of-use and the organisational performance was analysed with the use of Pearson's correlation to verify the hypothesis H2 and is presented in Tab. 4.

The results showed that the CRM time-of-use was statistically significantly correlated with organisational performance, which was not enough to accept the H2 hypothesis because the correlation analysis did not verify the cause–effect relationship. However, it was enough for an initial verification allowing to use it to build a regression model to fully confirm the H2 hypothesis and verify further hypotheses formulated above.

To do that and to verify the hypothesis H2a, the regression analysis with the moderator was performed.

3.3. IT reliability as a moderator for the relationships between the CRM time-of-use, and organisational performance

The relationship between the CRM time-of-use and organisational performance (hypothesis H2 and H2a) was analysed in the context of IT reliability to verify the statistical significance of this notion as a moderator of the given relationship. Regression analysis with a moderator was used for IT reliability as a general concept and for each of its three components separately. Statistical reasoning was based on the same procedure in all cases. In every case, as the first step, a new variable — moderator — was introduced. The moderator variable was built as a product of two standardised independent variables (the CRM time-of-use as a first independent variable and IT reliability as a second independent variable). As the second step, three regression models were built for every case (the analysis was performed using the Process macro for IBM SPSS Statistics). The first model was built as a base model for comparison, only independent variables (IT reliability as a second independent variable) were added as predictors. The second model was built using independent variables (IT reliability still as a second independent variable) together with the moderator as predictors to verify whether the moderating influence was occurring in the entire sample. To confirm that, the third regression model was built using only one independent variable (without IT reliability as a second independent variable) and the moderator as predictors. The results of the analysis are presented in Tab. 5.

The obtained models clearly showed that IT reliability was a moderator of the relationship between the CRM time-of-use and organisational performance (hypothesis H2a). The delta R2 and obtained model for IT reliability (the whole concept) as a moderator were statistically significant ($F(1, 1016) = 270.589$, $p < 0.001$). In the case of detailed models verifying the moderating role of three components of IT reliability, the results were not unambiguous. All of them were statistically significant (IT system reliability ($F(1, 1077) = 289.248$, $p < 0.001$), information reliability ($F(1, 1086) = 284.044$, $p < 0.001$) and service reliability ($F(1, 1090) = 251.208$, $p < 0.001$)). However, as shown in Tab. 5, the moderating role was positively verified only in the case of system reliability and information reliability. Therefore, the obtained results were the basis for positive verification of the hypotheses H2a. The hypothesis could be accepted stating that the higher was IT reliability, the stronger was the influence of the CRM time-of-use on organisational performance. Moreover, the first obtained models confirmed the cause–effect relationship between the CRM time-of-use and organisational performance (since $R2 = 0.66$ and CRM time-of-use was a statistically significant variable in the models) and allowed for the final acceptance of the H2 hypothesis stating that the CRM time-of-use had a positive influence on organisational performance.

Conclusions

The obtained results clearly confirm that the existing IT solutions should support CRM, and with

Tab. 3. Correlation analysis between IT reliability and the CRM time-of-use

Correlation	IT reliability	IT system reliability	IT information reliability	IT service reliability
CRM time-of-use	$r(1036)=0.408^{**}$, $p<0.001$	$r(1102)= 0.406^{**}$, $p<0.001$	$r(1111)= 0.367^{**}$, $p<0.01$	$r(1115)= 0.394^{**}$, $p<0.01$

Tab. 4. Correlation between the CRM time-of-use and the organisational performance

	Organisational performance
CRM time-of-use	$r(1117)=0.529^{**}$, $p<0.001$

Tab. 5. Research sample characteristics

Model description	R^2	Delta R^2	Moderator coef.	Standard error	t Stat	P Value
CRM time-of-use, IT reliability, Moderator *dependent v.: performance*	0.666	0.039	0.483	0.018	2.661	0.007
CRM time-of-use, IT system reliability, Moderator *dependent v.: performance*	0.668	0.040	0.474	0.016	2,801	0.005
CRM time-of-use, IT information reliability, Moderator *dependent v.: performance*	0.637	0.054	0.539	0.017	3.135	0.002
CRM time-of-use, IT service reliability, Moderator *dependent v.: performance*	0.639	0.001	0.299	0.016	1,818	0.069

such support, this management method positively influences organisational performance. Such a conclusion seems to be an important contribution to the studied field of research, filling the research gap concerning the mechanism of IT support for CRM. It remains consistent with the views from the literature (e.g. Ngai et al., 2009; Payne and Frow, 2005) and contributes to their extension. First of all, the correlation analysis confirms a strong positive relationship between the CRM time-of-use and organisational performance, confirming the method's rising ability to positively influence organisation's operations. Secondly, the regression analysis showed that IT reliability (and all of its components) were significant moderators of the relationship between the CRM time-of-use and organisational performance, confirming that IT support can strengthen that influence. The strongest moderating effect occurred in the case of IT information reliability. It seems to confirm views presented in the literature stating that information reliability is of particular importance in the case of supporting CRM using IT solutions (e.g. by Park and Kim, 2006; Liao et al., 2010; Liu et al., 2006). The least significant moderating effect occurred in the case of service reliability, which, in turn, was consistent with the view that CRM — as a method highly sensitive for IT solution support — is used by employees highly skilled in performing their tasks with the use of IT (Tworek, 2019). That is why the role of support service reliability is smaller than the role of the reliability of the system itself and its use, which more directly affect the tasks performed by a skilled user.

Therefore, it seems that the obtained results confirm that the alignment obtained in time (with the increase of the CRM time-of-use) may be a source for strengthening the influence of the CRM time-of-use on organisational performance due to the increase of the CRM quality. Moreover, its more efficient use in an organisation is influenced by IT reliability (especially, the reliability of information used in the IT solution), which is proven to be a moderator of this relationship.

In the modern economy, it is impossible to operate as a successful organisation without IT existence. It is equally common knowledge that IT might be the factor that supports management methods. Within these frames, the main aim of this article was achieved due to successful verification of the role of IT reliability as the factor strengthening the influence of CRM on organisational performance. The obtained results clearly showed that there was a positive, statistically significant correlation between IT reliability (and all of its components) and the CRM time-of-use. Moreover, they showed that IT reliability was a moderator of the relationship between the CRM time-of-use and organisational performance.

However, the performed empirical study is burdened with certain limitations. The hypotheses were tested based on one research sample, limited to organisations operating in Poland and Switzerland. Moreover, CRM was analysed as one of many existing management methods, and IT solution support was not considered separately for each of them. However, it seems to be a solid first step underlining the need

for further analysis of the subject, considering not only the time of use of CRM but also its maturity.

Acknowledgements

The paper was created as a result of the research project No. 2017/01/X/HS4/01967 funded by the National Science Centre.

Literature

Akroush, M. N., Dahiyat, J. S. E, Gharaibeh, J. H. S., & Abu-LailAL-Hilal, B.N. (2011). Customer relationship management implementation: An investigation of a scale's generalizability and its relationship with business performance in a developing country context. *International Journal of Commerce and Management, 21*(2), 158-191.

Al-Mashari, M., Al-Mudimigh, A., & Zairi, M. (2003). Enterprise resource planning: A taxonomy of critical factors. *European Journal of Operational Research, 146*(2), 352-364.

Bansal, P. (2005). Evolving sustainably: A longitudinal study of corporate sustainable development. *Strategic Management Journal, 26*(3), 197-218.

Bieńkowska, A., Tworek, K., & Zabłocka-Kluczka, A. (2019). Information technology reliability influence on controlling excellence. *The International Journal of Digital Accounting Research, 19*, 1-28.

Bull, C. (2003). Strategic issues in customer relationship management (CRM) implementation. *Business Process Management Journal, 9*(5), 592-602.

Chang, W., Park, J. E., & Chaiy, S. (2010). How does CRM technology transform into organizational performance? A mediating role of marketing capability. *Journal of Business Research, 63*, 849-855.

Chen, I., & Popovich, K. (2003). Understanding customer relationship management (CRM): People, process and technology. *Business Process Management Journal*, *9*(5), 672-688.

Davis, F. D. (1985). *A technology acceptance model for empirically testing new end-user information systems: Theory and results*. Doctoral dissertation, MIT USA.

Dawes, J. (1999). The relationship between subjective and objective company performance measures in market orientation research: further empirical evidence. *Marketing Bulletin-Department of Marketing Massey University, 10*, 65-75.

Delone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: a ten-year update. *Journal of Management Information Systems, 19*(4), 9-30.

Dess, G. G., & Robinson Jr, R. B. (1984). Measuring organizational performance in the absence of objective measures: the case of the privately held firm and conglomerate business unit. *Strategic Management Journal, 5*(3), 265-273.

Dubey, N. K., & Sangle, P. (2019). Customer perception of CRM implementation in banking context Scale development and validation. *Journal of Advances in Management Research*, *16*(1), 38-63.

Dwiastuti, A. Larasati, A., & Prahastuti, E. (2018). *The implementation of Customer Relationship Management (CRM) on textile supply chain using k-means clustering in data mining.* International Mechanical and Industrial Engineering Conference 2018.

Josiassen A., Assaf A. G., & Cvelbar, L. K. (2014). CRM and the bottom line: Do all CRM dimensions affect firm performance? *International Journal of Hospitality Management, 36*, 130-136.

Keramati, A., Mehrabi, H., & Mojir, N. (2010). A process-oriented perspective on customer relationship management and organizational performance: An empirical investigation. *Industrial Marketing Management 39*(7), 1170-1185.

Kim, H. S., & Kim, Y. G. (2009). A CRM performance measurement framework: Its development process and application. *Industrial Marketing Management, 38*(4), 477-489.

Kim, J., Suh, E., & Hwang, H. (2003). A model for evaluating the effectiveness of CRM using the balanced scorecard. *Journal of Interactive Marketing, 17*(2), 5-1.

Liao, S. H., Chen, Y. J., & Deng, M. Y. (2010). Mining customer knowledge for tourism new product development and customer relationship management. *Expert Systems with Applications, 37*(6), 4212-4223.

Light, B. (2001). *A review of the issues associated with customer relationship management systems.* Proceedings of the 9th European Conference on Information Systems, 1232-1241.

Lira A. M. D., Parisi, C., Peleias, I. R., & Peters, M. R. S. (2012). Uses of ERP systems and their influence on controllership functions in Brazilian Companies. *JISTEM-Journal of Information Systems and Technology Management, 9*(2), 323-352.

Little, R. G. (2003). *Toward more robust infrastructure: observations on improving the resilience and reliability of critical systems. System Sciences*. Proceedings of the 36th Annual Hawaii International Conference, IEEE.

Liu, Y., Zhou, C. F., & Chen, Y. W. (2006). Determinants of E-CRM in influencing customer satisfaction. In: *Pacific Rim International Conference on Artificial Intelligence* (pp. 767-776). Berlin, Heidelberg: Springer.

Lyytinen, K. (1987). Different perspectives on information systems: problems and solutions. *ACM Computing Surveys (CSUR)*, *19*(1), 5-46.

Maletic, M., Maletic, D., Dahlgaard, J., Dahlgaard-Park, S. M., & Gomišcek, B. (2015). Do corporate sustainability practices enhance organizational economic performance? *International Journal of Quality and Service Sciences, 7*(2/3), 184-200.

Ngai, E. W. T. (2005). Customer relationship management research (1992-2002): An academic literature review and classification. *Marketing Intelligence & Planning, 23*(6), 582-605.

Ngai, E. W., Xiu, L., & Chau, D. C. (2009). Application of data mining techniques in customer relationship

management: A literature review and classification. *Expert Systems with Applications, 36*(2), 2592-2602.

Park, C. H., & Kim, Y. G. (2003). A framework of dynamic CRM: linking marketing with information strategy. *Business Process Management Journal*, *9*(5), 652-671.

Payne, A., & Frow, P. (2005). A strategic framework for customer relationship management. *Journal of Marketing, 69*(4), 167-176.

Peppard, J. (2000). Customer relationship management (CRM) in financial services. *European Management Journal, 18*(3), 312-327.

Richards, K. A., & Jones, E. (2008). Customer relationship management: finding value drivers. *Industrial Marketing Management, 37*(2), 120-130.

Rosemann, M., & vom Brocke, J. (2015). The six core elements of business process management. In: *Handbook on business process management 1* (pp. 105-122). Berlin, Heidelberg: Springer.

Ryals, L., & Payne, A. (2001). Customer relationship management in financial services: towards information-enabled relationship marketing. *Journal of Strategic Marketing, 9*(1), 3-27.

Santouridis, I., & Tsachtani, E. (2015). Investigating the Impact of CRM Resources on CRM Processes: a Customer Life-Cycle Based Approach in the Case of a Greek Bank. *Procedia Economics and Finance*, *19*, 304-313.

Sivaraks, P., Krairit, D., & Tang, J. C. S. (2011). Effects of e-CRM on customer–bank relationship quality and outcomes: The case of Thailand. *Journal of High Technology Management Research, 22*, 141-157.

Soltani, Z., Zareie, B., Milani, F. S., & Navimipour, N. J. (2018). The impact of the customer relationship management on the organization performance. *Journal of High Technology Management Research, 29*, 237-246.

Tsou, H. T., & Huang, Y. W. (2018). Empirical Study of the Affecting Statistical Education on Customer Relationship Management and Customer Value in Hitech Industry. *Eurasia Journal of Mathematics*, *Science and Technology Education*, *14*(4), 1287-1294.

Tworek K. (2019). *Aligning IT with business: fostering organizational performance, employees' commitment and quality of management methods*, Cham, Great Britain: Springer.

Tworek, K. (2016). Model niezawodności systemów informacyjnych w organizacji [Reliability model of information systems in organization]. *Zeszyty Naukowe. Organizacja i Zarządzanie/Politechnika Śląska, 88*, 335-342.

Tworek, K. (2018a). *Information systems reliability in the context of higher education institutions. 10th annual International Conference on Education and New Learning Technologies.* Conference Proceedings, Palma de Mallorca (Spain), IATED Academy, 2-4 July.

Tworek, K. (2018b). *Reliability of information systems in organization in the context of banking sector: empirical study from Poland*, COGENT Business and Management.

Tworek, K., & Zabłocka-Kluczka, A. (2018). *IT reliability influence on organization benefits from business continuity management.* International Multidisciplinary Scientific Conference on Social Science SGEM.

Wan, S. (2009). Service impact analysis using business continuity planning processes. *Campus-Wide Information Systems, 26*(1), 20-42.

Waseem, J. (2019). Scale Development and Construct Validity of Organizational Capital in Customer Relationship Management Context: A Confirmatory Factor Analysis Approach. *Business Perspectives and Research, 7*(1), 76-91.

Zahedi, F. (1987). Reliability of information systems based on the critical success factors-formulation. *Mis Quarterly, 11*(2), 187-203.

Volume 11 • Issue 3 • 2019

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 4 January 2019
accepted: 30 May 2019

pages: 106-116

Reengineering of production processes and its impact on the financial situation and business performance of the company

Andrea Sujová, Ľubica Simanová, Katarína Marcineková

ABSTRACT

The current competitive environment is only favourable to those companies that can cope with changes and use them to their advantage. The innovation of business processes is required to improve financial performance. Scientific works have not yet offered an effective solution to the monitoring of the impact made by process reengineering on corporate financial results. This work presents the case of a business process reengineering in a particular company to improve its performance. The results of implemented reengineering are analysed from the point of view of the impact made on the financial situation of the company. The paper aims to demonstrate the implementation of reengineering and evaluate its impact on the financial standing of a company and its performance. The practical application of reengineering was made according to Hammer and Champy methodology, which is based on the analysis of production processes in the company, the implementation of selected reengineered production processes and the evaluation of the reengineering impact on the corporate financial situation and performance. During the evaluation, the selected indicators of financial performance, activity indicators, the indebtedness indicator, business performance indicators as a cash flow to measure financial flows and the economic value-added (indicator EVA) were calculated and analysed. Subsequent to financial analyses and based on the selected indicators, the authors concluded that the implemented reengineering of the production process increased the performance and value of the company, which had a positive impact on the company's financial situation. The funds spent on the proper implementation of the reengineering steps were effectively used, and the reengineering process was also timed. This contribution to the body of theoretic knowledge links the implementation of reengineering and the part of the financial analysis, which is related to the preparation, implementation and reengineering results.

KEY WORDS

process, process management, reengineering, business performance, business performance indicators

DOI: 10.2478/emj-2019-0025

Corresponding author:

Andrea Sujová

Mendel University in Brno, Czech Republic
e-mail: andrea.sujova@mendelu.cz

Ľubica Simanová

Technical University in Zvolen, Slovakia
e-mail: lubica.simanova@tuzvo.sk

Katarína Marcineková

Technical University in Zvolen, Slovakia
e-mail: xmarcinekovak@tuzvo.sk

Introduction

Processes exist in every organisation and are managed in different ways. Process management applies to repeated and the same processes. On the other hand, project management is used for unique processes, such as, for example, the process for the implementation of a new information system. An organisation, enterprise or company is an organised set of processes and activities arranged in a sequence. Efficient and effective process management is required to achieve a set of goals. The analysis, understanding, management and improvement of processes as well as their performance have become a daily job of all employees of an organisation and, especially, managers. The current approach to business management focuses on the improvement of business pro-

cesses. Therefore, companies are increasingly shifting their attention to the performance of internal business processes to improve corporate performance (Sujová et al., 2016). Production has a decisive influence on the operation of a company, its position in the market and the competitiveness of the manufactured products. Effective manufacturing processes are, therefore, essential for financial performance. Several options are available for the improvement of processes, but two approaches are considered the main, namely, process optimisation as continuous improvement and radical change through reengineering.

Companies use reengineering in the case of ineffective processes and when in need of a radical change. According to this approach, a company needs to focus on key processes with high added value and eliminate insignificant minor processes with minimal added value. Reorganised key processes lead to smooth operation and elimination of bottlenecks, which should have a positive impact on business performance and, consequently, on the company's financial standing.

Process reengineering is a methodology developed by Hammer and Champy (2000) and modified by many other authors. However, insufficient information is available in the case of economically effective reengineering of processes. This is one of the reasons why companies are afraid of radical changes and redesign of processes. Most scientific works and research focus on the reengineering methodology and anticipated effects. However, no solution has been offered yet for linking the implementation part of reengineering and the monitoring of its impact on the financial results of the company. Consequently, the authors of this article decided to focus on the economic impacts of process reengineering using one case in a chosen company.

The paper aims to demonstrate the implementation process of a production process reengineering and to pinpoint its impact on financial results and performance of the company through an analysis of traditional and modern financial indicators.

The first section of the paper is dedicated to the review of the literature regarding the issues of reengineering and financial analysis. The second part describes the methodology of the work, and the third part presents the achieved results, which are then discussed in the fourth part. At the end of the article, conclusions are offered.

1. Literature review

In their definitions of a process, Ciencala (2011), Grasseová et al. (2008), Svozilová (2011), Marcineková and Sujová (2015) indicated that it must have inputs and outputs, logical continuity, added value, an internal or external customer, a process owner and must be repeatable and measurable.

A process is closely related to process management, which has been defined by various authors. Business Process Management is a scientific discipline that explains how work is performed in businesses or organisations to ensure consistent outputs and to take advantage of opportunities brought by improved procedures and processes (Homzová, 2012).

Gejdoš (2006), Závadský and Kovaľová (2011), Papulová et al. (2014), Sujová and Čierna (2018) agreed that process-driven organisations are customer-centred and, therefore, thy create higher value for the customer, focus on process management through analyses and metrics, use concepts, methods and approaches to improve processes as well as optimise and model them to make more radical changes and improve their performance.

Various authors (Řepa, 2007; Hammer and Champy, 2000; Manganelli and Klein, 1994; Davenport, 1993) agree that reengineering as a permanent process improvement must be a part of a corporate strategy to help companies achieve leading positions on local or global markets. The greatest possible efficiency of a system can only be achieved by optimising each subsystem operating within its framework (Suchánek et al., 2015). In process reengineering, the emphasis is on making business processes as simple and economical as feasible, and servicing a customer order in the shortest possible time (Rašner and Rajnoha, 2006).

There is a number of reengineering methodologies that differ in scope, focus, and also practical and theoretical orientation. Řepa (2007) and Kovář et al. (2007) suggest that in addition to the selected methodologies listed in Tab. 1, there is another DoD methodology that was developed for the radical cost reduction, called Aris, which does not have a defined procedure, but provides a number of perspectives and tools to model individual aspects of the business existence, the PPP (Participatory Processes Prototyping) methodology combining new methods with traditional and supporting interconnected development of processes, technology and human potential.

BPR (Business Process Reengineering) is defined as the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, and service. In fact, a BPR effort changes practically everything in the organisation, including people, jobs, managers and values, because these aspects are linked together (Hammer and Champy, 2000).

Every change should be evaluated from an economic and financial points of view. Varcholová et al. (2007), Brealey (2000), Ručková (2010), Dubovická (2007), Neumaierová and Neumaier (2002), Mařík and Maříková (2005), Kotulič et al. (2010), Knápková et al. (2013), Hajdúchová (2000, 2011), Zalai et al. (2010), Tóthová et al. (2012) agree that financial indicators allow for a rapid and inexpensive picture of the company's financial performance. Evans (2018)

Tab. 1. Comparison of selected process reengineering methods

PROCEDURE	METHODOLOGY BY HAMMER AND CHAMPY	METHODOLOGY BY DAVENPORT	METHODOLOGY BY MANGANELLI AND KLEIN	METHODOLOGY BY KODAK
Project preparation	Introduction to reengineering	Vision and goals	Preparation of project	Initiation of a project
	Identification of business processes	Identification of business processes	Identification of project	
	Choosing business processes for reengineering			
Process reconstruction	Knowledge of selected business processes	Knowledge and measurement of processes	Vision	Knowledge of processes
	Redesign of selected business processes	Information technologies	Redesign - technical - personnel	Design of new processes
Implementation	Implementation of new business processes	Prototyping processes	Transformation	Transformation of the business
		Implementation processes		Change management

Tab. 2. Six phases of the Hammer and Champy methodology

PHASE	OBJECTIVE
Introduction into business reengineering	The "case for action" is a description of the organisation's business problem and current situation; it justifies the need for change. The "vision statement" describes how the organisation is going to operate and outlines the kind of results it must achieve. The top management should inform other employees about the visions
Identification of business processes	In this step, the most important business processes are identified and are described from a global perspective using a set of process maps. Process maps give a picture of the workflows through the company. The output of this phase is a number of process maps reflecting how these high-level processes interact within the company and in relation to the outside world
Selection of business processes	Candidates for reengineering are the most problematic processes, those with great impact on customers, processes with more chances to be successfully re-engineered or processes that contribute to the organisation's objectives. According to an organisation's strategic objectives, more criteria could be defined for selecting processes for redesign, such as increased customer value
Understanding of selected business process	The reengineering team needs to gain a better understanding of the existing selected processes. The objective is the provision of a high-level view of the process under consideration, for the team members to have the intuition and insight required to create a totally new and superior design
Redesign of the selected business processes	This is the most creative phase of the methodology because new rules and new ways of work should be invented. Imagination and inductive thinking should characterise this phase. Redesigning a process is not algorithmic or routine
Implementation of redesigned business processes	The last phase covers the implementation phase of the BPR project. Hammer and Champy believe that the success of the implementation depends on whether the five previous phases have been properly performed

Source: elaborated by the authors according to (Hammer and Champy, 2000).

points to the fact that a favourable financial result in the profit indicator may not necessarily mean operational efficiency evaluated by ratio indicators. The analysis of financial performance development can be made on the basis of financial ratio indicators and enable the prediction of future performance (Kiseľáková et al., 2018). Most authors recommend the ratio indicators for profitability analysis, activity indicators, indebtedness indicators, cash flow indicators, market value indicators of the enterprise, and the economic value-added (EVA) indicator.

2. Research methods

Based on the study of theoretical knowledge, a manufacturing company was recommended the methodology of process reengineering according to Hammer and Champy (2000). In the company, the methodology was practically implemented in the production process. The methodology had six phases, which are described in Tab. 2.

The evaluation phase was aimed at assessing the impact of the implemented reengineering solution through financial and economic indicators. Based on the recommendations of most authors, the analysis used profitability ratios, activity indicators, indebtedness indicators, performance indicators, market value indicators of the enterprise, and the economic value-added indicator EVA.

Profitability ratios are a form of expression of the resource efficiency that serves as the main criterion for capital allocation in a market economy. This includes, in particular, the following indicators (Zalai et al. 2010; Hajdúchová, 2000):

Return on assets ROA, which expresses the overall efficiency of the company, its production power. The following formula is used to calculate the return on assets:

$$ROA = \frac{Net\ Income}{Total\ assets} \quad (1)$$

Return on equity ROE, which expresses the return on equity of an enterprise. The relationship for the calculation of Return on Equity:

$$ROE = \frac{Net\ Income}{Equity} \quad (2)$$

Return on net assets RONA, which is calculated by dividing the company's net income in a given period by the total value of both — its fixed assets and its working capital. An increase in RONA indicates higher levels of profitability. RONA is calculated similarly to the ROA metric. Unlike ROA, RONA considers the company's associated liabilities. The RONA indicator is calculated as follows:

$$RONA = \frac{Net\ Income}{Fixed\ Assets + Working\ Capital} \quad (3)$$

ROSC, which represents the return on share capital of the company's owners. It only measures the effect for owners whose deposits are Share Capital. It informs them about the evaluation of the funds they have put into the business. A simple relationship is used for the calculation:

$$ROSC = \frac{Profit}{Share\ Capital} \quad (4)$$

Return on sales ROS, which is a ratio widely used to evaluate the entity's operating performance. ROS indicates how much profit an entity makes after paying for variable costs of production, such as wages, raw materials, etc. (but before interest and tax). It is the return achieved from standard operations and does not include unique or one-off transactions. This indicator encompasses the profit margin aspect. ROS is usually expressed as follows:

$$ROS = \frac{EBIT\ (EAT)}{Revenue} \quad (5)$$

Profit margin (PM), which is one of the most widely used profitability ratios and helps understand the relative profitability. It represents the percentage of sales turned into profits. Margins are computed from gross profit, operating profit or net profit. All three profit margins are calculated as the profit figure divided by revenue and multiplying by 100 (Berg et al., 2018). Operating profit margins correspond to ROS in percentage expression and the formula for calculation is as follows:

$$OPM = \frac{Operating\ profit\ EBIT\ (EAT)}{Revenue}\ x\ 100\ (\%) \quad (6)$$

Activity indicators reflect the ability of an enterprise to manage its assets effectively. Activity indicators include (Ručková, 2010; Kotulič et al., 2010; Brealey, 2000): *Total asset turnover ratio*, which indicates the number of turns over a given time interval (e.g. year), i.e., how many times the assets turn. It indicates the efficiency of the use of the company's assets.

$$Total\ Assets\ Turnover\ Ratio = \frac{Total\ assets}{Sales}\ x\ 365 \quad (7)$$

Inventory turnover ratio, which indicates the intensity of the use of inventory, i.e., how many times a year, the company transforms its inventory into sales.

$$Inventory\ Turnover\ Ratio = \frac{Sales}{Inventory} \quad (8)$$

Average collection period, which indicates how many days on average it takes until the money in the receivables is collected. It indicates the payment discipline of customers.

$$Average\ Collection\ Period = \frac{Daily\ receivables}{Sales/365} \quad (9)$$

Creditor's payment period, which reports on the payment discipline of the company itself to its suppliers and indicates the duration of payment of the obligation from the moment of its occurrence in days.

$$Creditor´s\ payment\ period = \frac{Daily\ obligation}{Sales/365} \quad (10)$$

Debt indicators serve to monitor the structure of the company's financial resources. The high share of own resources makes the company stable and independent; on the other hand, if the share is low, the company is unstable; thus, market fluctuations and creditor insecurity can have serious consequences (Hajdúchová, 2011; Tóthová et al., 2012).

Equity ratio explains the financial independence, the equity capital to meet the company needs.

$$Degree\ of\ self - financicng\ = \frac{own\ capital}{total\ capital}\ x\ 100\ \% \quad (11)$$

Total indebtedness indicates the degree of indebtedness of the business, the extent to which the debt is used to finance the company.

$$Total\ indebtedness = \frac{foreign\ capital}{total\ capital}\ x\ 100\ \% \quad (12)$$

Financial leverage shows the structure of the company's financial resources.

$$Financial\ leverage = \frac{foreign\ capital}{own\ capital} \quad (13)$$

Traditional cash-flow performance indicators are primarily financial and investment. Financial indicators deal with the financial position of the company in terms of its solvency. In contrast, investment indicators evaluate the company in terms of its future investment potential and stability for investors. The total cash-flow is measured using a direct or an indirect method. Operational Cash-Flow Calculations for Performance Evaluation were made using the indirect method and cash flow calculations from investment and financial activities by direct method according to Mařík & Maříková (2005) and Varcholová et al. (2007).

The economic value-added indicator (*EVA*) is an economic and financial indicator of business performance. Its main task is to measure the company's economic profit (Kiseľáková, 2018). The basic, most frequently used formula for calculating the EVA indicator is commonly (Ručková, 201; Knápková et al., 2013) is as follows:

$$EVA = NOPAT - WACC * NOA \quad (14)$$

where:
NOPAT — Net Operating Profit After Taxes,
NOA — Net Operating Assets,
WACC —Weighted Average Cost of Capital.

3. Research results

The following part of the paper presents the results of the reengineering process in the company and the financial analysis.

3.1. Implementation of process reengineering in the company

The implementation of process reengineering was divided into six steps.

The first step defined the objectives of reengineering — the construction of a new warehouse with a sophisticated sorting system and the automation of window production processes using a new fully automated line.

The second step was to identify business processes. To implement the reengineering process, the company used one production hall, in which all production processes were carried out. Recently, they implemented the CNC technology manufacturing process. In the process of reengineering, it was necessary to automate manufacturing operations, such as pickling, painting and drying. A map of window production processes before reengineering is shown in Fig. 1.

The third step was the selection of business processes for reengineering with the emphasis on the removal of manual labour and unproductive processes, and the more efficient storage of input materials. The biggest change due to the construction of the new hall occurred in the production processes of pickling, drying and painting, which were replaced by a new fully automated line.

The fourth step was to get to know the manufacturing processes that had a major impact on the quality of the final product. As these selected processes form a large part of the resulting quality of the

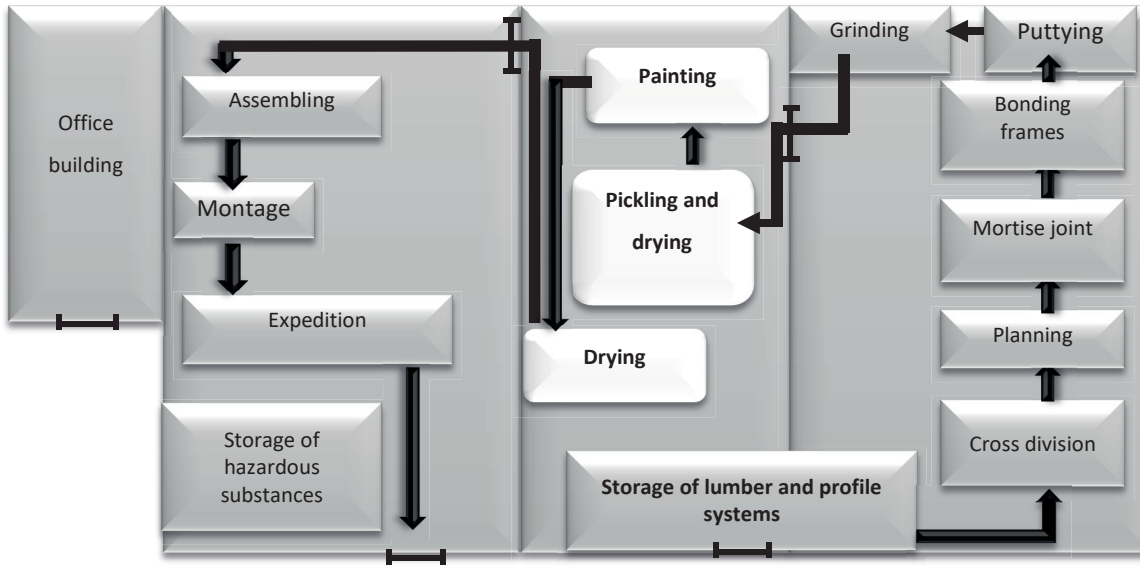

Fig. 1. Process map before reengineering

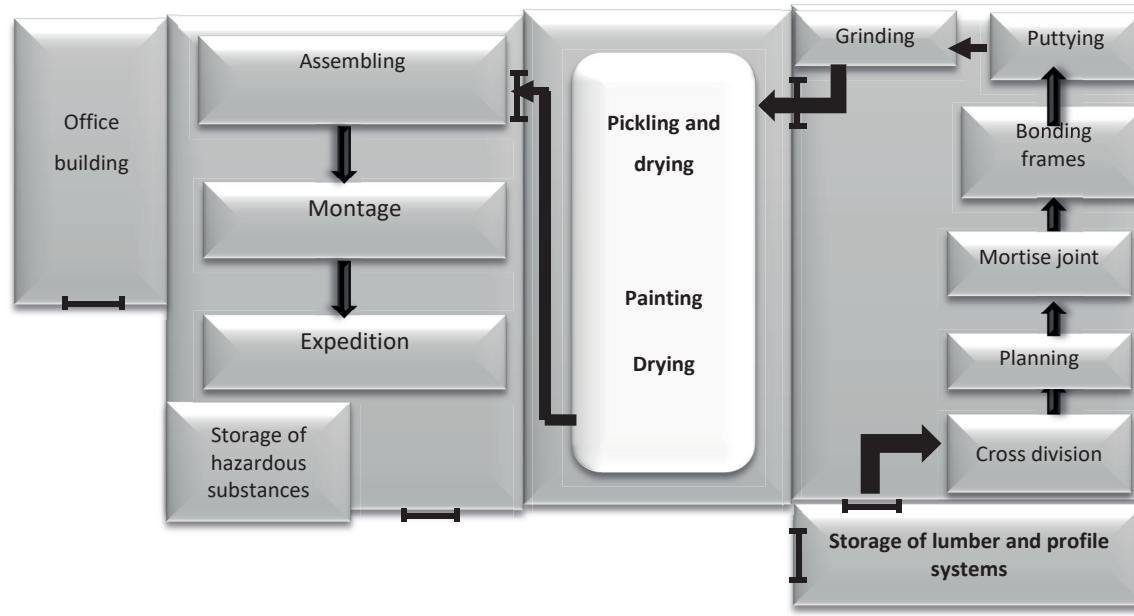

Fig. 2. Process map after reengineering

profile systems, their replacement with a fully automated line was key to the company.

The fifth step was the re-design of selected business processes. A change in the expansion of storage space with a sophisticated storage system and a change in manufacturing processes in the production of wooden windows was made to streamline the entire production process, reduce production costs, use human resources more efficiently, and improve the quality of finished products. These consequences had a positive impact on the company's financial position and performance.

Fig. 2 shows the arrangement of manufacturing and non-production processes after reengineering. New warehouse space was equipped with modern input material sorting, which also provided input inspection of raw materials. Pickling, painting and drying were replaced by a fully automated line. Completing, assembling and shipping were given more space, reducing the proportion of non-conformities due to mechanical damage.

In step six, new business processes were implemented. Preparation and implementation of project documentation preceded the construction of a new warehouse, the purchase of warehouse equipment and a new automated line. Funds for the construction of the hall were secured using a bank loan of EUR 170 000. The received subsidy funded the purchase of

a fully automated line. Currently, the operation is running under a new mode, and employees were provided with the necessary training to operate the new production line.

3.2. Evaluation of the impact of reengineering on the company's financial standing

The analysis of the financial situation in the company was carried out using profitability indicators, activity indicators, indebtedness indicators, cash flow ratios to measure financial flows and the EVA performance indicator. The profit margin, as one of the most important profitability indicators, was considered for the ROS indicator. Tab. 3 shows the profitability indicators aimed at monitoring business efficiency.

The results in Tab. 3 show that the return on assets increased in 2018 compared to 2015 by about 60%. The return on equity of 2018, when the results of the introduced reengineering were already known, increased from 8.11 to 43.73, which is of great value to both the business owner and in terms of the competition. The company achieved the highest return on assets in 2016 and 2017, which resulted from the higher NOPAT value. Return on equity reached its peak after the implementation of reengineering. The lowest level of return on sales was reached in 2016. Once the changes were made, and the results were evaluated, the profitability of sales increased by more than 80%.

Tab. 3. Profitability ratios

PROFITABILITY RATIOS	2015	2016	2017	2018
Return on assets ROA	1.36	1.24	1.17	2.26
Return on equity ROE	17.80	17.48	8.11	43.73
Return on net assets RONA	0.63	0.84	0.82	0.71
Return on share capital ROSC	1.36	1.12	1.10	1.76
Return on sales ROS	1.07	0.72	0.78	1.31

Tab. 4. Activity indicators

ACTIVITY INDICATORS	2015	2016	2017	2018
Total Assets Turnover [year]	1.04	1.39	1.22	1.40
Inventory turnover [days]	223.30	224.70	245.30	254.40

Tab. 5. Debt indicators

DEBT INDICATORS	2015	2016	2017	2018
Degree of self-financing	4.10	4.03	7.66	2.29
Total indebtedness	95.90	95.97	92.35	97.71
Financial leverage	16.10	17.36	8.52	23.89

Activity indicators express the efficiency of asset management in an enterprise. Based on the results presented in Tab. 4, activity indicators are increasing. Inventory turnover values were high due to high inventory levels for custom manufacturing.

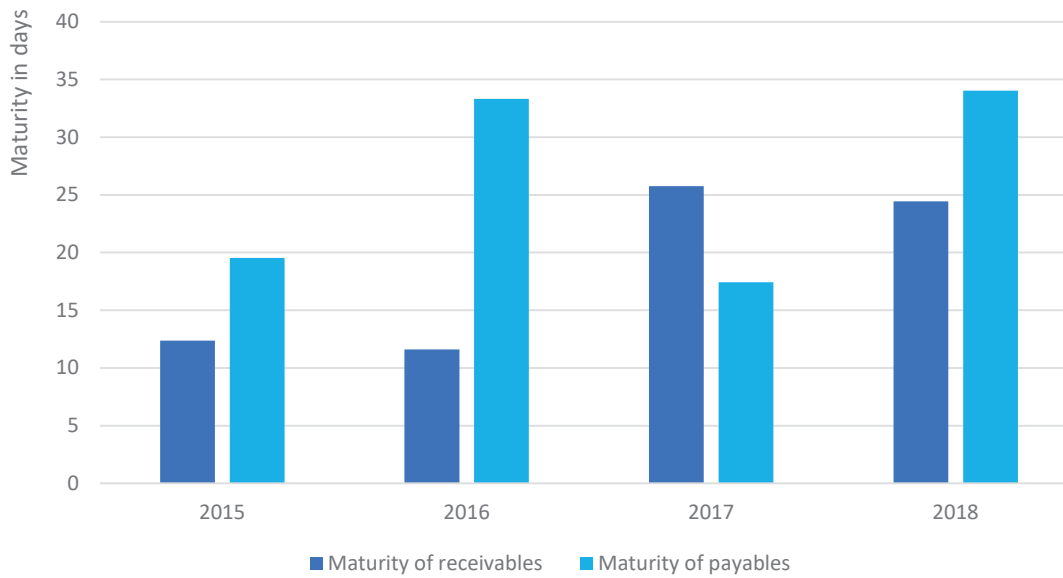

Fig. 3. Maturity of receivables and payables

Fig. 3 shows the difference in the maturity of receivables and payables. In addition to 2017, the repayment period of receivables is lower than the repayment period of payables. This was an advantage for the company and proved that the company had collected rather than paid. Also, based on the results achieved in the activity indicators, authors can state a positive impact on the financial situation of the company.

Debt indicators are used to monitor the company's financial resources. The share of own and foreign financial resources affects the financial stability of the company. As demonstrated in Tab. 5, the high share of foreign resources is cheaper for the company but represents less stability. In 2018, the debt was up to 97.71%. By increasing the value of the leverage, the company increased the share of foreign resources and, thus, the degree of debt.

Cash flow is a term that indicates the difference between cash and cash outflows over the reporting period. The overview of cash-flows, which are important for liquidity management, is presented in Tab. 6.

The results of the operative cash-flow calculated by the indirect method show that in 2017, ta radical decrease occurred compared to 2016, which was due to the decrease in inventories. Cash flow values from investment activity show that their amount was related to reengineering in the company. In 2018, after reengineering, the company managed to increase its cash-flow by more than 78%. The low cash-flow from investment activity in 2017 had an impact on the value of cash-flow from financial operations. The negative value was due to an increase in equity and changes in the structure of long-term foreign capital. The situation in 2016 reflects the company's readiness for the high level of investment that was actually accomplished in 2017. Undoubtedly, the investment had a positive effect on the cash flow from investment activity for the next period. Total cash flow values show that the company managed to generate its own financial resources. The values of the indicators provided a clear statement about the timely reengineering and its positive impact on the future financial standing.

Aiming to calculate the economic value-added EVA, it was necessary to define the profit from the main operating activity after NOPAT taxation, which is also listed in Tab. 7.

The company achieved the highest value in 2017. By implementing reengineering in 2016, the company increased its assets by EUR 133712. The value of tied capital in the main activity was approximately at the same level. Again, the reengineering had a positive impact on the economic results of the company as a whole. The cost of foreign capital ranged from 3.59% to 3.69% over the years. The average cost of capital for 2015, 2016, 2017 tended to grow and only dropped by more than 35% to 0.66 in the last reporting year, once again positively affecting the company's financial situation. The negative EVA in 2017 was due to the high average cost of capital, which was 1.02%. In 2017, the company also recorded the highest total capital for the entire period under review and, therefore, EVA was negative. By decreasing the average cost of capital by 35%, the company managed to increase its business performance by over 250% in 2018, which is high positive impact on the company's financial position.

Tab. 6. Cash-flow indicators

CASH FLOW INDICATORS [€]	2015	2016	2017	2018
Operating Cash-Flow	-73 272.00	179 586.45	65 968.79	54 562.31
Cash-Flow from investment activities	42 104.36	449 178.38	7 594.80	13 604.33
Cash-Flow from financial activities	46 120.45	519 247.68	- 30 752.48	64 534.17
Total-Cash Flow	14 952.81	1 148 012.51	42 811.11	132 700.81

Tab. 7. EVA indicator, net working capital and cost of foreign capital

EVA INDICATOR [€]	2015	2016	2017	2018
Net operating profit after tax NOPAT	9 402.77	12 380.59	13 189.21	9 933.77
Net working capital	565 865.00	643 429.00	739 108.00	678 921.00
Net Operating Assets NOA	1 395 870.00	1 187 149.00	1 340 456.00	1 320 861.00
Cost of foreign capital	3.60	3.69	3.60	3.59
Weighted Average Cost of Capital WACC	0.41	0.42	1.02	0.66
EVA	3 676.00	7 558.00	-508.00	1 281.00

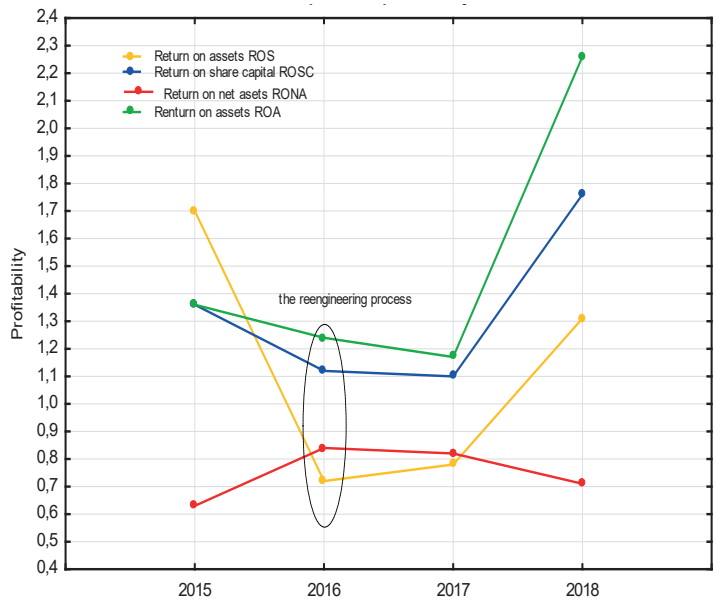

Fig. 4. Development of profitability indicators

4. Discussion of research results

The results demonstrated that reengineering of manufacturing processes could be implemented successfully using the methodology offered by Hammer and Champy (2000). The comparison of the financial situation of the company before and after the reengineering shows that this radical change was well-timed. Even though the decision to construct a new production hall and buy a fully automated production line seemed radical, it was actually the right thing to do.

The comparison of the results of the company's financial indicators showed a positive impact received from the implementation of the reengineering on the financial performance of the company (Fig. 4). Although the statistical validation was not made, the dependence between reengineering and change of profitability indicators is apparent.

As recommended by various authors (Varcholová et al., 2007; Brealey, 2000; Růčková, 2010; Dubovická 2007; Neumaierová and Neumaier, 2002; Marik and Mariková, 2005; Kotulič et al., 2010; Knapková et al., 2013; Hajduchová, 2000; Zalai et al., 2010; Toth et al., 2012), the selected financial indicators, namely, profitability ratios, activity indicators, debt indicators, traditional cash-flow performance indicators and the economic value-added indicator EVA, were suitable for evaluating the impact of reengineering on the financial performance of the company.

On this basis, as well as the presented example of their use in the assessment of the financial performance of the company that implemented the reengineering process according to the Hammer and Champy methodology, it can be stated that the selected financial indicators have a good predictive impact on the financial situation of the company in terms of sales, profit margin, inventories, equity and foreign capital, as well as capital costs. They can also be recommended for the evaluation of the reengineering process of other companies.

Conclusions

The impact achieved by reengineering of a manufacturing process in the chosen company was monitoring using financial indicators and proved that the reengineering was successful from the economic point of view. The overall efficiency of the company expressed in profitability indicators reached the highest values in 2017 and 2018, as a result of the implemented reengineering. Over the monitored period of four years, all activity indicators developed favourably in the upward trend. Foreign financial sources went up to 97%. This option was cheaper for the company but also meant less stability. The reengineering was financed from foreign sources, which was also reflected in the highest indebtedness in 2018 for the entire period under review. The leverage ratio was also confirmed by the financial leverage ratio. The results of the total cash flow showed that in each reporting year, the company was able to generate its

own financial resources. Average costs tended to grow, with a decline of more than 35% in 2018. The decrease was attributed to favourable credit terms in all years except 2017. Negative EVA in the year, in which reengineering was introduced, was attributed to high capital costs.

Based on financial analyses and the results of selected indicators, the authors of this article conclude that the introduction of reengineering in the production process was well-timed. At the same time, the results of the analyses showed that reengineering resulted in the improved company's performance and value, which had a positive impact on the company's financial situation. This was confirmed by the comparison of indicator values before and after the reengineering. The resources spent in the process of reengineering were effectively used, and the company's further functioning was set for future prosperity.

The analysis concerned only one company, which is the limitation of the paper. The validation of findings through statistical tests is, therefore, complicated and almost impossible. The evaluation and validation of reengineering effects through statistical analysis can be carried out on a larger research sample of more companies. This issue will be solved in the next research.

Acknowledgement

Authors are grateful for the support of the National Agency for Agricultural Research, Grant No. QK1820358.

Literature

Berg, M., Mrrewijk, Ch., & Tamminen, S. (2018). Trade, productivity and profitability. On profit levels and profit margins. *World Economy*, *41*(1), 52-64. doi: 10.1111/twec.12630

Brealey, R. A., & Myers, S. C. (2000). *Theory and practice of corporate finance.* Prague, Czech Republic: Viktoria publishing.

Cienciala, J. (2011). *Process-managed organization: process creation, development and measurability*. Prague, Czech Republic: Professional Publishing.

Davenport, T. H. (1993). *Process Innovation: Reengineering Work through Information technology. I.* Boston, United States: Harvard Business School Press.

Dubovická, L. (2007). *Model Approaches to Measuring Strategic Performance: Organization Performance. Approaches to its measurement and evaluation.* Košice, Slovakia: PHF.

Evans, O. (2018). Improved financial performance without improved operational efficiency: the case of Nigerian firms. *Forum Scientiae Oeconomia*, *6*(3), 25-39. doi: 10.23762/FSO_VOL6_NO3_2

Gejdoš, P. (2006). Six Sigma – a flexible system for improving business performance. *Acta Facultatis Xylologiae*, *68*(2), 103-111.

Grasseová, M., Dubec, R., & Horák, R. (2008). *Process management in the public sector: theoretical background and practical examples*. Brno, Czech Republic: Computer Press.

Hajdúchová, I. (2000). *Financial analysis of the company.* Zvolen, Slovakia: Technical University in Zvolen.

Hajdúchová, I. (2011). *Financial stability of the company.* Zvolen, Slovakia: Technical University in Zvolen.

Hammer, M., & Champy, J. (2000). *Reengineering - a radical transformation of the company: a manifestation of a revolution in business.* Prague, Czech Republic: Management Press.

Homzová, E. (2012). *Process management as a tool to increase business competitiveness*. Proceedings of International Scientific Conference MERKÚR 2012, OF EU, Bratislava: Publishing EKONÓM.

Kiseľáková, D., Šofranková, B., Čabinová, V., & Šoltésová, J. (2018). Analysis of enterprise performance and competitiveness to streamline managerial decisions. *Polish Journal of Management Studies*, *17*(2), 101-111. doi: 10.17512/pjms.2018.17.2.09

Knápková, A., Pavelková, D., & Šteker, K. (2013). *Financial analysis.* Prague, Czech Republic: Grada Publishing.

Kotulič, R., Kiraly, P., & Rajčaniova, M. (2010). *Business Financial Analysis* 2. Prague, Czech Republic: GRADA Publishing.

Kovaľová, M. (2010). *Design of a Model for Managing Strategic and Operational Performance of Business Processes: Business Economics and Management* Banská Bystrica, Slovakia: Matej Bel University.

Kovář, F., Kožíšková, H., & Hrazdilová Bočková, K. (2004). *Theory of Industrial Business Systems II.* Zlín Czech Republic: Tomas Bata University in Zlin.

Manganelli, R. L., & Klein, M. M. (1994). *The Reeingineering Handbook. A Step-by-Step Guide to Business Transformation. I.* New York, United States: Amacom.

Marcinekova, K., & Sujova, A. (2015). The influence of the process control level on the enterprises' ROE. *Procedia Economics and Finance, 34*, 290-295. doi: 10.1016/S2212-5671(15)01632-9

Mařík, M., & Maříková, P. (2005). *Modern methods of business evaluation and valuation (EVA, MVA, CF ROI). II*. Prague, Czech Republic: Ekopress.

Neumaierova, I., & Neumaier, I. (2002). *Company Performance and Market*. Prague, Czech Republic: Grada Publishing.

Papulová, Z., Papula, J., & Oborilová, A. (2014). *Process Management. A comprehensive view of the process management concept.* Bratislava, Slovakia: Kartprint.

Rašner, J., & Rajnoha, R. (2006). *Business Process Efficiency Management Tools*. Zvolen, Slovakia: TU in Zvolen.

Řepa, V. (2007). *Business processes: process management and modeling.* Prague, Czech Republic: Grada.

Ručkova, P. (2010). *Financial analysis: methods, indicators, use in practice.* Bratislava, Slovakia: Iura Edition.

Suchánek, P., Bucki, R., & Korjenic, A. (2015). Implementation of optimization methods in the selected areas of production logistics. *Forum Scientiae Oeconomia*, *3*(2), 65-79.

Sujová, A., Simanová, Ľ., & Marcineková, K. (2016). Sustainable Process Performance by Application of Six Sigma Concepts: The Research Study of Two Industrial Cases. *Sustainability, 8*(3), 260. doi: 10.3390/su8030260

Sujová, E., & Čierna, H. (2018). Optimization and improvement of test processes on a production line. *Management Systems in Production Engineering*, *26*, 88-92.

Svozilová. A. (2011). *Improving business processes*. Prague, Czech Republic: Grada.

Tóthová, A., Nagy, L., & Škriniar, P. (2012). *Financial and economic analysis of the company.* Bratislava, Slovakia: Sprint.

Varcholova, T. et al. (2007). *Business Performance Measurement*. Bratislava, Slovakia: Ekonom.

Zalai, K. et al. (2010). *Financial and economic analysis of the company*. Bratislava, Slovakia: Sprint.

Závadský, J., & Kovaľová, M. (2011). *Operational and strategic performance of business processes*. Bratislava, Slovakia: Slovak Committee for Scientific Management ZSVTS.

sciendo

ISMSME International Society for Manufacturing, Service and Management Engineering

received: 10 April 2019
accepted: 20 August 2019

pages: 117-131

Examining the Link between the Governance Mechanisms and Supply Chain Performance — an Empirical Study within the Triadic Context

Artur Swierczek

ABSTRACT

The goal of the research is twofold. First, it aims to reveal the basic modes of governance run by the manufacturer across the examined triadic supply chains. Secondly, the paper compares the groups of triadic supply chains, applying certain modes of governance, including network governance, in terms of the relational benefits and supply chain performance. To investigate the relationship between network governance and the supply chain performance, the Principal Component Analysis (PCA) with Varimax Rotation was used, followed by the cluster analysis and non-parametric tests. The study showed that the triadic supply chains significantly differentiate in terms of the modes of governance. Further findings also indicated that the triadic supply chains that follow the network governance mode consider their performance to be significantly higher in comparison to the supply chains that do not run this type of governance mechanism. Firstly, the research showed that it is difficult to unequivocally reveal the pure mechanisms of governance, undistorted by the influence of another distinct mode in the triadic supply chains. On the contrary, they are more or less influenced by other modes of governance distinguished in the literature. Likewise, it is also important to highlight that the mechanism of governance is inseparably bound with a certain dyadic relationship established between two actors in the wider structure of supply chains. The study also showed that incorporating a clan as a social mechanism of governance together with a market and hierarchy results in increasing the relational benefits and overall performance for both dyads in the triadic supply chains.

KEY WORDS

network governance, triads, supply chain

DOI: 10.2478/emj-2019-0026

Corresponding author:

Artur Swierczek

University of Economics
in Katowice, Poland
e-mail: artur.swierczek@uekat.pl

Introduction

Supply chain governance is perceived as a mechanism of coordination encompassing three distinct modes, namely, market, hierarchy and clan. A market mechanism involves the coordination mediated by a price mechanism, while a hierarchy concerns a supervisory structure to impose integration and apply bureaucratic routines, and a clan is anchored social capital which is a tacit resource attainable by individual actors through the networks of relationships. Apart from these three distinct modes, several studies increasingly investigate the issue of network governance indicating a simultaneous coexistence of these three modes (Dooley and Gubbins, 2019; Cardoso de Oliveira et al., 2019; Yeoman and Santos, 2019). Accordingly, the notion of network governance

underscores the role of informal social exchange systems together with the hierarchical structures within firms and formal contractual relationships between them, to coordinate the supply chain activities (Ahi and Searcy, 2013; Czakon, 2012; Jones et al., 1997). In other words, network governance encompasses the set of instruments to coordinate participating organisations and deliver certain outcomes (Grandori and Soda, 1995; Dyer and Singh, 1998). In our study, we seek to investigate whether network governance affects the value of relational benefits and the overall supply chain performance, as compared to the non-network based, distinct governance mechanisms. The goal of our research is twofold. First, it aims to reveal the basic modes of governance run by the manufacturer across the examined triadic supply chains. Secondly, the paper compares the groups of triadic supply chains, applying certain modes of governance, including network governance, in terms of the relational benefits and supply chain performance.

Our study makes two general contributions to the supply chain theory and practice. First, it simultaneously investigates three mechanisms of governance: market, hierarchy and clan in supply chains. Though the extant studies consider this issue, they do not take the full advantage of investigating the co-existence of the three mechanisms of governance. On the contrary, they mostly considered only two out of three mechanisms, and this does not contribute to drawing a full picture of governance in supply chains (Bradach, 1997; Cannon et al., 2000). Likewise, there is a paucity of research investigating the triadic structures of supply chains. The previous studies most often referred to the "ego-perspective" by examining the focal actor orchestrating the supply chain, thus omitting the perspective of other partners establishing this structure. Consequently, to challenge this issue, our study is conducted within the triadic context and investigates three subsequent actors (supplier–manufacturer–customer), forming the basic structure of a supply chain.

The paper consists of several parts. Following the introduction, the literature review offers the theoretical framework for the research methodology. Next, the findings of the analysis are presented, followed by the discussion and conclusions of the research.

1. Literature review

From the classical perspective of the Relational Contracting Theory and Transaction Cost Analysis (TCA), governance is viewed as the choice between market and hierarchy (Williamson, 1985). Market constructs revolve around contractual relationships over property rights. A market construct involves relationships mediated by a price mechanism and provides a high degree of flexibility to the companies in determining their willingness to form supply chains. Essentially, the market construct argues that companies prefer to be independent and will choose to collaborate only when they see particular advantages to themselves (Powell, 1990). In other words, this form of governance resembles new market-based relationships, characterised by arm's-length ties, deprived of both personal bonds and any form of central coordination of activities (Baker, 1990). The hierarchical construct of governance is positioned on the opposite side of the continuum. It is supposed to overcome the problems of non-engaged and loose relationships typical of market governance. Therefore, the construct of hierarchy emphasises a necessity to impose a supervisory structure and apply bureaucratic routines. It specifically refers to the level of control determined by explicit rules, procedures and standards that establish the rights and obligations of actors in supply chains (Choi and Hong, 2002). In this way, hierarchy assumes that the companies are more engaged in the established and committed long-lasting relationships (Lowndes and Skelcher, 1998; Pilbeam et al., 2012). However, on the other hand, it may reduce flexibility and innovation due to the higher level of formalisation and centralisation of power (Powell, 1991).

Beyond the recognition of market and hierarchy as a mutually exhaustive bipolar framework of governance, there have been numerous attempts to develop alternatives or supplement the existing model with other characteristics (Uzzi, 1996). Subsequent debates enabled to develop one of the most widely accepted approaches, which added a third construct of network governance to this bilateral framework (Coleman, 1988). In time, a discussion unfolded as to whether network governance was simply a combination of market and hierarchy constructs, or whether it would be better understood as a unique form of governance. In early works, network governance had been framed as a form combining the tenets of both market and hierarchy and positioned somewhere in the middle of the continuum between these two extreme forms of governance (Thorelli, 1986). In other words, the gap between market and hierarchy was filled with this third form of governance. Nonetheless, the current view usually acknowledges that a network is a dis-

tinct, non-market and non-hierarchical, and, thus not an intermediate form of governance, possessing complementary, multi-relational and reciprocal characteristics (Powell, 1990; Tachizawa and Wong, 2015). The current understanding of network governance highlights that purely economic exchanges may be shaped by social capital which is a tacit resource attainable by individual actors through the networks of relationships (Whipple et al., 2015). In other words, social capital creates opportunities for economic exchanges of goods which are difficult to price and enforce contractually (Uzzi, 1996). Therefore, the particular form of network governance will be, at least, partially anchored in the discretion of supply chain decision-makers, based on managers' previous experience, perception capability, mimicry, personal attitude (Provan and Kenis, 2007), professional background, opportunism, ambiguity, information accessibility etc. In light of the above, market and hierarchy are supplemented with clan structures, where all members of the transactional network share the social norms of the particular group (Dorsey, 2014). A clan as a distinct mode of governance has been found to have benefits relative to other — market and hierarchical — governance structures (Lund, 2003). A clan highlights a team-centred approach, establishing respectful relationships among the supply chain partners. Consequently, it encourages a win-win situation to the members in the supply chain (Sambasivan and Ching, 2010). Consequently, we consider network governance as a mechanism whose sine qua non is constituted by the simultaneous presence of all three modes, namely, market, hierarchy and clan.

As depicted in Fig. 1, network encompasses three distinct modes, i.e., market, hierarchy and clan, which form diverse configurations of governance (Thompson et al., 1991). In this vein, Heide (1994) compared network governance to a plural system established indirectly by means of "bringing the governance properties of one form to bear on another". Hence the following hypothesis: H1: Triadic supply chains significantly differentiate in terms of the modes of governance.

We argue that establishing network governance favours generating relational benefits that are not obtained by defeating another company (Zacharia et al., 2009; Bowersox et al., 2003). On the contrary, the relational benefits refer to the win-win situation where the multiple supply chain actors are winners (Dyer and Nobeoka, 2000; Joshi and Campbell, 2003). However, though relational benefits highlight the significance of reciprocal relationships and symmetrical exchange of the resources between two firms, it is still anchored in bilateral arrangements established between dyads. Therefore, despite its novelty, to make the full use of the relational approach in supply chains, there is a need to look beyond the dyad (Kannan and Tan, 2010; O'Leary-Kelly and Flores, 2002; Frohlich and Westbrook, 2001). Wasserman and Faust (1994) argue that a dyadic perspective cannot fully explain relational behaviours of two firms in the network. In other words, the companies in supply chains establish relationships not only with each other but also with the same third parties. Consequently, many companies are linked indirectly by third parties (Granovetter, 1985; Granovetter, 1992). Therefore, a triad — which is the smallest unit of network (Choi and Wu, 2009) — the next logical step after having studied dyadic relationships. In the opinion of Dubois and Fredriksson (2008), the existence of three actors linked to one another through three connected relationships is a starting point for the analysis of triads. In our study, we investigate the triads taking the form of triadic supply chains with the manufacturer as a focal actor located in the middle between the supplier and the customer.

In light of the above, moving the level of analysis from dyadic to triadic structures is an important step towards considering the more complex dynamics of supply networks (Wilhelm, 2011). In the same vein,

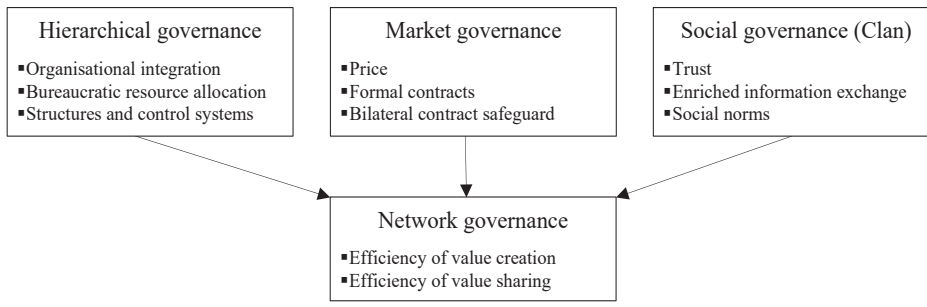

Fig. 1. Network as a plural form of governance
Source: (Czakon, 2012).

Lamming et al. (2000) posit that the articulation of supply networks, as an extension of supply chains, seeks to accommodate and explain the complexity associated with the creation and delivery of goods and services from the source of raw materials to their destination in end-customer markets. Consequently, a triadic research perspective becomes imperative to further comprehend network dynamics in supply chains (Choi and Wu, 2009) and is instrumental when investigating their relational benefits (Colotla et al., 2003).

The notion of relational benefits underscores the necessity of rejecting the short-sighted way of perceiving advantages as a temporary profit, with the supply chain leader being the only beneficiary, frequently at the expense of other partners. Instead, the relational benefits call for covering the aspirations and goals of all companies involved in achieving and sustaining advantages. Thus, we assume that the intensity of leveraging external resources among companies may lead to perceived inequity in the short term, but in the long run, it may have a positive effect on the strength of relational benefits with the triadic supply chains. This brings us to the following hypothesis: H2: Triadic supply chains that follow the network governance mode consider their supply chain performance to be significantly higher in comparison to the supply chains that do not run this type of governance mechanism.

2. Methodology

2.1. Sample and Research Instrument

The process of data gathering spanned over five months from December 2018 through May 2019, and consisted of several stages, adapted from Wu et al. (2010). Generally, we used a multiple-respondent approach to collect data for the study. To gather data from all three actors of the triadic supply chain, we combined methods based on probability and non-probability sampling. The method of stratified sampling was firstly applied to obtain information from the manufacturers (small, medium and large), while the snowball sample method was employed to collect data from the suppliers and the customers. In the first stage of the data collection process, a sample of 98 Polish manufacturers was targeted. Out of this number, a group of ten companies refused to fill in the questionnaire maintaining that their suppliers or customers would not be willing to participate in this research. Likewise, a large group of 50 manufacturers encountered problems with a negative attitude of suppliers or customers towards the questionnaire. Finally, a group of four manufacturers managed to encourage their suppliers and customers to participate in the survey; however, after receiving the questionnaire, they refused to take part in the research. Consequently, the study investigated the remaining number of 34 triads that established a simultaneous relationship with both a supplier and a customer.

The structure of the survey questionnaire was adapted to certain groups of respondents — actors playing different roles in the examined triadic supply chains. Accordingly, depending on the function served in the triad, each responding company answered a specific set of questions. Due to its central location, the manufacturer answered the questions concerning different modes of governance in the upstream and downstream dyad (categories 4–6 in Appendix A) and the relational benefits separately for both dyads — one formed with its supplier, and the other one established with its customer (category 1 in Appendix A). The other two groups of triad actors, the suppliers and the customers, answered the questions concerning governance and the relational benefits yielded in a certain dyad formed with the manufacturer — categories 1 and 4–6 (Appendix A), respectively. In addition, the group of customers was asked to answer the questions concerning the customer-focused performance to measure customer satisfaction derived from the service offered by the triadic supply chain (category 3 in Appendix A).

2.2. Measures

This study measured all items on a five-point Likert scale. Based on the prior studies, five indicators were identified demonstrating the extent, to which both parties in the particular dyad generated reciprocal effects (Salas et al., 2015; Kim and Choi, 2015; Whipple et al., 2015; Carter et al., 2017). The obtained responses from both actors in a dyad were then captured as averaged scores indicating the relational performance of upstream (supplier–manufacturer) and downstream (manufacturer–customer) dyads. To demonstrate the supply chain performance, we applied six opinion-based measures dealing with customer-focused performance. It allowed to capture the role of the market as the ultimate mechanism for determining supply-chain performance. This group covers issues connected with quality performance, delivery and flexibility performance, such as respon-

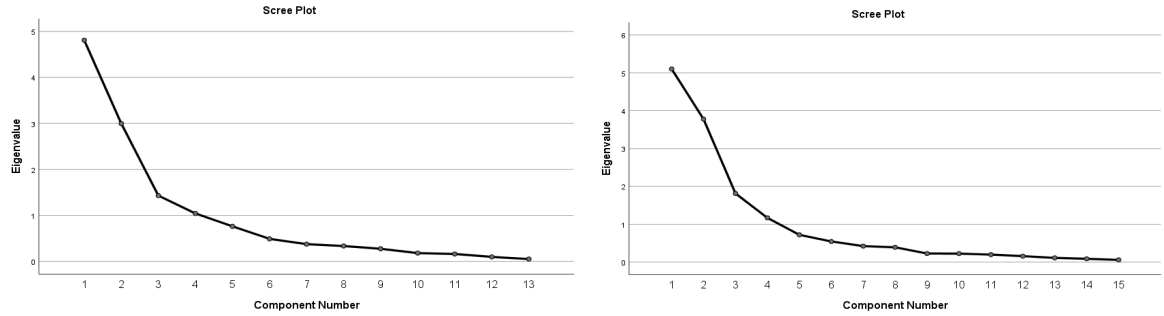

Fig. 2. Scree plots within two groups of variables (left for the upstream dyad, right for the downstream dyad)

siveness to customer requests or unexpected challenges, on-time delivery, delivery reliability, accuracy (Gligor and Holcomb, 2012). Finally, we used three groups of measures to indicate the price mechanism, hierarchical structures and clan. Building upon previous research, we identified a set of five indicators demonstrating the price mechanism anchored in the market form of governance (Noordewier et al., 1990; Wang, 2002; Mirkovski et al., 2016), a group of six indicators manifesting hierarchy (Eccles et al., 1992; Grant, 1996; Jones et al., 1997; Ashenbaum et al., 2009) and a class of four indicators reflecting a clan (Mesquita et al., 2008; Liu et al., 2009).

2.3. Research Methods

To investigate the relationship between network governance and supply-chain performance, a statistical analysis has been performed. In the first step, the variables indicating certain modes of network governance, the relational benefits and the supply chain performance were reduced using the Principal Component Analysis (PCA) with Varimax Rotation to highlight the main underlying multi-item orthogonal constructs. In the second step, the factor scores obtained using the PCA were used as criteria for classifying the sample into homogenous groups. As a classification method, we used a cluster analysis with a two-step approach recommended by Ketchen and Shook (1996). Accordingly, we used hierarchical cluster analysis to determine the number of clusters, followed by K-means cluster analysis to perform a group profiling and make necessary comparisons of the obtained clusters.

To identify the basic modes of governance in the investigated supply chains, the PCA was initially carried out in two groups of 15 variables each, which manifested network governance of both upstream and downstream dyads. The inspection of anti-image correlation matrix in the first group of variables resulted in eliminating one item, whose measure of individual sampling adequacy was below the nominal cut-off point of 0.5. In addition, one variable was dropped for its moderate exploratory relevance, as indicated by the factor loading that did not exceed 0.6 (Kline, 1994). In the second group, all variables were accepted for further analysis demonstrating satisfying values of individual sampling adequacy and factor loadings. Based on the analysis of the scree plot (Fig. 2) and eigenvalues of least 1 for each factor, the analysis showed a clean factor-loading pattern with minimal cross-loadings, and high loading on the one construct.

The results of PCA for both variables revealed a four-factorial solution, covering a total of 13 variables in the first group and 15 variables analysed in the second group, respectively (Tab. 1). In the group of variables manifesting network governance of the upstream dyad, one may enumerate the following four constructs: two constructs of hierarchical governance (HUD1 and HUD2), market governance (MUD) and a clan (CUD). None of the two constructs of hierarchical governance is entirely pure in terms of the modes of governance, as they consist of one variable initially qualified as the one characterising market mode of governance (HUD1), and a clan (HUD2). In the group of variables manifesting the network governance of a downstream dyad, PCA produced the following four constructs: market–clan governance (M-C_DD), two constructs of hierarchical governance (HDD1 and HDD2), and market governance (MDD). Similar to the previous analysis, the same variable indicating the market governance was classified into hierarchical governance (HDD1). Interestingly, most variables manifesting clan and market governance were qualified to the same construct (M-C_DD). This probably stems from the fact that these two sets of variables go hand-in-hand. More specifically, the autonomy offered by market governance favours the development of unconstrained social bonds among the companies in the investigated supply chains.

The rotation of PCA was converged in seven and six iterations for the first and second group, respectively. Likewise, the obtained factors explain 79.06, 79.05 percent of the total variance in the first and second groups of variables, respectively, which is an excellent result. To check the internal consistency of extracted constructs, we calculated the Cronbach's alpha coefficients which indicated satisfying level of at least 0.7 for each construct.

Apart from the factors manifesting the modes of governance, we also used the PCA with Varimax Rotation to extract the underlying factors of relational benefits and supply-chain performance. They were employed to make a profile of the investigated supply chains. The analysis performed in the space of two sets of variables manifesting the relational benefits of upstream and downstream dyads showed a clear pattern of a two-factorial solution with the factor loadings above 0.6 and a measure of individual sampling adequacy, derived from the anti-image matrices, above the nominal cut-off point of 0.5. The first construct was composed of variables indicating the relational benefits of the upstream dyad, while the second one embraced the variables of the relational benefits of the downstream dyad. Similarly, the PCA conducted in the space of variables manifesting the supply chain performance produced a one-factorial solution with loadings exceeding 0.6, individual sampling adequacy above 0.7, and a high value of total variance explained (82.9 percent).

The factor scores for network governance, obtained from the PCA, were applied in the second step of the analysis as clustering criteria to split the sample. At first, to determine the number of clusters, hierarchical cluster analysis with Ward's partitioning method and squared Euclidean distance were performed. The Ward's method attempted to minimise the sum of squares of any hypothetical clusters, which can be formed at each step. To determine the optimal number of groups, we used a dendrogram to display dissimilarity levels between clusters. The heights of the links represent the distance, at which each fusion was made, such that a greater dissimilarity between the objects indicated a greater distance between them and a taller link (Montalbano and Nenci, 2014). The optimal number of groups was derived by comparing the coefficients in the agglomeration schedule, Fig. 3, recommended as one of stopping rules (Everitt et al., 2001). As depicted in Fig. 3, the highest difference between the coefficients can be observed when two clusters are derived; however, as we intended to conduct a more in-depth analysis, a higher number of clusters was required. Ultimately, as a result of hierarchical cluster analysis for further investigation, we decided to apply three clusters, as this solution indicates the second-highest difference in the values of coefficients.

Tab. 1. Rotated Component Matrices (left for the upstream dyad, right for the downstream dyad)

	Component			
	HUD1	HUD2	MUD	CUD
MUD_1			0.896	
MUD_2			0.715	
MUD_4			0.805	
MUD_5	0.870			
HUD_1	0.856			
HUD_2	0.790			
HUD_3	0.774			
HUD_4		0.716		
HUD_5		0.827		
HUD_6		0.867		
CUD_1		0.791		
CUD_2				0.781
CUD_3				0.819

	Component			
	M-C_DD	HDD1	HDD2	MDD
MDD_1				0.895
MDD_2	0.778			
MDD_3	0.756			
MDD_4	0.842			
MDD_5		0.802		
HDD_1		0.853		
HDD_2		0.910		
HDD_3		0.611		
HDD_4			0.856	
HDD_5			0.848	
HDD_6			0.849	
CDD_1	0.749			
CDD_2	0.659			
CDD_3	0.891			
CDD_4	0.930			

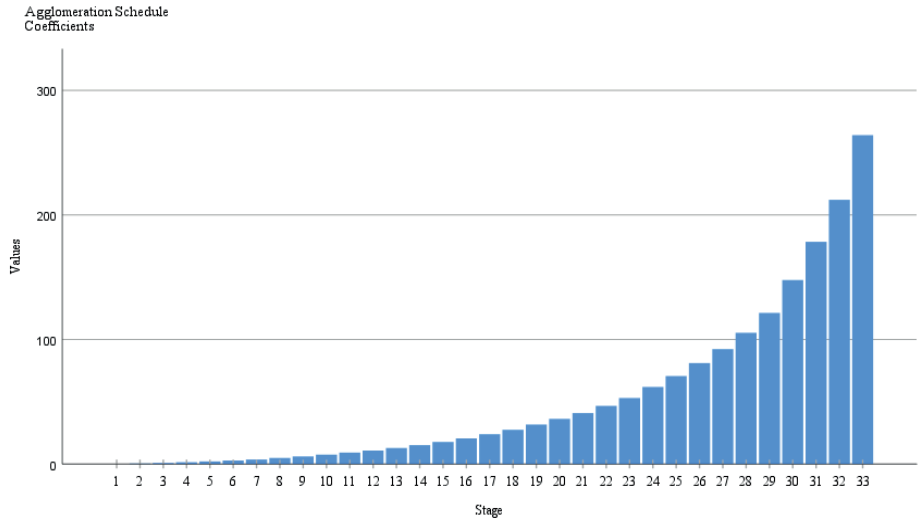

Fig. 3. Agglomeration schedule coefficients

Three clusters were used to carry out K-means cluster analysis to assign each case to the appropriate cluster. The criterion of the cluster membership was the minimal Euclidean distance between each case and the classification centre represented by a centroid (cluster centre). To additionally validate the obtained results of clustering, the outcome of K-means cluster analysis was compared with the class assignment obtained from the hierarchical cluster analysis. Based on the results of two partition methods, the contingency table was constructed, and the Rand index was calculated (Tab. 2).

The measure of agreement showed that 74.8 percent pairs of objects are placed in the same class. It means a high level of agreement and confirms the correct choice of K-means cluster analysis as the leading clustering method (Krieger and Green, 1999). The obtained clusters contain a diverse share of the research sample. Cluster 1 includes 26 percent of the sample; cluster 2 consists of roughly 56 percent, while cluster 3 covers 18 percent of the sample.

3. Research results and discussion

As demonstrated by the study, it is difficult to unequivocally reveal pure mechanisms of governance, undistorted by the influence of other distinct modes. For instance, the same two variables, typical for market governance (Market_5) belong to hierarchical governance in both upstream and downstream dyads. It may partially stem from the fact that this variable ("my company keeps reminding our partner that it can be easily replaced if it does not offer good deals"), can be either successfully qualified as the indicator of hierarchy. Likewise, in the case of governance applied in the upstream dyad, one variable typical for clans was included in the hierarchical mode of governance. The obtained finding extends the study of Bradach and Eccles (1991) who alluded that the constructs of market, hierarchy and social capital are not sole ideal types; quite the contrary,

Tab. 2. Contingency table

		K-means Cluster Analysis			Total
	Clusters	1	2	3	
Hierarchical Cluster Analysis	1	11	12	0	23
	2	0	5	2	7
	3	0	0	4	4
Total		11	17	6	34

Tab. 3. Kruskal-Wallis H Test for the network governance constructs in three clusters

	HUD1	HUD2	MUD	CUD	M-C_DD	HDD1	HDD2	MDD
Kruskal-Wallis H	6.490	15.305	14.183	5.368	10.805	2.965	8.185	17.475
df	2	2	2	2	2	2	2	2
Asymp. Sig.	0.039	0.000	0.001	0.068	0.005	0.227	0.017	0.000

they are intertwined and combined in various ways. Also, it is worth noting that the modes of governance tend to overlap across the dyads. Most often, there are at least two of them combined in each dyad. This finding is also confirmed by Lowndes and Skelcher (1998) who argued that in reality, a set of organisational arrangements is often associated with a variety of governance modes. At times, they might be similar in the triadic supply chains because the manufacturer, as a focal company, can transfer some experiences derived from one dyad (e.g. upstream) into another dyad (e.g. downstream). To determine statistically significant differences in the latent variable scores between the three group, the Kruskal Wallis H test was used. It allowed to compare the governance mechanisms across three clusters and validate their significance (Tab. 3).

As depicted in Tab. 3, two out of eight constructs (i.e. CUD and HDD1) turned out to be insignificant at $p < 0.05$. Consequently, we eliminated these two constructs from further analysis. Fig. 4 depicts the final cluster centres obtained from the network governance constructs. The remaining set of six constructs of governance mechanisms in the upstream and downstream dyads significantly differentiate three clusters. In the light of the obtained findings, we argue that in the case of the investigated supply chains, the hierarchical mode of governance prevails in both dyads. Specifically, two constructs of hierarchy were extracted in both dyads, while clan, if extracted as a sole construct, is insignificant or combined with the market mechanism. This clearly shows that control and hierarchy still dominate in shaping the relationships in the examined organisations. The obtained clusters can be then characterized in terms of the intensity of the modes of governance. In clusters 1 and 3, one may observe a significant difference between the modes of governance demonstrated in both upstream and downstream dyads. More specifically, cluster 1 indicates a moderate level of hierarchy and market in the upstream dyad and a strong market level in the downstream dyad. On the other hand, cluster 3 demonstrates a strong hierarchy and market in the upstream dyad and a strong hierarchy, market and a clan in the upstream dyad.

Cluster 2 highlights a moderate level of hierarchy in both dyads. Consequently, we consider the triadic supply chains in cluster 1 to particularly run market governance, the supply chain in cluster 2 to apply low hierarchy governance, and, finally, the organisations in cluster 3 to use network governance, due to the presence of all three modes of governance. In light of

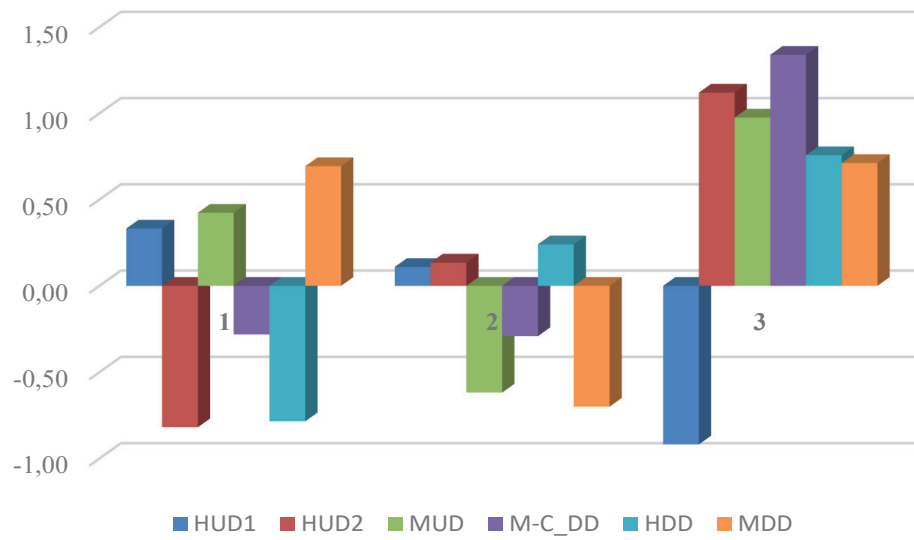

Fig. 4. Characteristics of clusters regarding the intensity of network governance

the above, the study lends support to H1 by showing that the triadic supply chains significantly differentiate in terms of the modes of governance at $p < 0.05$. Further on, we tested whether the investigated supply chains with network governance gained higher supply chain performance. First, we conducted the Mann-Whitney U tests to make necessary comparisons across three clusters in terms of relational benefits yielded by each dyad (Tab. 4).

Tab. 4 shows that the cluster of supply chains running market governance and low hierarchical governance do not significantly differentiate in terms of relational benefits, yielded both in the upstream and downstream dyads. Interestingly, the third cluster of supply chains that applies network governance demonstrates significant differences (at $p < 0.01$) as compared to the remaining two groups. Specifically, the triadic supply chains with network governance produced significantly higher mean ranks of 13.67 and 14.00 as compared to the group applying market governance in the upstream and downstream dyads, respectively. Similarly, a comparison between two clusters — one gathering the supply chains with network governance and the other one including the organisations running low hierarchical governance — demonstrates that the first class indicates more positive attitude towards relational benefits (mean ranks of 18.83 and 19.17 in the upstream and downstream dyads, respectively) as compared to the latter group (Tab. 5).

Consequently, incorporating clan as a social mechanism of governance with the market and hierarchical coordination systems results in increasing the relational benefits for both dyads in the triadic supply chains. In this vein, our study complements the findings of Capaldo (2014) who investigated the extent of knowledge benefits produced by the network governance mechanism. Finally, together with the relational benefits yielded in dyads, we also tested whether the clusters of triadic supply chains significantly differentiated in reference to the overall supply-chain performance. In general, the results of Kruskal-Wallis test statistics showed that the value of supply chain performance significantly differentiated all three clusters (at $p < 0.01$, Tab. 6).

More notably, an in-depth comparison of each pair of two clusters was obtained using the Mann-Whitney U tests. The results showed that the cluster applying market governance as well as the group implementing low hierarchical governance did not significantly differentiate in terms of the supply-chain performance (at $p < 0.05$, Tab. 7).

Nonetheless, the third cluster, gathering the triadic supply chains with network governance, significantly differs from two other groups: at the significance level $p < 0.003$ for the group running market governance and at $p < 0.002$ for the class with low hierarchical governance. As depicted in Tab. 8, the study demonstrates higher ranks of 13.83 and 19.33 for the performance in supply chains with net-

Tab. 4. Mann-Whitney U test statistics for clusters

Cluster		Relational benefits in the upstream dyad	Relational benefits in the downstream dyad
Market governance - Low hierarchical governance	Mann-Whitney U	80.000	67.000
	Wilcoxon W	146.000	133.000
	Z	-0.635	-1.247
	Asymp. Sig. (2-tailed)	0.525	0.212
Market governance - Network governance	Mann-Whitney U	5.000	3.000
	Wilcoxon W	71.000	69.000
	Z	-2.814	-3.017
	Asymp. Sig. (2-tailed)	0.005	0.003
Low hierarchical governance - Network governance	Mann-Whitney U	10.000	8.000
	Wilcoxon W	163.000	161.000
	Z	-2.871	-3.011
	Asymp. Sig. (2-tailed)	0.004	0.003

Tab. 5. Mann-Whitney U test ranks for clusters

Cluster		N	Mean Rank	Sum of Ranks
Relational benefits in the upstream dyad	Market governance	11	13.27	146.00
	Low hierarchical governance	17	15.29	260.00
	Total	28		
Relational benefits in the downstream dyad	Market governance	11	12.09	133.00
	Low hierarchical governance	17	16.06	273.00
	Total	28		
Relational benefits in the upstream dyad	Market governance	11	6.45	71.00
	Network governance	6	13.67	82.00
	Total	17		
Relational benefits in the downstream dyad	Market governance	11	6.27	69.00
	Network governance	6	14.00	84.00
	Total	17		
Relational benefits in the upstream dyad	Low hierarchical governance	17	9.59	163.00
	Network governance	6	18.83	113.00
	Total	23		
Relational benefits in the downstream dyad	Low hierarchical governance	17	9.47	161.00
	Network governance	6	19.17	115.00
	Total	23		

Tab. 6. Kruskal-Wallis Test Statistics for three clusters

	Supply Chain Performance
Kruskal-Wallis H	11.203
df	2
Asymp. Sig.	0.004

	Cluster	N	Mean Rank
Supply Chain Performance	Market governance	11	16.18
	Low hierarchical governance	17	14.06
	Network governance	6	29.67
	Total	34	

Tab. 7. Mann-Whitney U test statistics for clusters

Cluster		Supply Chain Performance
Market governance - Low hierarchical governance	Mann-Whitney U	79.000
	Wilcoxon W	232.000
	Z	-0.683
	Asymp. Sig. (2-tailed)	0.494
Market governance - Network governance	Mann-Whitney U	4.000
	Wilcoxon W	70.000
	Z	-2.922
	Asymp. Sig. (2-tailed)	0.003
Low hierarchical governance - Network governance	Mann-Whitney U	7.000
	Wilcoxon W	160.000
	Z	-3.081
	Asymp. Sig. (2-tailed)	0.002

Tab. 8. Mann-Whitney U test ranks for clusters

Cluster		N	Mean Rank	Sum of Ranks
Supply Chain Performance	Market governance	11	15.82	174.00
	Low hierarchical governance	17	13.65	232.00
	Total	28		
	Market governance	11	6.36	70.00
	Network governance	6	13.83	83.00
	Total	17		
	Low hierarchical governance	17	9.41	160.00
	Network governance	6	19.33	116.00
	Total	23		

work governance, as compared to the clusters running market governance and low hierarchical governance, respectively. This may suggest that significantly higher performance is produced in the triadic supply chains running network governance. In light of the above, the obtained findings lend support to H2. In line with the results, the triadic supply chains, which follow network governance, consider the supply chain performance to be significantly higher in comparison to the supply chains that do not run this type of governance mechanism.

Conclusions

This study firstly aimed to test whether the triadic supply chains significantly differentiated in terms of the modes of governance. The analysis of the relationship between network governance and the supply chain performance produced especially interesting outcomes. Specifically, we conclude that it is difficult to unequivocally reveal the pure mechanisms of governance, undistorted by the influence of other distinct modes. Consequently, the examined modes of governance tend to overlap across the dyads. Most often, as demonstrated in our study, there are at least two of them combined in each dyad. Regarding the specific content of governance mechanisms, we argue that in the case of the investigated supply chains, the hierarchical mode of governance prevails over the remaining two in both dyads. Likewise, we also posit that the mechanisms of governance might be similar across both dyads in the triadic supply chains, as the manufacturer, being the focal company, can transfer some experiences derived from one dyad (e.g. upstream) to another dyad (e.g. downstream).

Secondly, we sought to examine whether the triadic supply chains that followed network governance considered their supply chain performance to be significantly higher in comparison to the supply chains that did not run this type of governance mechanism. As depicted in our research, incorporating a clan as a social mechanism of governance with the market and hierarchical coordination systems resulted in increasing the relational benefits for both dyads in the triadic supply chains. The obtained findings also showed that together with the relational benefits yielded in dyads, the clusters of triadic supply chains significantly differentiated in reference to the overall supply chain performance. More specifically, we concluded that significantly higher performance was yielded in the triadic supply chains running network governance. In other words, the triadic supply chains, which apply network governance, consider their supply chain performance to be significantly higher in comparison to the supply chains that do not run this type of governance mechanism.

The findings obtained in the study contribute to the theory and practice of supply-chain management. Firstly, the research showed that it is difficult to unequivocally reveal the pure mechanisms of governance, undistorted by the influence of other distinct modes in the triadic supply chains. On the contrary, they are more or less influenced by the other modes of governance distinguished in the literature. Likewise, it is also important to highlight that the mechanism of governance is inseparably bound with the certain dyadic relationship established between two actors in the wider structure of supply chains. Consequently, in the triadic structure of supply chains, composed of two dyads, one may distinguish two relatively distinct modes of governance, while one sole mechanism of governance that dominates over

the others cannot be distinguished. Quite the opposite, at times, in case of triadic supply chains, the mechanisms can become similar, as they are usually orchestrated by the same focal company, in our study, the manufacturer. Nevertheless, among all three modes of governance, hierarchy seems to play the most important role in coordinating the supply chain activities. Understandably, the study showed that incorporating a clan as a social mechanism of governance, together with market and hierarchical, results in increasing the relational benefits for both dyads in the triadic supply chains. Our research also found that higher performance can be obtained in the triadic supply chains that run network governance as compared to other modes of governance.

Acknowledgments

The study was financed by the National Science Centre, Poland as a research project no. 2015/18/M/HS4/00388.

Literature

Ahi, P., & Searcy, C. (2013). A comparative literature analysis of definitions for green and sustainable supply chain management. *Journal of Cleaner Production*, *52*(15), 329-341. doi: 10.1016/j.jclepro.2013.02.018

Ashenbaum, B., Maltz, A., Ellram, L., & Barratt, M. A. (2009). Organizational alignment and supply chain governance structure. *International Journal of Logistics Management*, *20*(2), 169-186. doi: 10.1108/09574090910981279

Baker, W. E. (1990). Market Networks and Corporate Behavior. *American Journal of Sociology*, *96*(3), 589-625. doi: 2781065

Bowersox, D. J., Closs, D. J., & Stank, T. P. (2003). How to master cross-enterprise collaboration. *Supply Chain Management Review*, *91*(1), 18-27.

Bradach, J. (1997). Using the Plural Form in the Management of Restaurants Chains. *Administrative Science Quarterly*, *42*, 276-303. doi: 10.2307/2393921

Cannon, J. P., Achrol, R. S., & Gundlach, G. T. (2000). Contracts, Norms, and Plural Form Governance. *Academy of Marketing Science Journal*, *28*(2), 180-194. doi: 10.1177/0092070300282001

Capaldo, A. (2014). Network Governance: A Cross-Level Study of Social Mechanisms, Knowledge Benefits, and Strategic Outcomes in Joint-Design Alliances. *Industrial Marketing Management*, *43*(4), 685-703. doi: 10.1016/j.indmarman.2014.02.002

Cardoso de Oliveira, M. C., Cardoso Machado, M., Chiappetta Jabbour, Ch. J., & Lopes de Sousa Jabbour, A. B. (2019). Paving the way for the circular economy and more sustainable supply chains: Shedding light on formal and informal governance instruments used to induce green networks. *Management of Environmental Quality: An International Journal*. doi: 10.1108/MEQ-01-2019-0005 (forthcoming)

Carter, C. R., Kosmol, T., & Kaufmann, L. (2017). Toward a Supply Chain Practice View. *Journal of Supply Chain Management*, *53*(1), 114-122. doi: 10.1111/jscm.12130

Choi, T. Y., & Hong, Y. (2002). Unveiling the structure of supply networks: case studies in Honda, Acura, and DaimlerChrysler. *Journal of Operations Management*, *20*(5), 469-493. doi: 10.1016/S0272-6963(02)00025-6

Choi, T. Y., & Wu, Z. (2009). Taking the leap from dyads to triads: Buyer-supplier relationships in supply networks. *Journal of Purchasing and Supply Management*, *15*(4), 263-266. doi: 10.1016/j.pursup.2009.08.003

Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology*, *94*, 95-120. doi: 10.1086/228943

Colotla, I., Shi, Y., & Gregory, M. J. (2003). Operation and performance of international manufacturing networks. *International Journal of Operations & Production Management*, *23*(10), 1184-1206. doi: 10.1108/01443570310496625

Czakon, W. (2008). Koordynacja sieci – wieloraka forma organizacji [Network Governance as a Plural Form of Coordination]. *Przegląd Organizacji*, *9*, 7-10.

Czakon, W. (2012). *Sieci w zarządzaniu strategicznym* [*Networks in the Strategic Management*]. Warszawa, Poland: Wolter & Kluwer.

Dooley, L., & Gubbins, C. (2019). Inter-organisational knowledge networks: synthesising dialectic tensions of university-industry knowledge discovery. *Journal of Knowledge Management*. doi: 10.1108/JKM-06-2018-0343 (forthcoming)

Dorsey, J. D. (2014). Agency theory and alcohol distribution: A framework for public policy discourse. *Journal of Marketing Development and Competitiveness, 8*(3), 59-69.

Dubois, A., & Fredriksson, P. (2008). Cooperating and competing in supply networks: making sense of a triadic sourcing strategy. *Journal of Purchasing and Supply Management*, *14*, 170-179. doi:10.1016/j.pursup.2008.05.002

Dyer, J., & Nobeoka, K. (2000). Creating and managing a high-performance knowledge sharing network: the Toyota case. *Strategic Management Journal*, *21*(3), 345-367. doi:10.1002/(SICI)1097-0266(200003)

Dyer, J., & Singh, H. (1998). The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage. *Academy of Management Review*, *24*(4), 660-679. doi: 10.2307/259056

Eccles, R. G., Nohria, N., & Berkley, J. D. (1992). *Beyond the Hype: Rediscovering the Essence of Management*. Boston, United States: Harvard Business School Press.

Everitt, B. S., Landau, S., Leese, M., & Stahl, D. (2011). *Cluster Analysis*. 5th ed. Chichester, Great Britain: Wiley.

Frohlich, M. T., & Westbrook, R. (2001). Arcs of Integration: an International Study of Supply Chain Strategies. *Journal of Operations Management*, *19*(2), 185-200. doi: 10.1016/S0272-6963(00)00055-3

Gligor, D. M., & Holcomb, M. C. (2012). Understanding the Role of Logistics Capabilities in Achieving Supply Chain Agility: A Comprehensive Literature Review. *Supply Chain Management: An International Journal*, *17*(4), pp. 438-453. doi: 10.1108/13598541211246594

Grandori, A., & Soda, G. (1995). Inter-firm networks: antecedents, mechanisms and forms. *Organization Studies*, *16*(2), 183-214. doi: 10.1177/017084069501600201

Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *American Journal of Sociology*, *91*(3), 481-510. doi: 10.1086/228311

Granovetter, M. (1992). *Problems of explanation in economic sociology*. In: Nohria, N., & Eccles, R. G. (Eds.), Networks and organizations: Structure, form, and action, Boston, United States: Harvard Business School Press.

Grant, R. M. (1996). Towards a knowledge-based theory of the firm, *Strategic Management Journal*, *17*(2), 109-122.

Heide, J. B. (1994). Interorganizational Governance in Marketing Channels. *Journal of Marketing*, *58*(1), 71-85. doi: 10.2307/1252252

Jones, C., Hesterly, W. S., & Borgatti, S. P. (1997). A General Theory of Network Governance: Exchange Conditions And Social Mechanisms. *Academy of Management Review*, *22*(4), 911-945. doi: 10.2307/259249

Jones, C., Hesterly, W., & Borgatti, S. (1997). A General Theory of Network Governance: Exchange Conditions and Social Mechanisms, *Academy of Management Review*, *22*(4), 911-945. doi: 10.2307/259249

Joshi, A. W.,& Campbell, A. J. (2003). Effect of Environmental Dynamism on Relational Governance in Manufacturer-Supplier Relationships: A Contingent Framework and an Empirical Test. *Academy of Marketing Science Journal*, *31*(2), 176-188. doi:10.1177/0092070302250901

Kannan, V. R., & Tan, K. Ch. (2010). Supply chain integration: cluster analysis of the impact of span of integration. *Supply Chain Management: An International Journal*, *15*(3), 207-215. doi: 10.1108/13598541011039965

Ketchen, D., & Shook, C. (1996). The application of cluster analysis in strategic management research: an analysis and critique. *Strategic Management Journal*, *17*(6), 441-458. doi: 10.1002/(SICI)1097-0266(199606)

Kim, Y., Choi, T. (2015). Deep, Sticky, Transient, and Gracious: An Expanded Buyer-Supplier Relationship Typology. *Journal of Supply Chain Management*, *51*(3), 61-86. doi: 10.1111/jscm.12081

Kline, P. (1994). *An Easy Guide to Factor Analysis*. Padstow, Great Britain: TJ Press.

Krieger, A. M., & Green, P. E. (1999). A generalized rand-index method for consensus clustering of separate partitions of the same data base. *Journal of Classification*, *16*(1), 63-89. doi: 10.1007/s003579900043

Lamming, R., Johnsen, T., Zheng, J., & Harland, C. (2000). An initial classification of supply networks. *International Journal of Operations & Production Management*, *20*(6), 675-691. doi: 10.1108/01443570010321667

Liu, Y., Luo, Y., & Liu, T. (2009). Governing buyer – supplier relationships through transactional and relational mechanisms: evidence from China. *Journal of Operations Management*, *27*(4), 294-309. doi: 10.1016/j.jom.2008.09.004

Lowndes, V., & Skelcher, C. (1998). The Dynamics of Multi-organizational Partnerships: An Analysis of Changing Modes of Governance. *Public Administration*, *76*(2), 313-333. doi: 10.1111/1467-9299.00103

Lund, D. B. (2003). Organizational culture and job satisfaction. *Journal of Business & Industrial Marketing*, *18*(2/3), 219-236. doi: 10.1108/0885862031047313

Mesquita, L. F., Anand, J., & Brush, T. H. (2008). Comparing the resource-based and relational views: knowledge transfer and spillover in vertical alliances. *Strategic Management Journal*, *29*, 913-941. doi: 10.1002/smj.699

Mirkovski, K., Lowry, P. B., & Feng, B. (2016). Factors that influence interorganizational use of information and communications technology in relationship-based supply chains: evidence from the Macedonian and American wine industries. *Supply Chain Management: An International Journal*, *21*(3), 334-351. doi: 10.1108/SCM-08-2015-0343

Montalbano, P., & Nenci, S. (2014). The Trade Competitiveness of Southern Emerging Economies: A Multidimensional Approach Through Cluster Analysis. *World Economy*, *37*(6), 783-810. doi: 10.1111/twec.12195

Noordewier, T. G., John, G., & Nevin, J. R. (1990). Performance outcomes of purchasing arrangements in industrial buyer-vendor relationships. *Journal of Marketing*, *54*(4), 80-93. doi: 10.2307/1251761

O'Leary-Kelly, S. W. O., & Flores, B. E. (2002). The integration of manufacturing and marketing/sales decisions: impact on organizational performance. *Journal of Operations Management*, *20*(3), 221-240. doi: 10.1016/S0272-6963(02)00005-0

Pilbeam, C., Alvarez, G., & Wilson, H. (2012). The governance of supply networks: a systematic literature review. *Supply Chain Management: An International Journal*, *17*(4), 358-376. doi: 10.1108/13598541211246512

Powell, W. (1991). *Neither market nor hierarchy: network forms of organization*. In: Thompson, G., Frances, J., Levacic, R., Mitchell, J. (Eds.), Markets, hierarchies and networks: the co-ordination of social life. London, Great Britain: Sage.

Powell, W. W. (1990). Neither market nor hierarchy: Network forms of organization. In: Staw, B. M., & Cummings, L. L. (Eds.), *Research in Organizational Behavior* (pp. 295-336). Greenwich, Great Britain: JAI Press.

Provan, K. G., & Kenis, P. (2007). Modes of Network Governance: Structure, Management, and Effectiveness. *Journal of Public Administration Research and Theory*, *18*(2), 229-252. doi: 10.1093/jopart/mum015

Salas, E., Reyes, D., & Woods, A. (2015). *The assessment of team performance: Observations and needs*. In: von Davier, A. A., Kyllonen, P. C., & Zhu, M. (Eds.), *Innovative Assessment of Collaboration* (pp. 21-36). Springer International Publishing Switzerland.

Sambasivan, M., & Ching, N. Y. (2010). Strategic alliances in a manufacturing supply chain: Influence of organizational culture from the manufacturer's perspective. *International Journal of Physical Distribution & Logistics Management*, *40*(6), 456-474. doi: 10.1108/09600031011062191

Tachizawa, E. M., & Wong, C. Y. (2015). The performance of green supply chain management governance mechanisms: a supply network and complexity per-

spective. *Journal of Supply Chain Management*, *51*(3), 18-32. doi: 10.1111/jscm.12072

Thompson, G., Frances, J., Levačić, S., & Mitchell, J. (Eds.), *Markets, hierarchies and networks: The coordination of social life*. London, Great Britain: Sage.

Thorelli, H. B. (1986). Networks: Between markets and hierarchies. *Strategic Management Journal*, *7*(1), 37-51. doi: 10.1002/smj.4250070105

Uzzi, B. (1996). The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect. *American Sociological Review*, *61*(4), 674-698. doi: 10.2307/2096399

Wang, C. X. (2002). A general framework of supply chain contract models. *Supply Chain Management: An International Journal*, *7*(5), 302-310. doi: 10.1108/13598540210447746

Wasserman, S., & Faust, K. (1994). *Social Network Analysis: Methods and Applications*. Cambridge, Great Britain: Cambridge University Press.

Whipple, J. M., Wiedmer, R., & Boyer, K. K. (2015). A Dyadic Investigation of Collaborative Competence, Social Capital, and Performance in Buyer – Supplier Relationships. *Journal of Supply Chain Management*, *51*, 3-21. doi: 10.1111/jscm.12071

Wilhelm, M. M. (2011). Managing coopetition through horizontal supply chain relations: Linking dyadic and network levels of analysis. *Journal of Operations Management*, *29*(7-8), 663-676. doi: 10.1016/j.jom.2011.03.003

Williamson, O. E. (1985). *The Economic Institutions of Capitalism*, New York, United States: Free Press.

Wu, Z., Choi, T. Y., & Rungtusanatham, M. J. (2010). Supplier-supplier relationships in buyer-supplier-supplier triads: Implications for supplier performance. *Journal of Operations Management*, *28*(2), 115-123. doi: 10.1016/j.jom.2009.09.002

Yeoman, R., & Mueller Santos, M. (2019). A complex systems model for transformative supply chains in emerging markets. *International Journal of Emerging Markets*. doi: 10.1108/IJOEM-02-2017-0044 (forthcoming)

Zacharia, Z. G., Nix, N. W., & Lusch, R. F. (2009). An analysis of supply chain collaborations and their effect on performance outcomes. *Journal of Business Logistics*, *30*(2), 101-123. doi: 10.1002/j.2158-1592.2009.tb00114

APPENDIX A. An Excerpt of the Questionnaire

Categories	No.	Abbreviation	Question
Please rate the relational performance of a dyad with reference to company B in each of the following areas: (1—'strongly disagree', 3—'neutral', 5—'strongly agree')			
1. Relational benefits of upstream / downstream	1.1.	RB_UD_1/ RB_DD_1	Two companies are more profitable or more competitive together than they would have been alone
	1.2.	RB_UD_2/ RB_DD_2	The benefits derived from the combination must be greater than the capabilities of each individual
	1.3.	RB_UD_3/ RB_DD_3	Working with B has allowed overcoming some problems, and thus derive substantial benefits for the dyad
	1.4.	RB_UD_4/ RB_DD_4	Sharing opinion and discussion with B often lead to increased benefits for both actors of the dyad
	1.5.	RB_UD_5/ RB_DD_5	The ongoing costs of coordination of a dyadic relationship are balanced by its benefits
Please rate your customer-focused performance to measure customer satisfaction in each of the following areas: (1—'strongly disagree', 3—'neutral', 5—'strongly agree')			
2. Supply chain performance	2.1.	SP_1	The customers are satisfied with the product quality
	2.2.	SP_2	The customers are satisfied with the product conformance to the market expectations
	2.3.	SP_3	The customers are satisfied with the product volume/variety/flexibility
	2.4.	SP_4	The customers are satisfied with manufacturing efficiency
	2.5.	SP_5	The customers are satisfied with the product development cycle time
	2.6.	SP_6	The customers are satisfied with the response to changes in manufacturing
Please rate mechanisms of network governance with reference to company B in the following areas: (1—'strongly disagree', 3—'neutral', 5—'strongly agree')			
3. Market	3.1.	MUD_1/MDD_1	The price is a predominant factor that determines my collaboration with B
	3.2.	MUD_2/MDD_2	My company is very active in searching for new partners who can potentially substitute B
	3.3.	MUD_3/MDD_3	My company can easily switch to another partner, dropping out of the collaboration with B
	3.4.	MUD_4/MDD_4	The goods delivered by my company to B can be easily delivered by my competitors
	3.5.	MUD_5/MDD_5	My company keeps reminding our partner that it can be easily replaced if it does not offer good deals
4. Hierarchy	4.1.	HUD_1/HDD_1	My company very actively interferes in the operations performed by B
	4.2.	HUD_2/HDD_2	My company controls B using certain formal methods
	4.3.	HUD_3/HDD_3	My company would be exposed to high costs when switching from B
	4.4.	HUD_4/HDD_4	My company provides B with formal guidelines concerning how to solve problems and/or deal with disruptions
	4.5.	HUD_5/HDD_5	My company resolves ongoing disputes with B by referring to clauses in signed contracts
	4.6.	HUD_6/HDD_6	My company tends to closely monitor opportunistic behaviours of partner B, such as ignorance of responsibilities, price inflation, late deliveries and partial information disclosure
5. Clan	5.1.	CUD_1/CDD_1	My company strives to build trust and a sense of community by organising meetings and training to encourage B to be empathic and have a mutual understanding
	5.2.	CUD_2/CDD_2	My company maintains a discussion with B concerning all relevant issues of its operations and strategy
	5.3.	CUD_3/CDD_3	My company keeps trying to develop trust with B
	5.4.	CUD_4/CDD_4	Disruptions in collaboration with B are productively resolved in the spirit of mutual understanding