Strategic management

International Journal of Strategic Management and Decision Support Systems in Strategic Management

Vol. 24, No. 2
2019
ISSN 2334-6191 (Online)
UDC 005.21
University of Novi Sad
Faculty of Economics in Subotica

Strategic Management

International Journal of Strategic Management and
Decision Support Systems in Strategic Management

www.smjournal.rs

Publisher University of Novi Sad, Faculty of Economics in Subotica
Segedinski put 9-11, 24000 Subotica, Serbia
Tel: +381 24 628 000
Fax: +381 546 486
http://www.ef.uns.ac.rs

For Publisher Aleksandar Grubor, *University of Novi Sad, Faculty of Economics in Subotica, Serbia*

Editor-in-Chief Aleksandar Grubor, *University of Novi Sad, Faculty of Economics in Subotica, Serbia*

Proofreading Željko Buljovčić

Prepress Aleksandar Vugdelija

Print Sitoprint Žitište, Serbia

Circulation 150

The Journal is published quarterly.

Strategic Management

International Journal of Strategic Management and
Decision Support Systems in Strategic Management

ISSN 1821-3448, UDC 005.21

Strategic Management is a quarterly journal addressing issues concerned with all aspects of strategic management. It is devoted to the improvement and further development of the theory and practice of strategic management and it is designed to appeal to both practicing managers and academics. Specially, Journal publishes original refereed material in decision support systems in strategic management.

Thematic Fields

- Mission and Philosophy of the Organization
- Culture and Climate of the Organization
- Effectiveness and Efficiency of the Organization
- Structure and Form of the Organization
- Strategic Analysis
- Aims and Strategies
- Process of Strategic Management
- Characteristics of Strategic Management in the New Economy
- Contemporary Ontological, Epistemological and Axiological Suppositions on the Organization and its Environment
- Analysis of the Organization and its Interaction with the Environment
- Structure and Dynamics of the Organizational Environment
- Uncertainty and Indistinctiveness of the Organizational Environment
- Synchronic and Diachronic Analysis of the Organizational Environment
- Analysis Techniques of the Organization
- Business Processes, Learning and Development within the Context of Strategic Management
- Evaluation and Measuring of the Potential and Realization of the Organization within the Context of Strategic Management
- Strategic Control in Contemporary Management
- Information Technologies in Strategic Management
- Business Intelligence and Strategic Management
- Decision Support Systems and Artificial Intelligence in Strategic Management

All scientific articles submitted for publication in Journal are double-blind reviewed by at least two academics appointed by the Editor's Board: one from the Editorial Board and one independent scientist of the language of origin - English. Reviewers stay anonymous. Authors will timely receive written notification of acceptance, remarks, comments and evaluation of their articles.

Strategic Management

International Journal of Strategic Management and
Decision Support Systems in Strategic Management

www.smjournal.rs

ISSN 1821-3448
UDC 005.21
2019, Vol. 24, No. 2

Contents

STRATEGIC MANAGEMENT, Vol. 24 (2019), No. 2, pp. 003-011

DOI: 10.5937/StraMan1902003V

Received: November 04, 2018
Accepted: January 31, 2019

Brick-and-Mortar Retailers: Becoming Smarter with Innovative Technologies

Katija Vojvodić
University of Dubrovnik, Department of Economics and Business Economics, Dubrovnik, Croatia

Abstract
Nowadays, advanced interactive in-store technologies provide brick-and-mortar retailers with a wide range of opportunities to interact with customers. Based on a comprehensive review of the academic and practitioner literature, the purpose of this paper is to advance understanding of smart, innovative technologies in brick-and-mortar retail settings, and to determine a framework for further analysis. In addition, a pilot survey was conducted to gain better understanding of self-service technology from the perspective of food retailers. Despite the perceived diminishing role, brick-and-mortar retailers have the potential to be powerful players in the future of shopping. Apart from adapting to the latest technology, the key to retailers' success is introducing customers to the emerging technology within smart retail settings while encouraging their active digital engagement. Technological advancements help retailers gather various information on consumer behaviour, as well as their expectations, needs and preferences. By developing their technological capabilities, retailers will be able to create a unique in-store experience and make shopping in brick-and-mortar stores enjoyable.

Keywords
Brick-and-mortar retailers, innovative in-store technology, smart shopping, customer behaviour.

Introduction

In the present digital era, brick-and-mortar retailing is being challenged to become smarter and provide greater value to both consumers and retailers (Dacko, 2017). In particular, continual innovation and digitalization are critical when helping retailers' to create a sustainable competitive advantage (Inman & Nikolova, 2017) and capitalise on strategic opportunities (Kim, Lee, Mun, & Johnson, 2017). In this sense, Pantano, Priporas, & Dennis (2018) developed the idea of smart retailing, i.e. the emerging retail scenario based on the use of innovative technologies to improve retail service and to develop innovation management strategies. Furthermore, the use of technology-enriched retail services is of great importance to improve the overall retail service quality and to create a more personalised retail experience. Consequently, it also enhances the overall retailers' performance.

In addition, the rapid growth of digital technologies and ongoing transformation in retailing sector allow for augmenting the shopping experience (Willems, Smolders, Brengman, Luyten, & Schöning, 2017). In general, customer experience represents a means of differentiation and a challenging issue for retailers (Terblanche, 2018). In this sense, the use of radio frequency identification (RFID) technology and other smart in-store technology applications provide retailers with data on customer behaviour in real-time. However, customers often think that innovations serve primarily to the service providers to cut costs rather than to extend customer service levels (Nijssen, Schepers, & Belanche, 2016).

Based on an extensive review of the recent literature, this paper aims to advance understanding of innovative in-store technologies in retail settings, and to determine a framework for further analysis. Therefore, the paper is structured as follows. After the introduction, the first section deals with the smart shopping whereas the second section examines innovative

in-store technologies in the retail environment. The third section brings out the findings of the pilot survey on self-service technologies (SSTs) from the perspective of food retailers. The fourth section proposes a research agenda for further study in the context of smart innovative in-store technologies. Finally, in the last section some conclusions have been drawn upon.

1. Smart shopping

Nowadays, retail store operations face a variety of novel challenges and complexities (Shandong, Robb, & DeHoratius, 2018). It can be argued that many customer-facing Internet of Things technologies have become an integral part of the retail industry. These include smart shopping carts, augmented reality, interactive displays, smart mirror interactive technology (magic mirrors or memory mirrors), RFID tags, and smart kiosks (Balaji, Kumar Roy, Sengupta, & Chong, 2017). In the context of smart applications in the retail industry, Chaudhuri (2018) depicts smart fitting rooms, smart shelves, smart advertising using beacons, intelligent vending machines and store screening robots. In addition, Hilton, Hughes, Little, & Marandi (2013) examine self-service technology that replaces the customer-service employee experience with a customer-technology experience. This also raises many questions regarding the loss of jobs caused by technological change (Chessell, 2018; Nica, 2018; Grossman, 2018; Nica et al. 2018; Sorells, 2018). Generally, SSTs are mainly offered to reduce retailer costs and enhance customer's experience (Orel & Kara, 2014). Furthermore, Djelassi, Diallo, & Zielke (2018) found that technology experience is a driver of SST and store customers' satisfaction.

According to Hagberg, Sundstrom, & Egels-Zandén (2016), digitalization represents an ongoing transformation that is of great importance for the retail sector. Accordingly, they specify transformations associated with retailing exchanges, the nature of retail offerings, retail settings, and the actors who participate in retailing. With regard to retail innovation and the time choice for the innovation introduction, Pantano (2016) argues that the innovation success requires a deep understanding of risks and benefits of the process, as well as of the best moment for the introduction of innovation. In addition, Renko and Druzijanic (2014) highlight that innovative technology helps consumers make their shopping decisions. Moreover, technology and tools help consumers facilitate decision-making (Grewal, Roggeveen, & Nordfält, 2017). Furthermore, comfortable retail environments increase both utilitarian value and hedonic value (Ainsworth & Foster, 2017). Therefore, Kumar Roy, Balaji, Quazi, & Quaddus (2018) stress that retail stores should focus on smart technologies that are simple, yet offer enhanced customer value through improved shopping efficiency. Similarly, Kallweit, Spreer, & Toporowski (2014) stressed that retailers have to emphasize the service-related value of innovative technologies.

In recent years, a pleasure gather experience during the shopping activity has grown in importance in the context of brick-and-mortar shopping (Pantano & Naccarato, 2010). Smart shopping includes consumers seeking to minimize the expenditure of time, money, or energy to gain hedonic or utilitarian value from their experience (Atkins & Kim, 2012). Further, Kumar Roy, Balaji, Sadeque, Nguyen, & Melewar (2017) have outlined that smart customer experience directly enhances satisfaction and reduces perceived risk towards smart retail technologies. As argued by Inman & Nikolova (2017), new shopper-facing technologies affect shopper perceptions of the retailer and, consequently, mediate behavioural intentions.

2. Innovative in-store technologies

With the rapid advances in Internet technology, many retailers view Internet of Things as a potential basis for achieving sustainable competitive advantage and long-term profitability (Balaji et al., 2017). In the following, smart in-store technologies such as RFID-based smart fitting rooms, smart shelves, smart shopping carts, self-checkout systems, and technology-mediated realities will be discussed.

2.1. RFID-based smart fitting rooms

Generally, as regards benefits of the radio frequency identification (RFID) technology, Mehrjerdi (2011) emphasizes automation, transparency, asset management, velocity, insight, traceability, security, reliability, and capability. According to Haq and Farooq (2019), an augmented fitting room is an equivalent of in-store dressing room, which enables customers to try on clothes virtually instead of physically (p. 102). Wong, Leung, Guo, Zeng, & Mok (2014) emphasize that customers who use the fitting rooms want to determine whether different outfits suit them.

As soon as customer brings items into the fitting room, they are shown on the screen. While trying out the items, shopper does not need to exit the fitting room to collect another desired item. Instead, an alert is sent to the store attendant on their mobile device, who then brings the item (Chaudhuri, 2018). The RFID readers provide information on items taken into the fitting room and browsed through the interactive computer system (Choi, Cheung, Yang, & Yang, 2015). Later, such information is used to formulate appropriate and sustainable retailing strategies.

As stressed by Mukherjee, Smith, & Turri (2018), RFID-based smart fitting rooms increase and generate purchase activities only for high-quality brands, whereas they are ineffective for the low-quality brands. By identifying customer behaviour in real-time, it is possible to create a more personalised retail experience (Landmark & Sjøbakk, 2017).

2.2. Smart shelves

According to Gaukler & Seifert (2007), smart shelves are retail shelves that have RFID readers built-in, and their main purpose is to prevent out-of-stock situations from occurring at the shelf (p. 33). Similarly, Pradhan (2007) notes that this allows the store to restock inventory on demand and avoid lost sales due to empty shelves. Chaudhuri (2018) focuses on smart shelves with digital-camera sensors and analytics technology to track shoppers' behaviour towards products on shelves and to keep track of items on the shelves.

In addition, Sanghera et al. (2007) outline the following advantages of smart-shelf system: maintaining better efficiency in inventory management, notifying store personnel of misplaced items, and determining the sale potential of an item in a timely fashion (p. 143). On the other hand, they also indicate several disadvantages, e.g. rising costs due to the need of many readers and tags, interference of signals, and inability of readers to read all items in case of densely packaging stuff on a shelf.

2.3. Smart shopping carts

Smart shopping carts are shopping carts or trolleys attached with a tablet (Balaji et al., 2017, p. 32). In addition, Van Hove et al. (2018) stressed that they serve as an inspiration tool. Apart from saving time and making shopping easy, smart shopping carts can help in lessening work and in making a superior shopping knowledge for the customer (Karjol, Holla, & Abhilash, 2018). They can retrieve and store information in real-time, answer queries, and enable check out without waiting in the line. Moreover, smart shopping carts can track consumer pathways through the store and offer functional insights into their reactions to specific displays or promotions along the way (Raju, Zhang, Sorensen, DeHerder, & Blatt, 2011). In that context, Van Ittersum, Wansink, Pennings, & Sheehan (2013) analysed how real-time feedback can influence customer spending and they found out that smart shopping carts increase repatronage intentions for budget shoppers while keeping them stable for nonbudget shoppers. By guiding customers through the shopping process, smart shopping carts assist customers and make the overall shopping experience easier and more enjoyable.

2.4. Self-service checkouts

In the context of SSTs, self-checkout systems (SCS) are becoming increasingly popular, especially in the supermarket setting. Regarding ethical acceptability, self-service checkouts were found to be the most acceptable technology-based initiative (Fullerton, Brooksbank, & Neale, 2017). To increase retail patronage, it is very important to focus on improving self-service technology service quality (Lee & Yang, 2013). In case of a self-service failure, customers prefer the employee to correct the problem and let them complete the transaction (Collier, Breazeale, & White, 2017). In that sense, Wang, Harris, & Patterson (2012) highlight the importance of preventing frequent failures and providing speedy recovery in the SST context. Therefore, retailers should install a sufficient number of user-friendly self-checkouts with attentive employees to encourage usage and reduce the perceived risk and anxiety (Kazancoglu & Yarimoglu, 2018).

The study by Lee and Lyu (2016) reveals that only utilitarian attitudes have a significant effect on the intention to use self-service technologies. On the other hand, in a hedonic oriented self-service environment fun alone is a significant predictor of customer enjoyment (Collier & Barnes, 2015). Collier, Moore, Horky, & Moore (2015) found that during the SST transaction, four situational variables, i.e. order size, wait-time tolerance, location convenience, and employee presence had a strong influence in customers' SST decisions. Additionally, Bulmer, Elms, & Moore (2018) found that unwilling customers feel a sense

of social obligation to use self-service checkouts at times in order to help others.

In addition to previous usage behaviour, situational factors (time pressure, basket size, coupons and queue length at the SSTs and staffed checkouts) influence customers' decisions to use SSTs (Demoulin & Djelassi, 2016). Furthermore, SST usage intentions were positively correlated to retail patronage intentions (Lee, 2015). Study by Lee (2017) showed the inverse relationship between the need for interaction with a retail employee and the intentions to use SSTs. Further, Lee, Cho, Xu, & Fairhurst (2010) conclude that individual differences when using the retail self-checkouts can be attributed to consumer traits that are determined by some of the demographic factors. With regard to age, older consumers have shown less experience with fewer types of SSTs; they manifest less confidence when using SST, report missing human interaction to a greater degree, and they use self-checkout less often when the additional option is available (Dean, 2008).

2.5. Technology-mediated realities

Technology-mediated realities mainly refer to augmented reality (AR) and virtual reality (VR). However, the boundaries between these new realities have not been clarified yet (Flavian, Ibanez-Sanchez, & Orus, 2018). According to Martin (2018), augmented reality (AR) works by placing content produced on a computer alongside something that is real, i.e. it bridges the gap between the real world and the digital world. Although there are many types of AR display technologies, three major types include head mounted displays, handheld displays, and spatial displays (Bozkurt, 2018). Retailers use AR packaging, displays, and signage to engage customers as they shop in-store (Peddie, 2017). Poushneh & Vasquez-Parraga (2017) show that augmented reality significantly shapes user experience and as such subsequently influences user satisfaction and users' willingness to buy goods.

On the other hand, Vazquez & Kent (2017) note that virtual reality can be seen as a world portrayed through a three-dimensional computerised interface that mimics the environment of the real world (p. 188). In other words, the user is completely engaged in a virtual world (Toellner, 2014). The beneficial effects of VR are most marked in case of high perceived crowding (Van Kerrebroeck, Brengman, & Willems, 2017).

3. Self-service technology: a pilot survey

Based on the innovative in-store technologies what were depicted in the previous sections and previous research in the field, the main objective of this pilot survey was to gain better understanding of SSTs from the perspective of food retailers. Purposive sampling technique, i.e. expert sampling was used to recruit six retail managers. As argued by Etikan, Musa, & Alkassim (2016), expert sampling is a positive tool to use when investigating new areas of research, to garner whether or not further study would be worth the effort (p. 3). For the purpose of this paper, the author conducted e-mail interviews with experts in the field of retail self-service technologies. The aim of the survey was to assess food retailers' perceptions of benefits and challenges associated with the use of SST systems, the current use of the systems, their experiences in adopting these systems as well as their plans for the future. In that context, particular emphasis was put on self-service checkouts as a widespread form of SSTs across the retail sector globally.

The interview questions were embedded in the e-mail message and sent to retail managers. In addition to questions, instructions to the participants on completing the interview were also included. Furthermore, questions were concise in order to avoid any miscommunication and misinterpretation. None of the participants asked for additional clarifications or further explanations. Therefore, there was no need for follow-up questions. Four participants responded before the deadline date, whereas two reminders were sent to the remaining participants who responded afterwards. Qualitative data were collected from November 2018 to January 2019 using e-mail interviews with six retail managers from the top ten leading food retailers in Croatia. Two of the managers interviewed held a managing or regional director position; one participant was a board member, whereas three of them held a head of store position. The first part of the interview included the data on retailers (i.e. origin, market and retail formats operated). Table 1 shows sample characteristics.

The second part of the interview was dealing with retailers' perceptions of SST systems, their experiences and plans for the future. All retail

managers that were interviewed were aware of numerous benefits associated with the use of SST systems. In this sense, retailers emphasized the following benefits: achieving competitive advantage, increasing service quality and customer satisfaction, improving productivity, increasing service efficiency, enhancing the overall shopping experience, redeploying employees to other areas, reduced costs, and reduced waiting time. In addition, management also commented that SST systems could positively affect their business.

Table 1 Sample characteristics

Retailer	Origin	Market	Retail formats
Retailer 1	Domestic	Local	Hypermarkets, supermarkets, convenience stores
Retailer 2	Foreign	National	Hypermarkets, supermarkets
Retailer 3	Domestic	National	Hypermarkets, supermarkets, convenience stores
Retailer 4	Domestic	Regional	Supermarkets, convenience stores
Retailer 5	Foreign	Regional	Hypermarkets, supermarkets
Retailer 6	Domestic	Regional	Hypermarkets, supermarkets, convenience stores

Source: Author's research

With regard to the use of SST systems, all retail managers interviewed recognized the importance of implementing SST systems in their stores. In terms of two main types of SST installations, significant differences can be observed. On the one hand, all six retail managers reported that they provided interactive self-service installations, mainly self-service weighing machines and price checkers. On the other hand, only one retailer (retailer No. 3) confirmed the use of installed self-service checkout machines in some stores. It can be noted that diffusion of self-service checkouts is quite limited in food retailing business in Croatia. As regards experiences when adopting self-service checkout machines, retailer No. 3 expressed the overall satisfaction with the system. As regards customer adoption, retail manager stated that approximately one-third of customers used the self-service checkout machines in their stores. In terms of challenges associated with the use of SST systems, four managers pointed out consumers' willingness to use the self-service checkouts. According to two managers interviewed, encouraging customers to start using self-service checkouts is crucial in retail settings. In addition, all retail managers that were interviewed stressed the importance of well-trained employees assisting customers when using SST systems.

In terms of their plans for the future, all of the retail managers stated that they are familiar with numerous advancements in the field of innovative in-store technologies. However, only two retailers (retailer No. 2 and retailer No. 3) were keen to point out their intention and further spread of self-service checkout machines. On the other hand, other retailers were not enthusiastic about the adoption of self-service checkout machines in their retail stores and they agreed that these machines were not priorities for their businesses. Two retailers argued that customers were not ready to adopt self-service checkouts and pointed out frequent technical failures of self-service checkout machines. Further, one retailer emphasized the role of sales personnel and the aim of creating relationship with their customers. Likewise, one retailer stressed the importance of enhancing social interaction in stores and, in particular, in the context of elderly consumers. In addition, three retailers also highlighted the issue of shoplifting and the rise of supermarket self-checkout scams as major obstacles to adoption of self-service checkouts.

4. Smart in-store technology: Research propositions

As noted previously, current retailing is moving to a smart perspective (Pantano et al., 2018). However, the literature on advanced, innovative technologies in retail settings and customer-related behaviour is still rather limited. In that sense, Foroudi, Gupta, Sivarajah, & Broderick (2018) highlight that previous work failed to address the influence of smart technology usage, combined with behavioural intention of the customer, on the dynamics and experience of customers. Therefore, further research should deal with the challenges emerging from the adoption of such smart technologies. The pilot survey presented in the third section is limited due to its sample size and, therefore, it is insufficient for generalizing. However, it does provide a starting point for future analysis. Although it is evident that experts in the field recognize numerous

advantages of retail self-service technologies, customer feedback is missing. Consequently, future work should concentrate on the effects of smart technology on customers' experience. In particular, it is important to identify how smart technologies influence shopping patterns and consumers' experiences of the in-store environment. Moreover, the introduction of emerging in-store technologies requires the identification of customer clusters based on the usage of these technologies.

In the context of technologically sophisticated retail services, concerns have arisen with regard to the customers' adoption and their psychological reactions towards smart retail technologies (Kumar Roy et al., 2017). More work should be done to find out how the introduction of advanced technologies, such as smart fitting rooms, technology-mediated realities, smart shopping carts, or self-checkout systems modifies the retailing context and affects the overall consumers shopping experience. Further, Priporas, Stylos, & Fotiadis (2017) revealed that consumers expect the technology to enable them to make informed shopping decisions. Consequently, in a brick-and-mortar retail context it is crucial to determine how smart technologies affect the traditional customer decision-making process. Additionally, consumers' expectations of interactions in the smart retailing setting are also worth examining.

Further research is also needed to determine customers' attitude and preferences towards different smart technologies in the retail sector. Moreover, it is important to examine how the use of smart in-store technologies enhances customer experience and loyalty. In addition, their acceptance of and resistance to these technologies are questions in need of further investigation. In particular, these considerations could be examined in terms of various generational cohorts (e.g., Baby Boomers, generation X, generation Y, and generation Z). Additionally, Kumar Roy et al. (2017) suggest that smart customer experience directly enhances satisfaction and reduces perceived risk. Consequently, further studies should also look into the impact of innovative smart technologies on customers' satisfaction and willingness to buy goods.

Conclusion

The phenomenon of digitalization is strongly reshaping the overall brick-and-mortar retail settings. Nowadays, smart technologies provide a wide range of opportunities to interact with customers in retailing contexts. Moreover, new interactive technologies provide brick-and-mortar retailers with comprehensive insight into new information on consumer behaviour, as well as their expectations, needs and preferences. In that context, particular importance should be placed on the introduction of innovative smart technologies in the physical retail environment. Despite the perceived diminishing role, brick-and-mortar retailers have the potential to be powerful players in the future of shopping. By developing their technological capabilities, retailers will be able to make shopping in brick-and-mortar stores enjoyable and to create a unique in-store experience.

One of their main goals should be introducing customers to interactive technologies within smart retail settings to encourage their active digital engagement. Technological advancements help retailers gather various customer-related information and identify their shopping preferences and purchasing trends. Investments in smart innovative technologies create differentiation in brick-and-mortar retail settings and enable individualization and personalization of consumers' shopping experiences. Consequently, gaining a better understanding of the smart shopper behaviour will enable retailer managers, marketers, retail store personnel, and designers of technological interfaces to more accurately target their consumers. Additionally, consumers' digital engagement may lead towards creating a unique experience and customer loyalty.

Based on a comprehensive review of the academic and practitioner literature, the paper synthesizes current findings to contribute to the existing body of knowledge on the usage of smart, innovative technologies in brick-and-mortar retail settings. In addition, it may present a starting point for better understanding and researching the phenomenon of digital transformation in brick-and-mortar retail settings. As noted previously, the literature offers limited understanding of consumer behaviour and attitude towards the usage of in-store innovative technologies. On a wider level, future research needs to be carried out to identify how the introduction of advanced technologies modifies the brick-and-mortar retailing context. Overall, more research is still needed to analyse the challenges emerging from the adoption of smart technologies in brick-and-mortar shopping contexts. In particular, an important issue to examine is how innovative

technologies affect customers' in-store experience and to find out their expectations from the interactions in such smart retailing setting.SM

References

Ainsworth, J., & Foster, J. (2017). Comfort in brick and mortar shopping experiences: Examining antecedents and consequences of comfortable retail experiences. *Journal of Retailing and Consumer Services*, 35, 27-35. https://doi.org/10.1016/j.jretconser.2016.11.005

Atkins, K. G., & Kim, Y.-K. (2012). Smart shopping: conceptualization and measurement. *International Journal of Retail & Distribution Management*, 40 (5), 360-375.

https://doi.org/10.1108/09590551211222349

Balaji, M. S., Kumar Roy, S., Sengupta, A., & Chong, A. (2017). User Acceptance of IoT Applications in Retail Industry. In I. Lee (Ed.), *The Internet of Things in the Modern Business Environment* (pp. 28-49). Hershey: IGI Global.

https://doi.org/10.4018/978-1-5225-2104-4.ch002

Bozkurt, A. (2018). Augmented Reality With Mobile and Ubiquitous Learning: Immersive, Enriched, Situated, and Seamless Learning Experience. In Information Resources Management Association, *Virtual and Augmented Reality: Concepts, Methodologies, Tools, and Application* (pp. 603-617). Hershey: IGI Global https://doi.org/10.4018/978-1-5225-5469-1.ch029

Bulmer, S., Elms, J., & Moore, S. (2018). Exploring the adoption of self-service checkouts and the associated social obligations of shopping practices. *Journal of Retailing and Consumer Services*, 42, 107-116. https://doi.org/10.1016/j.jretconser.2018.01.016

Chaudhuri, A. (2018). *Internet of Things, for Things, and by Things*. Boca Raton: CRC Press. https://doi.org/10.1201/9781315200644

Chessell, D. (2018). The Jobless Economy in a Post-Work Society: How Automation Will Transform the Labor Market. *Psychosociological Issues in Human Resource Management*, 6 (2), 74-79. https://doi.org/10.22381/pihrm6220187

Choi, S. H., Cheung, H. H., Yang, B., & Yang, Y. X. (2015). Item-Level RFID for Retail Business Improvement. In I. Lee (Ed.), *RFID Technology Integration for Business Performance Improvement* (pp. 1-26). Hershey: IGI Global.

https://doi.org/10.4018/978-1-4666-6308-4.ch001

Collier, J. E. & Barnes, D. C. (2015). Self-service delight: Exploring the hedonic aspects of self-service. *Journal of Business Research*, 68 (5), 986-993. https://doi.org/10.1016/j.jbusres.2014.09.036

Collier, J. E., Moore, R. S., Horky, A., & Moore, M. L. (2015). Why the little things matter: Exploring situational influences on customers' self-service technology decisions. *Journal of Business Research*, 68 (3), 703-710.

https://doi.org/10.1016/j.jbusres.2014.08.001

Collier, J. E., Breazeale, M., & White, A. (2017). Giving back the "self" in self service: customer preferences in self-service failure recovery. *Journal of Services Marketing*, 31 (6), 604-617. https://doi.org/10.1108/JSM-07-2016-0259

Dacko, S. G. (2017). Enabling smart retail settings via mobile augmented reality shopping apps. *Technological Forecasting and Social Change*, 124, 243-256. https://doi.org/10.1016/j.techfore.2016.09.032

Dean, D. H. (2008). Shopper age and the use of self-service technologies. *Managing Service Quality: An International Journal*, 18 (3), 225-238. https://doi.org/10.1108/09604520810871856

Demoulin, N. T. M, & Djelassi, S. (2016). An integrated model of self-service technology (SST) usage in a retail context. *International Journal of Retail & Distribution Management*, 44 (5), 540-559. https://doi.org/10.1108/IJRDM-08-2015-0122

Djelassi, S., Diallo, M. F., & Zielke, S. (2018). How self-service technology experience evaluation affects waiting time and customer satisfaction? A moderated mediation model. *Decision Support Systems*, 111, 38-47.

https://doi.org/10.1016/j.dss.2018.04.004

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, 5 (1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11

Flavian, C., Ibanez-Sanchez, S., & Orus, C. (2018). The impact of virtual, augmented and mixed reality technologies on the customer experience. *Journal of Business Research*. https://doi.org/10.1016/j.jbusres.2018.10.050

Foroudi, P., Gupta, S., Sivarajah, U., & Broderick, A. (2018). Investigating the effects of smart technology on customer dynamics and customer experience. *Computers in Human Behavior*, 80, 271-282. https://doi.org/10.1016/j.chb.2017.11.014

Fullerton, S., Brooksbank, R., & Neale, L. (2017). Consumer perspectives on the ethics of an array of technology-based marketing strategies: An exploratory study. *Asia Pacific Journal of Marketing and Logistics*, 29 (5), 1079-1096.

https://doi.org/10.1108/APJML-09-2016-0179

Gaukler, G. M., & Seifert, R. W. (2007). Applications of RFID in Supply Chains. In H. Jung, F. F. Chen & B. Jeong (Eds.), *Trends in Supply Chain Design and Management: Technologies and Methodologies* (pp. 29-48). London: Springer-Verlang. https://doi.org/10.1007/978-1-84628-607-0_2

Grewal, D., Roggeveen, A. L., & Nordfält, J. (2017). The Future of Retailing. *Journal of Retailing*, 93 (1), 1-6. https://doi.org/10.1016/j.jretai.2016.12.008

Grossman, T. (2018). The Rise of an Automated Jobless Society: Do Cutting-Edge Technologies Expel Workers Swifter than the Economy Can Identify New Jobs for Them?. *Psychosociological Issues in Human Resource Management*, 6 (2), 62–67. https://doi.org/10.22381/pihrm6220185

Hagberg, J., Sundstrom, M., & Egels-Zandén, N. (2016). The digitalization of retailing: an exploratory framework. *International Journal of Retail & Distribution Management*, 44 (7), 694-712. https://doi.org/10.1108/IJRDM-09-2015-0140

Haq, I., & Farooq, A. M. (2019). TryOn: An Augmented Reality Fitting Room. In S. Umair & M. Y. Shah (Eds.), *Mobile Devices and Smart Gadgets in Human Rights* (pp. 98-131). Hershey: IGI Global. https://doi.org/10.4018/978-1-5225-6939-8.ch005

Hilton, T., Hughes, T., Little, E., & Marandi, E. (2013). Adopting self-service technology to do more with less. *Journal of Services Marketing*, 27 (1), 3-12. https://doi.org/10.1108/08876041311296338

Inman, J. J., & Nikolova, H. (2017). Shopper-Facing Retail Technology: A Retailer Adoption Decision Framework Incorporating Shopper Attitudes and Privacy Concerns. *Journal of Retailing*, 93 (1), 7-28. https://doi.org/10.1016/j.jretai.2016.12.006

Kallweit, K., Spreer, P., & Toporowski, W. (2014). Why do customers use self-service information technologies in retail? The mediating effect of perceived service quality. *Journal of Retailing and Consumer Services*, 21 (3), 268-276. https://doi.org/10.1016/j.jretconser.2014.02.002

Karjol, S., Holla, A. K., & Abhilash, C. B. (2018). An IOT Based Smart Shopping Cart for Smart Shopping. In T.N. Nagabhushan, V. N. Manjunath Aradhya, P. Jagadeesh, S. Shukla, Chayadevi, M. L. (Eds.), *Cognitive Computing and Information Processing* (pp. 373-385). Singapore: Springer Verlag. https://doi.org/10.1007/978-981-10-9059-2_33

Kazancoglu, I., & Yarimoglu, E. K. (2018). How food retailing changed in Turkey: spread of self-service technologies. *British Food Journal*, 120 (2), 290-308. https://doi.org/10.1108/BFJ-03-2017-0189

Kim, H.-Y., Lee, J. Y., Mun, J. M., & Johnson, K. K. P. (2017). Consumer adoption of smart in-store technology: assessing the predictive value of attitude versus beliefs in the technology acceptance model. *International Journal of Fashion Design, Technology and Education*, 10 (1), 26-36. https://doi.org/10.1080/17543266.2016.1177737

Kumar Roy, S., Balaji, M. S., Sadeque, S., Nguyen, B., & Melewar, T. C. (2017). Constituents and consequences of smart customer experience in retailing. *Technological Forecasting and Social Change*, 124, 257-270. https://doi.org/10.1016/j.techfore.2016.09.022

Kumar Roy, S., Balaji, M. S., Quazi, A., & Quaddus, M. (2018). Predictors of customer acceptance of and resistance to smart technologies in the retail sector. *Journal of Retailing and Consumer Services*, 42, 147-160. https://doi.org/10.1016/j.jretconser.2018.02.005

Landmark, A. D., & Sjøbakk, B. (2017). Tracking customer behaviour in fashion retail using RFID. *International Journal of Retail & Distribution Management*, 45 (7/8), 844-858. https://doi.org/10.1108/IJRDM-10-2016-0174

Lee, H.-J., Cho, H. J., Xu, W., & Fairhurst, A. (2010). The influence of consumer traits and demographics on intention to use retail self-service checkouts. *Marketing Intelligence & Planning*, 28 (1), 46-58. https://doi.org/10.1108/02634501011014606

Lee, H.-J., Yang, K. (2013). Interpersonal service quality, self-service technology (SST) service quality, and retail patronage. *Journal of Retailing and Consumer Services*, 20 (1), 51-57. https://doi.org/10.1016/j.jretconser.2012.10.005

Lee, H.-J. (2015). Consumer-to-store employee and consumer-to-self-service technology (SST) interactions in a retail setting. *International Journal of Retail & Distribution Management*, 43 (8), 676-692. https://doi.org/10.1108/IJRDM-04-2014-0049

Lee, H.-J., & Lyu, J. (2016). Personal values as determinants of intentions to use self-service technology in retailing. *Computers in Human Behavior*, 60, 322-332. https://doi.org/10.1016/j.chb.2016.02.051

Lee, H.-J. (2017). Personality determinants of need for interaction with a retail employee and its impact on self-service technology (SST) usage intentions. *Journal of Research in Interactive Marketing*, 11 (3), 214-231. https://doi.org/10.1108/JRIM-04-2016-0036

Martin, B. S. (2018). *Augmented Reality*. Chicago: Norwood House Press.

Mehrjerdi, Y. Z. (2011). RFID and its benefits: a multiple case analysis. *Assembly Automation*, 31 (3), 251-262. https://doi.org/10.1108/01445151111150596

Mukherjee, A., Smith, R. J., & Turri, A. M. (2018). The smartness paradox: the moderating effect of brand quality reputation on consumers' reactions to RFID-based smart fitting rooms. *Journal of Business Research*, 92, 290-299. https://doi.org/10.1016/j.jbusres.2018.07.057

Nica, E. (2018). Will Robots Take the Jobs of Human Workers? Disruptive Technologies that May Bring About Jobless Growth and Enduring Mass Unemployment. *Psychosociological Issues in Human Resource Management*, 6 (2), 56–61. https://doi.org/10.22381/pihrm6220184

Nica, E., Manole, C., & Stan, C. I. (2018). A Laborless Society? How Highly Automated Environments and Breakthroughs in Artificial Intelligence Bring About Innovative Kinds of Skills and Employment Disruptions, Altering the Nature of Business Process and Affecting the Path of Economic Growth. *Journal of Self-Governance and Management Economics*, 6 (4), 25-30. https://doi.org/10.22381/jsme6420184

Nijssen, E. J., Schepers, J. J. L., & Belanche, D. (2016). Why did they do it? How customers' self-service technology introduction attributions affect the customer-provider relationship. *Journal of Service Management*, 27 (3), 276-298. https://doi.org/10.1108/JOSM-08-2015-0233

Orel, F. D., & Kara, A. (2014). Supermarket self-checkout service quality, customer satisfaction, and loyalty: Empirical evidence from an emerging market. *Journal of Retailing and Consumer Services*, 21 (2), 118-129. https://doi.org/10.1016/j.jretconser.2013.07.002

Pantano, E., & Naccarato, G. (2010). Entertainment in retailing: The influences of advanced technologies. *Journal of Retailing and Consumer Services*, 17 (3), 200-204. https://doi.org/10.1016/j.jretconser.2010.03.010

Pantano, E. (2016). Benefits and risks associated with time choice of innovating in retail settings. *International Journal of Retail & Distribution Management*, 44 (1), 58-70. https://doi.org/10.1108/IJRDM-03-2015-0047

Pantano, E., Priporas, C. V., & Dennis, C. (2018). A new approach to retailing for successful competition in the new smart scenario. *International Journal of Retail & Distribution Management*, 46 (3), 264-282. https://doi.org/10.1108/IJRDM-04-2017-0080

Peddie, J. (2017). *Augmented Reality: Where We Will All Live*. Berlin: Springer. https://doi.org/10.1007/978-3-319-54502-8

Poushneh, A., & Vasquez-Parraga, A. Z. (2017). Discernible impact of augmented reality on retail customer's experience, satisfaction and willingness to buy. *Journal of Retailing and Consumer Services*, 34, 229-234. https://doi.org/10.1016/j.jretconser.2016.10.005

Pradhan, S. (2007). *Retailing Management: Text and cases*. New Delhi: Tata McGraw-Hill.

Priporas, C.-V., Stylos, N., & Fotiadis, A.K. (2017). Generation Z consumers' expectations of interactions in smart retailing: A future agenda. *Computers in Human Behavior*, 77, 374-381. https://doi.org/10.1016/j.chb.2017.01.058

Raju, J. J., Zhang, Z., Sorensen, H., DeHerder, R., & Blatt, D. (2011). *Strategies for Success in Retail (Collection)*. Pearson Education.

Renko, S., & Druzijanic, M. (2014). Perceived usefulness of innovative technology in retailing: Consumers' and retailers' point of view. *Journal of Retailing and Consumer Services*, 21 (5), 836-843. https://doi.org/10.1016/j.jretconser.2014.02.015

Sanghera, P., Thornton, F., Haines, B., Kleinschmidt, J., Das, A. M., Bhargava, H., & Campbell, A. (2007). *How to Cheat at Deploying and Securing RFID*. Burlington: Syngress Publishing.

Shandong, M., Robb, D. J., & DeHoratius, N. (2018). Retail store operations: Literature review and research directions. *European Journal of Operational Research*, 265 (2), 399-422. https://doi.org/10.1016/j.ejor.2017.07.003

Sorells, B. (2018). Will Robotization Really Cause Technological Unemployment? The Rate and Extent of Potential Job Displacement Caused by Workplace Automation. *Psychosociological Issues in Human Resource Management*, 6 (2), 68–73. https://doi.org/10.22381/pihrm6220186

Terblanche, N. S. (2018). Revisiting the supermarket in-store customer shopping experience. *Journal of Retailing and Consumer Services*, 40, 48-59. https://doi.org/10.1016/j.jretconser.2017.09.004

Toellner, J. (2014). *Mobile services in retail and their influence on customer satisfaction*. Hamburg: Diplomica Verlag.

Van Hove, S., De Letter, J., De Ruyck, O., Conradie, P., All, A., Saldien, J., & De Marez, L. (2018). Human-Computer Interaction to Human-Computer-Context Interaction: Towards a Conceptual Framework for Conducting Users Studies for Shifting Interfaces. In A. Marcus & W. Wang (Eds.), *Design, User Experience, and Usability: Theory and Practice* (pp. 277-293). Heidelberg: Springer International Publishing. https://doi.org/10.1007/978-3-319-91797-9_20

Van Ittersum, K., Wansink, B., Pennings, J. M. E., & Sheehan, D. (2013). Smart Shopping Carts: How Real-Time Feedback Influences Spending. *Journal of Marketing*, 77 (6), 21-36. https://doi.org/10.1509/jm.12.0060

Van Kerrebroeck, H., Brengman, M., & Willems, K. (2017). Escaping the crowd: An experimental study on the impact of a Virtual Reality experience in a shopping mall. *Computers in Human Behavior*, 77, 437-450. https://doi.org/10.1016/j.chb.2017.07.019

Vazquez, D., & Kent, A. (2017). Online retail design. In A. Petermans & A. Kent (Eds.), *Retail Design: Theoretical Perspectives* (pp. 174-196). New York: Routledge.

Wang, C., Harris, J., & Patterson, P. G. (2012). Customer choice of self-service technology: the roles of situational influences and past experience. *Journal of Service Management*, 23 (1), 54-78. https://doi.org/10.1108/09564231211208970

Willems, K., Smolders, A., Brengman, M., Luyten, K., & Schöning, J. (2017). The path-to-purchase is paved with digital opportunities: An inventory of shopper-oriented retail technologies. *Technological Forecasting and Social Change*, 124, 228-242. https://doi.org/10.1016/j.techfore.2016.10.066

Wong, W. K., Leung, S. Y. S., Guo, Z. X., Zeng, Z. H., & Mok, P. Y. (2014). Intelligent apparel product cross-selling using radio frequency identification (RFID) technology for fashion retailing. In W. K. Wong & Z. X. Guo (Eds.), *Fashion Supply Chain Management Using Radio Frequency Identification (RFID) Technologies* (pp. 159-186). Cambridge: Woodhead Publishing https://doi.org/10.1533/9780857098115.159

✉ Correspondence

Katija Vojvodić

University of Dubrovnik, Department of Economics and Business Economics
Lapadska obala 7, 20000 Dubrovnik, Croatia

E-mail: katija.vojvodic@unidu.hr

STRATEGIC MANAGEMENT, Vol. 24 (2019), No. 2, pp. 012-033

DOI:10.5937/StraMan1902011D

Received: December 12, 2018
Accepted: March 15, 2019

Agile architecture in the digital era - trends and practices

Zoran Dragičević
Company Boksit, Milići, Republic of Srpska, Bosnia and Herzegovina
Saša Bošnjak
University of Novi Sad, Faculty of Economics in Subotica, Subotica, Serbia

Abstract
The speed of response to change and fluidity are key preconditions for the next generation of IT solutions in the digital world. We are witnessing a rather unimaginable expansion of the use of technology in everyday life, on the one hand, and a continuous increase in the speed of software delivery, on the other, which significantly increased expectations and contributed to the adoption of agile methods and practices, shifting the pendulum of software architecture from traditional to agile methods and practices. Agile architecture, as a result of the transformation of a traditional and agile approach to software development, is a new approach that uses agile techniques to deliver a flexible architecture, adaptable to changing demands, tolerant to changes, which is the result of the iterative-incremental design of the agile process of software development. In recent years, there has been a shift in focus, in practice and research, from people and processes to integration technologies and application's hosting, which has led to the emergence of microservices and increased interest in software architecture and design. One consequence of this is the emergence and development of new approaches in the process of building Agile architecture, such as Continuous Architecting, Lean Architecting or Evolutionary Architecting, which essentially share the same goals. In this connection, in order to understand better the concept and the new role of Agile architecture in the digital era, it is necessary to study the genesis of Agile architecture, as a special approach in software development, to identify current trends and practices that are adapted to the contemporary digital environment (scalability, distribution, complexity). The results of conducted systematic literature review will help researchers and practitioners in better understanding of what Agile architecture is and its role, the current trends and directions of future development, and practices that are particularly useful in the development of complex software, with the aim of broadening the application and improvement of the agile software development process.

Keywords
agile architecture, trends, challenges, success factors, practices, software development

Introduction

The World Economic Forum (WEF) and Accenture launched the *Digital Transformation Initiative* in 2015 to explore the impact of digitalization on business and society. The results released in 2017 predict that the digital transformation will bring a value of $ 100 trillion in the next decade.

Getting cheaper and better technologies, such as mobile, cloud, sensors, analytics and IoT (Internet of Things), with the ability to combine in innovative ways, exponentially accelerate progress. Technology becomes a multiplier in the digital era (WEF & Accenture, 2017) (Figure 1).

The expansion of the technology is accompanied by a continuous increase in the speed of software delivery, which has greatly increased expectations and contributed to the adoption of agile methods and practices. The pillars of software architecture have shifted from traditional to modern methods and practices (Erder & Pureur, 2016), while the speed of response to change and fluidity are key preconditions for the next generation of IT solutions in the digital world (Gartner, 2014).

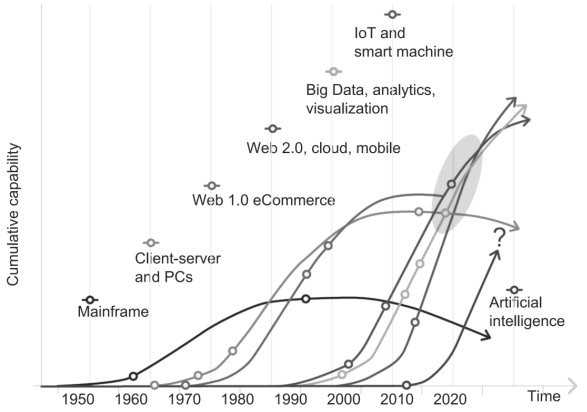

Figure 1 Expansion of technologies in the digital era
Source: WEF & Accenture, 2017.

Agile architecture, as a point of consensus on the process and structure (Kruchten, 2013), is an approach that uses agile techniques to deliver good architecture (Madison, 2010). Kruchten (2013) considers agile architecture as two-dimensional (1) as a software architecture that is versatile, evolving and easily changing, flexible and at the same time resistant to change, and (2) as an agile way to define architecture by an iterative approach, allowing gradual the evolution of architectural design in step with a better understanding of problems and constraints.

Waterman, Noble and Allan (2015) under the term agile architecture mean "*an architecture that satisfies the definition of agility by being able to be easily modified in response to changing requirements, is tolerant of change, and is incrementally and iteratively designed – the product of an agile development process*", where agility is "*the team's ability to create change, respond to change and learn from change so that it can better deliver value*".

With the support of modern practices, technology and tools, the division between the development and production environment is increasingly being blurred, creating a combined ecosystem (Bellomo, Ernst, Nord & Kazman, 2014), so, in the digital age, agile architecture extends to a complete combined ecosystem, which has been particularly influenced by new approaches: Continuous (Erder & Pureur, 2015), Lean (Coplien & Bjørnvig, 2010) and Evolutionary (Ford, Parsons & Kua, 2017) architecture, which add new practices, but essentially share the same goals (Booch, 2010; Holmes & Nicolaescu, 2017).

Through the application of continuous practices, especially continuous delivery, there is a change in focus, in practice and research, from people and processes to integration technologies and application hosting (RESTfull HTTP, cloud computing, DevOps) (Zimmermann, 2016b), which led to the emergence of microservices (Fowler & Lewis, 2014; Newman, 2015) and increased interest in software architecture and design, so that discussion of quality attributes such as scalability, performance, etc. or the discussion of the application of architectural patterns and frameworks, is no longer seen as the BDUF or YAGNI (Zimmermann, 2016b).

Microservices are becoming a key link in the advancement chain that (r)evolutionarily alters the process of software development and delivery (Richardson & Smith, 2016), while new issues arise in the development of complex distributed systems. The digital era brings new challenges that require an innovative approach to finding optimal solutions bearing in mind the wider, combined ecosystem. In this regard, it is necessary to examine in detail current trends and practices of agile architecture in the digital era. Based on the available information there is no study that systematically investigates trends and practices of agile architecture in the digital era.

The rest of this paper is as follows: Section 2 describes the applied methodology, Section 3 presents the results related to the trends and practices of agile architecture in the digital era, Section 4 discusses general considerations, provides answers to research questions, compares similar research, lists identified contradictory attitudes, determines possibilities for further research and constraints. The final part of the paper contains conclusions.

2. Methodology

Research into the trends and practices of agile architecture in the digital era is based on the Systematic Literature Review (SLR) method and the guidelines provided by Kitchenham (2007). SLR is a method for the realization of secondary studies on the results collected from primary studies. SLR protocol was used to define: research question, search process, inclusion/exclusion criteria, quality assessment, method of data collection and analysis. The goal of the research is to answer the following research questions (RQ):

***RQ1**: What are the current trends in Agile architecture, bearing in mind the emergence of different approaches: Continuous, Lean and Evolutionary, in software engineering?*

***RQ2**: What are the practices of developing and implementing Agile architecture in a modern digital environment?*

The search process strategy involved search queries, datasets over which a query and data sources that would be used to identify primary candidate studies (Kitchenham, 2004). Based on research questions, a search query was defined as: *(agile OR lean OR evolutionary OR continuous) AND (architecture OR architecting) AND software AND development.*

In order to increase the probability of finding the desired primary studies, the query was performed on the following datasets: *Title* and *Abstract*. The literature search was carried out by combining automatic and manual searches. The automatic search includes four electronic databases: *IEEE Xplore*, *ACM*, *ArXiv* and *Google Schoolar*, in order to select high quality, reviewed publications in journals and conferences, as well as other publications relevant to the subject of research and research questions.

For each database, based on research questions, a search query is specifically adapted, e.g. for *Google Schoolar* customized query was: *"agile architecture" OR "continuous architecture" OR "lean architecture" OR "evolutionary software architecture"*. A manual search was carried out using the so-called *snowballing* (Jalali & Wohlin, 2012), i.e. iterative searches and finding relevant publications based on references identified in primary publications (*backward snowballing*), as well as publications where primary publications are referenced (*forward snowballing*) (Webster & Watson, 2002).

The inclusion and exclusion criteria were used to assess the suitability of the content of each primary study in relation to the research questions raised (Kitchenham, 2004). The inclusion and exclusion criteria are given in Table 1.

The results of the process of selection of primary studies are presented in Table 2. The selected publications have passed the quality assessment. The quality assessment criteria are defined in the light of the recommendations of Kitchenham (2007) and Dybå and Dingsøyr (2008).

To make an assessment, each publication was subjected to a set of questions that tested the quality of the publication as a whole, the quality, and significance of results and conclusions, as well as the relevance and contribution to the expansion of knowledge and a better understanding of agile architecture. For extraction and qualitative data analysis, the thematic analysis technique and the Atlas.ti software tool was used. The statistics of the selection process regarding the number of primary studies by type of sources and years are shown in Figures 2 and 3.

Table 1 The inclusion and exclusion criteria

Criteria	Assessment Criteria
Include	Publications that define or discuss Agile, Continuous, Lean or Evolutionary Architecture
Include	Publications from journals, conferences, workshop sessions, book chapters, or websites/blogs.
Include	English-language publications, published in the time interval from 2001 to 2017.
Exclude	Publications which are clear that they are not related to the Agile, Continuous, Lean or Evolutionary software development architecture.
Exclude	Publications that just mention the terms Agile, Continuous, Lean or Evolutionary architecture in software development.
Exclude	Non-primary publications (e.g. Systematic Literature Reviews).

Source: Authors

Table 2 Results of the process of selection

Criteria # of articles	IEEE Xplore	ACM	ArXiv	Google Schoolar
After search using query	418	1022	50	145
Selected on title & abstract	47	32	6	25
After removal of duplicates	47	29	6	18
After quality assessment	37	7	1	11
Added by snowballing	5			
Total	**61**			

Source: Authors

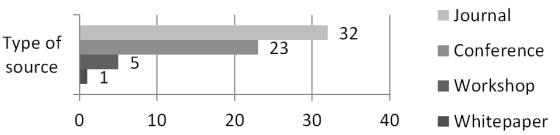

Figure 2 Number of primary studies by type of source
Source: Authors

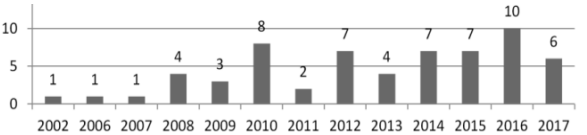

Figure 3 Number of primary studies per year
Source: Authors

3. Results

In this section the results of the research, firstly the trends of the challenges and success factors of agile architecture in the digital era, and then the identified practices, are presented.

3.1. Trends of agile architecture in the digital era

In order to get an answer to the RQ1: *What are the current trends in Agile architecture, bearing in mind the emergence of different approaches: Continuous, Lean and Evolutionary, in software engineering?*, the trends of challenges and success factors have been identified and presented by analyzing selected publications.

3.1.1. The challenges of agile architecture in the digital era

Ten key challenges have been identified, which are associated with several different sources (Table 3).

Table 3 The challenges of agile architecture in the digital era

Challenge	2001-2010	2011-2014	2015-2017
Balancing agility and architecture	S04 S12 S14 S15 S16	S21 S23 S26 S28 S29 S38	S39 S41 S44 S53 S57
Preserving the conceptual integrity and consistency of architecture		S20 S22 S28 S30	S50
Architecture documentation	S03 S09 S18	S30	S42 S47
Scaling	S01 S04 S06 S07 S10	S29 S32	S45 S49 S59 S60
Interdependence of components	S06	S31 S34	S44 S51
Interdependence of requirements	S08	S23 S30	S23 S30
Product life cycle management - optimization of the process and flow of values	S10	S22 S23 S27 S31	S41
Organization, communication and coordination	S06 S07	S28 S29 S31 S32 S35	S42 S45 S47 S49 S53
Application of microservice architecture			S45 S46 S52 S54 S57 S58 S59 S60 S61
New business models of digital economy		S27	S56

Source: Authors

Balancing agility and architecture

Leffingwell, Martens and Zamora (2008) doubt the raising of emergent architecture by refactoring, in the context of the scaled agile process of development and highlight the dangers of over-focusing on urgency (*tyranny of the urgent*). Kruchten (2010) and Abrahamsson, Babar and Kruchten (2010) emphasize the tension between adaptation and anticipation, and the risk of accumulating technical debt as a consequence of an insufficient focus on architecture, while Madison (2010) emphasizes the need to balance business and architectural priorities. For Blair, Watt and Cull (2010), the challenge is to identify the right moment for making key decisions, in order to balance emergent and *Up-Front* design. The issue of improving architectural design in agile methods is being raised (Prause & Durdik, 2012), as well as the issue of optimization of architectural increment in order to achieve the balance of the price of delay of decisions and price of corrections, i.e. refactoring (Nord, Ozkaya & Sangwan, 2012). Waterman, Noble and Allan (2012) explores the design of a minimal up-front architecture, while Fontdevila and Salías (2013) ask the question how to use agile approach and software architecture to increase quality, direct the development process and continuously flow the value for users.

Ozkaya, Gagliardi and Nord (2013) emphasizes importance of integrating agile and architectural principles in order to improve the visibility of project status and to improve risk management tactics when scaling volume, team and/or time. In the context of the increasing importance and wide use of Continuous Delivery (CD), it is particularly important to design architecture for CD (Bellomo et al., 2014).

In the digital era, the pressure is increased for rapid delivery of value (Erder & Pureur, 2016), while maintaining the speed of project realization and product stability (Bellomo, Nord & Ozkaya, 2013), with architecture playing a major role in value streams delivery (Power & Conboy, 2015).

Waterman et al. (2015) puts a focus on the choice of an optimal strategy for the implementation of agile architecture, depending on the degree of influence of different driving forces in a given context. Martini and Bosch (2016) emphasize the challenge of continuous

focus on architecture in order to eliminate technical debt and prevent erosion of architecture because the accumulated technical debt and the degree of refactoring are directly proportional to the misconception about actual architecture (Holmes & Nicolaescu, 2017).

Preserving the conceptual integrity and consistency of architecture

Miyachi (2011) raises the issue of long-term architectural maintenance efficiency, bearing in mind the exponential increase in the cost of correcting errors by the flow of time, especially after the delivery of the software.

Hayata, Han and Beheshti (2012) explores the possibilities of combining lean architecture with agile software development, and the application of lean thinking to preserve the integrity of the architecture. There is a need for a strong focus on preserving conceptual integrity through the planning of regular meetings between top-level design teams (Fontdevila & Salias, 2013), as well as through constant checking of design compliance with architecture (Mirakhorli & Cleland-Huang, 2013).

In the digital era, the importance of long-term preservation of architectural integrity is emphasized, so Erder and Pureur (2016) define an architect as one "*allowing the implementation of software products by directing architectural decisions in a way to protect the conceptual integrity of products*".

Architecture documentation

In order to reduce dependence on undocumented, "*tribal memory*" and preserve intellectual property, Booch (2007; 2010) emphasizes the need for socialization of architecture, whereby it is crucial to find the right measure and method of documenting depending on the complexity of the system. Erdogmus (2009) emphasizes the importance of architecture visibility for making effective decisions, and a particular challenge to documented knowledge is its practical application, as well as the relevance of documentation that is not automatically generated (Mirakhorli & Cleland-Huang, 2013).

In the digital era, the days of presenting architecture with a set of documents are counted, but the architecture is represented by a code executed on the physical infrastructure of the user, the so-called "*realized architecture*" (Erder & Pureur, 2016). Woods (2015) claims that in connection with documentation of architecture, the real challenge is to answer the question "*Who will read it?*", while Gerdes et al. (2016) puts the focus of a challenge of minimal documentation of architecture in order to prevent its erosion, with the requirements: preserve architectural knowledge, improve communication, streamline implementation and support architecture assessment.

Scaling

The intense development of software companies brought challenges to scaling the size of the team (Ambler, 2002; Leffingwell et al., 2008; Moore & Spens, 2008), with a particular problem finding the right people with the desired behavior in large distributed teams (Moore & Spens, 2008). Experience shows that scaling brings challenges in terms of consistency of data and an increase in the number of errors in the race for reaching deadlines (Isham, 2008). Ambler (2009) puts a special focus on the challenge of effectively managing the agile software development process for scaling. Ozkaya et al. (2013) recognizes the challenges associated with three scaling perspectives: the scope, development team and time, while Eckstein (2014) emphasizes the influence of complexity parameters: the degree of change and degree of uncertainty.

In the digital era, one of the major challenges is the scaling of monolithic applications (Villamizar et al., 2015; Taibi, Lenarduzzi, Pahl & Janes, 2017), which often contain a large number of functionality/services, of which a small number requires scaling, causing unnecessary engagement of resources. Scaling also has significant challenges in team organization, communication and collaboration, the role and responsibility of the architect (Britto, Šhmite & Damm, 2016). At the extreme level, scaling brings the greatest challenges that require the use of reactive models for fast response, exceptional elasticity, resistance to failure and asynchronous communication (Pautasso, Zimmermann, Amundsen, Lewis & Josuttis, 2017b).

Interdependence of components

The interdependence of components, including components belonging to a third party (Bellomo, Kruchten, Nord & Ozkaya 2014; Waterman et al., 2015) is a significant challenge that requires increased effort, focus and time (Moore & Spens, 2008), complicates understanding, increases delivery time, and discourages developers to test, implement, and experiment (Buschmann & Henney, 2013).

This challenge is growing in modern complex development and production environment, where systems of systems or software ecosystems are formed, with a multitude of interdependencies between commercial and dedicated software, hardware platforms and organizational entities, each of which has its own evolutionary cycle (Poort, 2016).

Interdependence of requirements

Critical interdependencies in user requirements can lead to significant refactoring with the consequences of the entire structure of the software (Babar, 2009). The hidden interdependencies of the requirements lead to increasing the interdependence of the components (modules) in the design, which further create ad-hoc communication flows between different teams, where teams come to the end of waiting for the completion of the work of other teams or to duplicate the work, causing such conflicts and aggravating management which can ultimately lead to the suspension of the project (Nord et al., 2012). For some extremely complex systems, it is not far from the truth that "*everything affects everything*", and especially the interdependence between functional and non-functional requirements (Mirakhorli & Cleland-Huang, 2013). Poort (2016) considers the interdependence of demands in light of architecturally significant events, adding a time dimension.

Product life cycle management - optimization of the process and flow of values

Although management does not bind to agile approach, agile projects must be managed, because management is directly related to the possibility of scaling, and for this are preferred lean management practices (Ambler, 2009). It is essential to focus on improving workflow and quality while eliminating delays and errors in order to avoid unnecessary work on corrections (Hayata et al., 2012). A particular challenge is an effective management of the workflow process, which consists of linked, interdependent tasks, e.g. when it is necessary to determine the optimal size of architectural increment in order to prevent and eliminate architectural losses (excess production, delays, and defects) (Nord, et al., 2012).

Poppendieck and Cusumano (2012) summarized the aforementioned challenges in a set of principles: optimize the whole, eliminate waste, build quality in, learn constantly, deliver fast, engage everyone, and keep getting better. In this regard, it is necessary to identify and remove any obstacle that frustrates the stakeholders or developers and blocks the work of the team (Buschmann & Henney, 2013). Also, it is necessary to identify the architectural challenges that are obstacles to the flow of value, i.e. the obstacles to the efficient work of the team, for example, unnecessary work, transfer of responsibility, delays, unfulfilled architectural requirements, etc. (Power & Conboy, 2015).

Organization, communication and coordination

When forming teams, it is necessary to find people of appropriate character and behavior (Moore & Spens, 2008) because poor communication between architects and teams working in parallel leads to the problem of "*shooting at a moving target*" (Isham, 2008). Development teams generally do not have enough knowledge or experience to combine agile methods and techniques in the right way, depending on the context (Ramakrishnan, 2010), while, in a scaled context, it is not realistic to require all team members to deal with architecture, because this is sometimes impossible due to size, e.g. 100+ team members (Eckstein, 2014).

Therefore, the need for effective communication between stakeholders (Fontdevila & Salias, 2013; Woods, 2015) and coordination of development teams (Ozkaya et al., 2013; Martini & Bosch, 2016) is emphasized, while ensuring that the development process supports project teams, and not vice versa (Buschmann & Henney, 2013). A particular challenge is to align the architecture and structure of the organization, i.e. vertical and horizontal decomposition of the system, and mapping software modules with people and/or teams responsible for their development, in order to minimize the communication links between teams (Nord, Ozkaya & Kruchten, 2014).

In the digital era, in the conditions of a distributed environment, a close communication is required between the team that developed the module/service and the teams that use it (Villamizar et al., 2015) to avoid problems because of poor mutual understanding due to a different interpretation terms (Gerdes et al., 2016). Poor communication between teams (in relation to communication within teams) leads to conflict in the realization of tasks, which only can be identified by code revision (Britto et al., 2016).

Application of microservice architecture

Non-trivial challenges are inherent in distributed SOA-based systems, such as data integrity, consistency conservation, design and service interface evolution, application/service/ infrastructure management and security (Zimmermann, 2016b). Microservices, as another SOA incarnation, is further characterized by life-cycle challenges (development, testing, delivery, scaling, operations, modification, and replacement), such as: tolerance for failure, distributed transactions, heterogeneous data distribution, versioning, and granularity (Villamizar et al., 2015).

Although microservices and SOA carry great potential to improve flexibility and sustainability by applying and combining their principles and practices, they still need to show long-term cost-effectiveness (Zimmermann, 2016a). Combined development and production environment is complicated, as microservices require a sophisticated DevOps infrastructure, based on cloud and container technologies, which support a hyper-agile, lean process of software development and delivery (O'Connor, Elger & Clarke, 2017).

The application of microservices may be difficult in conditions of tightly connected components. With the challenge of finding a balance between complexity and flexibility, security and other quality attributes problems are possible (Holmes & Nicolaescu, 2017), with a particular emphasis on finding balance between performance and granularity (Shadija, Rezai & Hill, 2017). Many developers have a problem due to the change of paradigm from *in-process* to *calls across* a process boundary, as well as problems with versioning and error management, while redundancy in the implementation of microservices (coarse-grained & fine-grained) often prevents reuse (Pautasso et al., 2017a).

The challenge may also be the coordination of the work around the API gateway, i.e. the appearance of a bottleneck that blocks other teams. In addition, it is important to automate testing and monitoring to answer the questions of how to find out something is wrong and how to collect data for the purpose of visualization. It is essential to understand the fact that a large system has different rules from a small system, e.g. in a small system, redundancy is avoided, transactions are processed and a common data model is defined, while in a large systems redundancy is required, compensation is used instead of transactions, and a common data model is a recipe for failure. With this in mind, it is ***particularly problematic that programming is mainly taught on small systems***. This situation requires greater use of tools, technologies, and designs at the system level to hide delivery and scaling jobs from developers (Pautasso et al., 2017b).

New business models of digital economy

The software value-creation epicenter has changed, so instead of focusing on transaction management and equipment control, new business models, such as *Two-sided Market* and *Creating engaging experiences,* require the construction of ecosystems that will attract users with the ability to understand and focus on the important needs of users who are not adequately serviced. The user experience design is the fundamental element of this approach (Poppendieck & Cusumano, 2012).

In the digital era, wide access to the Internet, mobile devices, SaaS (*Software-as-a-Service*) products, massively consumed startup products have led to a change from B2B to B2C and the emergence of a *pay-per-use* business model (Villamizar et al., 2015). The API economy further increases the complexity, so modern systems are expected to be automatically, horizontally scaled to the required number of machines, automatically delivered anywhere, manageable, exchangeable, resistant, with zero tolerance for failure, self-adjusting and unbreakable. The boundaries of the context of Internet-scaled systems and their architecture become blurred, while monolithic software applications have been changed by Internet-based ecosystems based on microservice architecture with more dynamic and complex runtime characteristics (Hohpe, Ozkaya, Zdun & Zimmermann, 2016).

3.1.2. The success factors of agile architecture in the digital era

Ten key success factors have been identified which are associated with several different sources (Table 4).

Understanding the context and selecting the implementation strategy

One of the key characteristics of the agile process is a strong awareness of the context, i.e. the ability to know what is going on (Madni, 2008), while Babar (2009) argues that in agile approach context analysis, definition of problems and specifications of the request are shifted to the user.

Table 4 The success factors of agile architecture in the digital era

Success factor	2001-2010	2011-2014	2015-2017
Understanding the context and selecting the implementation strategy	S05 S08 S16 S17	S21 S26 S35 S37	S41 S44 S46 S50 S56 S58 S59
Understanding the role, responsibilities and competencies of an architect	S04 S08 S13 S15	S19 S24 S25 S30 S31 S32 S35 S36	S42 S46 S49 S50 S53 S56 S57 S58
Traditionalization of agile approach	S03 S09 S18	S30	S42 S47
Application of lean principles and practices	S01 S04 S06 S07 S10	S29 S32	S45 S49 S59 S60
Application of continuous principles and practices	S06	S31 S34	S44 S51
Use of architectural styles, design patterns and components	S08	S23 S30	S23 S30
Decomposition and granularity	S10	S22 S23 S27 S31	S41
An evolutionary approach	S06 S07	S28 S29 S31 S32 S35	S42 S45 S47 S49 S53
Quality attributes - continuous focus and prioritization			S45 S46 S52 S54 S57 S58 S59 S60 S61
Application of tools and technologies in the combined ecosystem		S27	S56

Source: Authors

For Abrahamson (2010) the context is crucial for balancing agility and architecture, whereby the context includes: project size, architecture stability, business model, team distribution, degree of change, age of the system, criticality and management, as well as the influence of other factors: the market situation, the strength and policy of the company, the expected life cycle of the product, the type of product, organizational culture and history.

Although the software architecture is relevant to the members of the agile teams (Falessi et al., 2010), agile methods are only suitable for projects in a particular context (Prause & Durdik, 2012), while the context determines the amount of *Up-Front* work on architecture (Waterman et al., 2012). Nord et al. (2014) emphasize the importance of the context for aligning system architecture, organization structure and production infrastructure, while 20 contextual factors related to project, team, practices and organization determine whether architecture can emerge as a result of continuous refactoring (Chen & Babar, 2014) .

In the digital era, context change is one of the main obstacles to the continuous process flow (*workflow*) (Power & Conboy, 2015). Architects, depending on the particular context, must adapt *Risk-and-Cost Driven Design* (RCDD) methods, pragmatic modeling, and technical debt management to make effective decisions (Zimmermann, 2016a), so organizations values the architect by ability to make the right decisions in an unclear context (Erder & Pureur, 2016). Internet-connected architecture adds complexity and blurs the boundaries of the system context

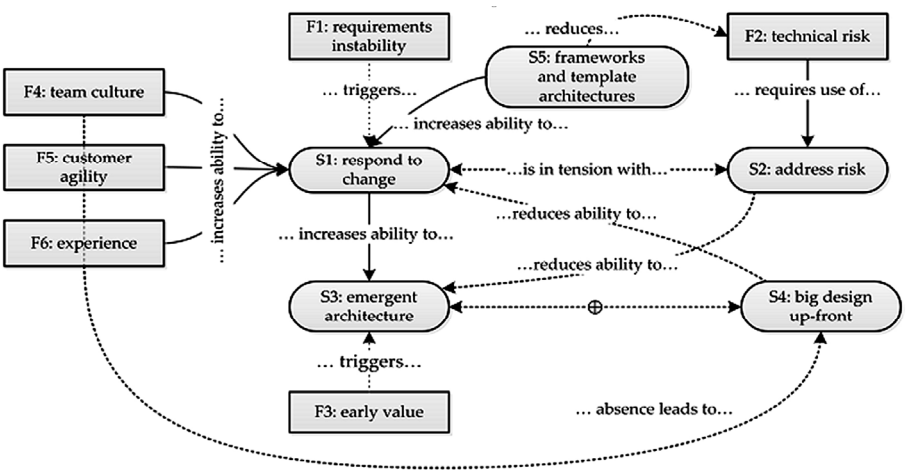

Figure 4 Agile architecture forces and implementation strategies
Source: Waterman et al., 2015.

(Hohpe et al., 2016). *Domain Driven Design* (DDD), bounded context and *Conway's law* are key success factors of microservices (Pautasso et al., 2017a), while changing boundaries of the service context over time is one of the most significant challenges of microservice architecture (Pautasso et al., 2017b).

Based on the importance of the influence of individual driving forces (demand instability, technical risk, rapid delivery of value, team culture, user agility and experience) in a given context, one of the following strategies for implementing agile architecture can be selected (Figure 4) or combine multiple strategies (Waterman et al., 2015):

Respond to changes - a strategy directly linked to the agility of teams where greater agility of architecture and new tolerance for change allows architecture to continuously present the best solutions to the evolving problem. The team can use the following tactics: simple design, iterative proactive architecture revision, the use of good design practices, delaying architectural decisions, and planning for options.

Addressing risk - reduces the impact of risk before the problem arises, usually *Up-Front*, especially for decisions that have a wide impact (e.g. selection of technological streak or architectural style), where architecture is designed so that it is possible to build a system with the required quality attributes with an acceptable level of risk.

Emergent design - the team adopts minimum *Up-Front* decisions, such as the choice of technology stack or architectural style/pattern, whereby these decisions are sometimes implicit, or have already been made (e.g. by users), and can be viewed as constraints, then we have the so-called total emergent design. The team considers only current requirements, ignoring long-term, with the simpler design that allows the product to reach the market as soon as possible (*MVP - Minimum Viable Product*).

Big Design Up-Front - requires the identification of all requirements and a complete architectural design before development begins (although architecture can evolve during development) which makes this strategy unwelcome in an agile approach. It can be considered in case of extreme risk, but is more often driven by the lack of agility of the user than by the technical risk.

Frameworks & templates - means the use of software frameworks, templates, and reference architectures, providing standard solutions for standard problems and reducing the number of architectural decisions. The use of the *Convention over Configuration* (CoC) paradigm reduces complexity since many architectural decisions are embedded in a framework, so formerly architectural decisions are now considered design decisions, and an easier change in architectural decisions is of great use in the application of agile methods. It should be aware that a framework does not always represent a comprehensive solution, so this strategy is combined with other strategies (Waterman *et al*., 2015).

Understanding the role, responsibilities and competencies of an architect

The traditional role of an architect is changing, which implied deep domain knowledge, a high level of abstraction in defining the structure, and an implicit or explicit right to make a decision in the field of interest (Poort, 2016). The architect focuses on delivering architecture as a service (Blair et al., 2010; Faber, 2010), coding according to needs, transferring technical knowledge (Babar, 2009), assisting the team in "*violation of rules*", providing communication on minimum documentation, with a division of responsibilities on the quality attributes (architect) and functionality (team) (Faber, 2010).

The architect must be a good communicator (Faber, 2010), while management skills are important in large distributed teams (Babar, 2009). The key role of the architect is to focus on the question "*What is blocking the agility of the team?*" (Buschmann & Henney, 2013) and to remove any obstacle that blocks the team's agility and frustrates the stakeholders (Mirakhorli & Cleland-Huang, 2013). He must have a clear architectural vision (Buschmann, 2012), to think beyond structure and technology by dealing with the structure of organization and production infrastructure (Nord et al., 2014), spending the most time with people living with his decisions (Buschmann, 2012).

The architect is involved in all phases of the development process while delaying his decisions (Hadar & Sherman, 2012). Coding as needed, giving preference to mentoring and teaching in relation to documentation, spends time with the user to understand how the system will be used, and the real requirements are derived from feedback from the users (Mirakhorli & Cleland-Huang, 2013). Although decisions can be made by the team, the architect takes care that the decisions

are consistent throughout the system, even when multiple teams work simultaneously, thus protecting the conceptual integrity of architecture and design. The architect has leadership qualities (Buschmann, 2012), technical knowledge and experience in design (Buschmann & Henney, 2013).

In the digital era, the role of the architect, which evolved from a specialist in a traditional architectural domain to a solution architect, was changed (Erder & Pureur, 2016; Zimmermann, 2016a). The architect must take into account scaling, complexity and distribution (Britto et al., 2016), and focus on system design that will be incrementally tested and quickly delivered in different environments (development, testing, production) across different platforms, private and public clouds (Erder & Pureur, 2016), where hardware infrastructure is added to the scope of competencies of the architect (Hohpe et al., 2016).

The architect becomes a connecting element, building bridges between teams and different levels of organization through leadership (Hohpe et al., 2016) and taking responsibility for design decisions that are risky, costly, and difficult to change (Woods, 2015), with constant management and monitoring of the current state of architecture (Holmes & Nicolaescu, 2017). The architect takes into account the complete life cycle of the software product, understands the source code, works in a decentralized manner, processes the government through the delivery process, removes all obstacles and provides resources for product delivery, directing and delivering timely decisions, minimizing multitasking and ensuring a coherent and sustainable product architecture (Erder & Pureur, 2016).

Leadership, mentoring and the translation of complex concepts into understandable concepts become more important than ever before (Hohpe et al., 2016). Different architectural competences are required at various management levels: technical skills, domain expertise, communicativeness and charisma (Martini & Bosch, 2016). The architect must have extensive knowledge of business domain and technology, as well as current architectural and agile practices (Holmes & Nicolaescu, 2017). He must be able to transfer and combine knowledge from isolated domains, must have broad views, including views on other industries as a source of new ideas (Hohpe et al., 2016).

The architect must act quickly and facilitate decision-making in an uncertain environment, in which knowledge and experience are needed, nontechnical skills such as communication and the ability to operate in ambiguous contexts are increasingly critical (Erder & Pureur, 2016). Due to the increasing "*need for speed*" in the digital era, additional skills are needed, as architects are involved in development, operations and maintenance, so they need to improve their business, financial, communication and educational skills.

In recent years, the trend of inversion of specialization is evident, where, for example, development of microservices or certain functionalities, requires full-stack developers that combine the skills of database design, integration, business logic of the domain and user interface, so that the role of the architect becomes virtual, i.e. becomes the responsibility of the team. Although increasing the complexity of the technology does not support this trend, time will show whether such a trend will be sustainable over the long term.

Generalists are necessary in distributed systems to deal with cross-cutting aspects such as: development of cross-domain software solutions, service deployment and testing (Pautasso et al., 2017a). At the same time, the development of the middleware platform reduces the need for architectural decisions, and by increasing the capacity and possibilities of a collaborative development environment, modern software tools further reduce the need for an architect (Hohpe et al., 2016).

Traditionalization of agile approach

In order to overcome the gap between speed and stability, traditional and agile methodologies are combined (Nord & Tomayko, 2006), in so-called traditionalization of the agile process of software development using architectural practices (Ambler, 2002; Babar, 2009; Erdogmus, 2009; Abrahamsson et al., 2010; Faber, 2010; Kruchten, 2010; Madison, 2010; Matković, Tumbas & Sakal, 2011) while at the same time combining various agile methods, techniques and practices (Ramakrishnan, 2010).

Agile approach is inclusive (Hayata et al., 2012), so ethno-relativism gradually prevails over ethno-centrism in the relation of agility and architecture (Kruchten, 2010), resulting in a wide application of architectural principles and practices in the agile process of development (Miyachi, 2011; Bellomo, Kruchten, et al., 2014; Eckstein, 2014; Nord et al., 2014), including risk

analysis (Ozkaya et al., 2013) and architectural modeling (Durdik, 2011; Prause & Durdik, 2012).

In the digital era, the application of architectural principles and practices in the agile development process, where ones are used in the conditions of the desired state, and the others outside the conditions of the desired state (Bellomo et al., 2013), is needed, but not sufficient. It is necessary to apply combined practices from other areas (from management to engineering), as well as the transformation of the development process according to the situational context (O'Connor et al., 2017).

Application of lean principles and practices

Lean principles enable efficient management in the agile development process by means of a management mechanism that motivates and supports IT professionals to do what an organization deems necessary (Ambler, 2009). Lean architecture emphasizes the importance of the form in relation to the structure. It focuses on the requirements of not only the users, but also the broader stakeholders, and along with the static, it includes a dynamic component, too (Booch, 2010). While the agile approach has a focus on speed, lean is focused on the "*right way*", avoiding premature optimization, timely thinking and planning through the early engagement of the team, domain experts and users in the architectural design (Hayata et al., 2012).

The combination of agile and lean practices, and the application of a lean concept for flow management, enables visualization, monitoring of technical debt and errors, balancing the allocation of critical architectural tasks and improving process flows, contributing to the reduction of total delay and number of errors/corrections (Buschmann, 2012). The application of lean approach has the potential to unify architecturally important tasks with functionalities, as opposed to agile methods that mainly create artificial boundaries, so defining tasks becomes a major problem (Nord et al., 2012).

Lean principles and thinking mean a focus on the complete product life cycle, i.e. combining design, development, delivery and validation in one feedback loop focusing on finding and delivering value, and continuous learning. By developing new business models (for example, *Two-sided market* & *Creating engaging experience*), the deeper understanding of what the user wants to do and how the software can help him with it (*design thinking*) is increasingly important, where the key to success is the ability of a gradual change (Poppendieck & Cusumano, 2012).

In the digital era, in order to achieve a continuous flow of values through the organization (*end-to-end*), lean thinking begins with an understanding of the flow of values and possible barriers in the course of value, with architecture being an integral part of this process. In this regard, it is important to use proactive (leading) metrics for the quality of current flows that can identify hidden obstacles in flow of value (Power & Conboy, 2015). Open, lean and sustainable architectural practices and techniques are required to build comprehensive and understandable frameworks, including sophisticated DevOps lean infrastructure (*service deployment pipeline*) with service monitoring, adapted for decentralized continuous delivery of value (Zimmermann, 2016a).

Combining agile practices and *lean start-up* that will support the flow of values from concept to production, and continuous learning from user experience, in a continuous development cycle (*build-measure-learn*), are crucial for the software product to go on the market and provide long-term survival (Hohpe et al., 2016; Pautasso et al., 2017a).

Application of continuous principles and practices

Madni (2008) emphasizes the continuous and incremental deployment, as the second most important principle of agile architecture, while for Isham (2008) continuous integration (CI) significantly reduces complexity and risk. In order to balance the agility and architecture, a continuous focus on architecture and continuous refactoring (CR) is necessary (Erdogmus, 2009; Booch, 2010), while the evolutionary and continuous development process and the exchange of ideas are crucial to achieving essential architecture (Blair et al., 2010).

Speed drives everything else, therefore continuous delivery (CD), with increased focus on CI (Bellomo, Ernst, et al., 2014; Nord et al., 2014), becomes important to enable continuous flow (CF) delivering new software to the production environment in a safe and reliable way (Poppendieck & Cusumano, 2012), even in the case of critical and very large online systems (Nord et al., 2014). Therefore, interest in the CD is growing steadily (Bellomo, Ernst, et al., 2014). On the other hand, Continuous Learning (CL) minimizes the effort to create functionality that

users will not need (YAGNI) (Poppendieck & Cusumano, 2012). CR is needed for good architecture (Fontdevila & Salias, 2013; Mirakhorli & Cleland-Huang, 2013), even sufficient for emergent architecture, if certain contextual factors are met (Chen & Babar, 2014).

In the digital era, CR continues to play a significant role (Hohpe et al., 2016; Holmes & Nicolaescu, 2017), CI tools are applied (O'Connor et al., 2017) with the continuous improvement of the agile development process (Scrum AND) integrating test-driven practices, such as automated *Test-Driven Development* (TDD) and CI, focusing on *built-in-product* quality attributes: modifiability, performance, availability, interoperability, security, usability, testability and deployability (Bellomo, Gorton & Kazman, 2015). The CD attracts great attention due to its potential (Bellomo et al., 2015; Chen, 2015; Erder & Pureur, 2016; Hohpe et al., 2016; Zimmermann, 2016b; O'Connor et al., 2017; Pautasso et al., 2017a, 2017b), such as: faster market entry, production of the "*right*" product, improved productivity and efficiency, better product quality, more satisfied users (Chen, 2015).

In this regard, the deployability feature appears as a completely new concept or quality attribute, which aims to reduce complexity and shorten the cycle, in the form of small, incremental, automated and reliable delivery (Bellomo et al., 2015) that enable a continuous flow of values (Power & Conboy, 2015). Architectural challenges arise due to CD (Chen, 2015), decentralized CD (Zimmermann, 2016b) and the appearance of microservices.

Microservices eliminate the so-called *single point of failure* using a CD strategy that only changes individual microservices while delivering it, without interruption, in others (Chen, 2015), allowing rapid scaling and delivery of applications for millions of users on cloud platforms (Villamizar et al., 2015). In a continuous family, a new practice, called Continuous Architecting (CA) emerged (Erder & Pureur, 2016; Martini & Bosch, 2016; Holmes & Nicolaescu, 2017), which presents a set of rules, architectural styles and tools that help the rapid delivery of software, supported by architectural principles (Holmes & Nicolaescu, 2017).

Use of architectural styles, design patterns and components

Applying component-based and pattern-based approaches is essential for building an intentional architecture (Leffingwell et al., 2008), while architectural style and principles should guide implementation, taking into account the form, not just the structure (Booch, 2010). Agile methods do not support the reuse of patterns, planning of reference architecture and components, or the development of a product line. Therefore, it is necessary to combine agile methods and architectural modeling with patterns and components (Durdik, 2011).

Architectural dynamics and agile principles can be supported by architectural patterns in order to avoid BDUF, e.g. *Sashimi pattern* or *Concentric approach* (Fontdevila & Salias, 2013). Architecture can be viewed in the light of the application of patterns and tactics that affect the time and cost of implementation, testing and delivery of changes. It is possible to apply different styles, patterns and tactics (*N-tier*, *client-server*, *SOA*, *publish-subscribe*...) to achieve agile architecture (Bellomo, Kruchten, et al., 2014), bearing in mind that strong components dependency is obstacles for continuous integration (Bellomo, Ernst, et al., 2014).

In the digital era, microservices and SOA, or (micro) service design patterns and principles, are an integral part of digital frameworks with quality stories, C4 architectural modeling, decision sharing (Y-statement), architecturally visible coding style, architectural refactoring and architectural roadmap (Zimmermann , 2016a). In modern Internet-based systems, which are flexible, dynamic, and based on microservices, long-term sustainable architecture is more a set of patterns and principles than a static, stable structure (Woods, 2016). Therefore, the need for the application of architectural styles (Pautasso et al., 2017b), design patterns and principles (Britto et al., 2016), at different levels, from architecture, through design to implementation (Gerdes et al., 2016), is greater than ever.

Decomposition and granularity

Attribute-driven design (ADD) method supports horizontal (*breadth-first*) and vertical (*deep-first*) approach to decomposition of design, which depends on the business context, domain knowledge and application technology (Nord & Tomayko, 2006). Although the feature/business-centric decomposition should be the primary

approach, for more efficient delivery of the project, the decomposition in line with architectural boundaries and frameworks should once again take priority, because iterations over architectural boundaries can open too many simultaneous challenges by increasing risk, such as simultaneous work with a large number of technologies. Therefore, the decomposition must be in line with the nature of the software product (Madison, 2010).

There are more approaches to the decomposition of domain problems and architectural aspects (Durdik, 2011). Unlike functionality, design is not easy to decompose into smaller tasks or "*technical stories*" and engage in agile practices (Bellomo, Kruchten, et al., 2014). The focus on horizontal decomposition (infrastructure and system elements, as well as common services) is needed in conditions of unstable infrastructure and production environment.

The more stable the infrastructure (platform, framework, tools) is, it is possible a better functional, vertical decomposition, which reduces the need for communication and coordination, and allows for better synchronization of the teams for parallel work (Nord et al., 2014). Expanded functionality should be divided into smaller increments that enable fast delivery of value to the user and fast feedback from users (Chen & Babar, 2014).

In the digital era, SOA and microservices, i.e. services of different granularity (macro & micro), reduce dependency with the help of vertical decomposition, allowing their independent development, testing and delivery (Villamizar et al., 2015; Poort, 2016; Zimmermann, 2016b; Holmes & Nicolaescu, 2017; Taibi et al., 2017), where the decomposition approach is chosen based on the context, vision, requirements and criteria of dependency, where DDD is one, but not the only one (Pautasso et al., 2017a).

Bearing in mind that the system will change over time for sure and that the service decomposition (or composition) is a reaction to the change of domain problems, the services should be designed to be updatable and/or rejectable, with the granularity evolving according to the requirements and experience, i.e. it should not be dictated by the choice of architectural style (Pautasso et al., 2017b). It should be kept in mind that granularity has an effect on performance (Pautasso et al., 2017a; Shadija et al., 2017).

An evolutionary approach

An evolutionary approach to the development of architecture is essential, whether seen as the evolution of intentional architecture (Ambler, 2002), the evolution of the minimal (walking skeleton) architecture (Abrahamsson et al., 2010), a continuous evolutionary process that results in an essential architecture (Blair et al., 2010), an evolutionary approach to the design of prototype and delivery (Nord & Tomayko, 2006) or a continuous incremental-iterative evolution that inhibits the erosion forces for the survival of every economically viable system (Booch, 2007; Erdogmus, 2009). The achievement of the evolutionary architecture of complex systems, as one of the principles of agile architecture (Madni, 2008), requires integration of architectural principles and agile approach (Babar, 2009).

The possibility of the evolution of the system is one of the advantages of software architecture (Durdik, 2011), which is important both for long-term systems and when the system should be translated from the state of "as-is" to the state of "to-be" (Ozkaya et al., 2013). Rare are systems that are built from scratch, but the existing architecture, which is becoming the subject of continuous evolution (Mirakhorli & Cleland-Huang, 2013), is mainly used, and an evolutionary approach is also suitable for building a core product line architecture (Harper & Dagnino, 2014).

For an evolutionary approach, those practices that enable small changes (increments) in short iterations, as well as techniques that allow fast feedback and learning, should be kept in mind, with the constant evolution of the requirements and their interrelations (Bellomo, Kruchten, et al., 2014; Nord et al., 2014), as well as the need for "*just enough anticipation*" (Poort, 2014).

In the digital era, software architecture evolves, from mainly technical discipline, to inclusion of business, sociological and cultural aspects, while, on the other hand, the rapid development of technology and new business models constantly moves the target in advance (Hohpe et al., 2016). ***The pressure to evolve software systems by delivering value at shorter time intervals is greater than ever*****,** instead of 1 or 2 times per year, a competitive market requires weekly, daily or even shorter delivery times (O'Connor, et al., 2017).

There is a growing consensus that good architectural foundations allow rapid, reliable and sustainable evolution of complex software using

an iterative-incremental approach (Bellomo et al., 2015; Woods, 2016). The application of the evolutionary design (Bellomo et al., 2013; Zimmermann, 2016b; Pautasso et al., 2017a) implies alignment with decisions that are later difficult to change and the application of tactic "*start stupid and evolve*" (Pautasso et al., 2017b), while avoiding architectural changes in each individual iteration, as this leads to cost increases (Waterman et al., 2015), but defects need to be timely identified in order to preserve the long-term evolution and sustainability of architecture (Britto et al., 2016).

Evolution of components (Woods, 2015) and services (Zimmermann, 2016b) implies the application of the principle of backward compatibility, so that the changes affect users less. Evolution and change should get the lead, with timely anticipation of future architecturally significant events and their evolution point of view (Poort, 2016). It seems that the next phase, the so-called dynamic evolution, be even more radical, with intelligent dynamic compositions, cloud platforms, and linking IoT (Woods, 2016).

Quality attributes - continuous focus and prioritization

Traditional architectural methods (QAW, ADD, ATAM, CBAM) put an early focus on quality attributes (Nord & Tomayko, 2006), as opposed to agile methods that focus on fast delivery of value and enable improvement in so-called "*3 big*": quality, productivity and morale (Leffingwell et al., 2008). While the traditional approach is used to evaluate the quality attributes, advocates of the agile approach argue that refactoring helps to acquire the quality attributes. Quality attributes and their prioritization are not in the focus of agile approach, as they are often not a measure of success, but a focus on functionality, budget and delivery deadlines (Babar, 2009).

Quality attributes should be in the focus as soon as possible, with the division of responsibilities to the architect (quality attributes) and development team (functionality) (Faber, 2010). A combination of architectural and agile techniques is needed to achieve a balance between business (functionality) and architectural (quality attributes) priorities (Madison, 2010). Undefined quality attributes are the causes of design, documentation and code problems (Prause & Durdik, 2012). In order to support a continuous flow of values, prioritization needs to consider the dependence between functional stories and non-functional requirements (quality attributes), and consequently, the dependent functional requirements earlier in development should be withdrawn (Buschmann, 2012; Nord et al., 2012; Fontdevila & Salias, 2013).

Quality attributes are an integral part of risk analysis and architecture evaluation (e.g. *QA utility tree*) (Ozkaya et al., 2013). Identifying and prioritizing quality attributes, as a continuous process, is crucial for the implementation of valuable functionalities without the risk of intensive re-design or complex coordination between multiple teams (Nord et al., 2014). The possibility of continuous and rapid delivery (deployability) can also be considered as a quality attribute (Bellomo, Ernst, et al., 2014).

In the digital era, and the Internet-connected system, the focus is on the quality attributes, agility and decision-making (Hohpe et al., 2016; Woods, 2016; Holmes & Nicolaescu, 2017), so architectural requirements are involved in sprint planning and demo prototyping, in such a way that explicit attention to architecture allows long-term modifiability and evolution (Britto et al., 2016). Lack of prioritization of quality attributes leads to problems in security, monitoring, and integration (Woods, 2015). In the CD context, the priorities of individual quality attributes are increased: deployability, security, loggability, modifiability, monitorability, testability (Chen, 2015), as they ensure that architecture is optimized for different phases of the development cycle (Holmes & Nicolaescu, 2017).

For the users, the most important are the following quality attributes: functionality, quality, availability, ease of use, performance, variability, safety, interoperability and simple testing (Tumyrkin, Mazzara, Kassab, Succi & Lee 2016), where prioritization of quality attributes positively affects the reduction of documentation (Gerdes et al., 2016).

Microservices are a good choice if they meet the required quality assignments, but account must be taken of possible changes in the requirements, especially when it comes to security, as well as a balance of flexibility and complexity (Holmes & Nicolaescu, 2017).

Application of tools and technologies in the combined ecosystem

Although Ambler (2002) puts focus on people, communication and techniques, a good choice of implementation technology can simplify development, improve system extensibility and

ease of use (Leffingwell et al., 2008). Traditionally, there was a strict division of applications and support infrastructure (testing, configuration and management tools, deployment scripts, and other components), which was not considered as an integral part of the system.

However, by applying combined practices, with the support of modern tools, this division between the development and production environment is increasingly being eradicated by forming a combined ecosystem (Bellomo, Ernst, et al., 2014) where CD is primarily used instead of a project approach, and architecture must be designed from the beginning to support dynamic updates and continuous changes (Poppendieck & Cusumano, 2012).

Fontdevila and Salías (2013) emphasize the importance of technology and tools at four levels: frameworks and testing tools, quality assurance tools, tools for monitoring metrics about flexibility and long-term maintenance (*maintainability*), and deployment tools & configuration, while Mirakhorli and Cleland-Huang (2013) suggest the use of code and design testing tools. Application of the DevOps concept involves merging development and operations into one team, using CD-enabled tools even in the case of large, online, critical systems (Nord et al., 2014).

In the digital era and the Internet-connected system, system of systems or software ecosystems are formed in all industries (Hohpe et al., 2016) with interconnections between commercial and custom-made software, hardware platforms and organizational entities, of which each has its own evolutionary cycle (Poort, 2016).

In such an environment, architectural decisions are also technology-related decisions about frameworks, language, platforms, etc. (Gerdes et al., 2016), whereby information is to be shared with simple tools (Woods, 2015). The architect must prove the benefit of new technologies by creating an executive prototype, as part of an architectural runaway (Erder & Pureur, 2016). Modern open source development tools, code management, testing, deployment, production, monitoring and configuration are gaining importance, while the contemporary effective software development process is hardly conceivable to the previous generation of developers (O'Connor et al., 2017).

For this reason, the focus of the researchers and practitioners has shifted from people and processes to integration technologies and platforms (*RESTFull API, cloud computing, DevOps*) (Zimmermann, 2016b). Observed from a modern architectural perspective, along with a set of architectural rules, it is also necessary to provide support tools, which will support both incremental and agile delivery methods such as CD (Holmes & Nicolaescu, 2017).

As the capabilities of development platforms and environments increase, development teams are increasingly accepting tools and practices that allow them to avoid major BDUF decisions, to divide them and eliminate dependencies, in which they help the intensive development of middleware platforms that reduce the need for architectural decisions by integrating them into technological environment, further reducing the need for an architect.

This trend raises the question of whether the need for an architect is lost, and some Internet-scaling companies (like Google and Spotify) have almost no positions with the name of the architect, with their architecture living in code, with documented decisions, managed through a version control system or code review tools that support visualization techniques and tools (Hohpe et al., 2016).

Microservices require automated deployment tools and the DevOps strategy (develop, test, deploy, operate, monitor) (Villamizar et al., 2015), so, the modern technological environment

Table 5 Agile architecture practices in the digital era

Practice	2001-2010	2011-2014	2015-2017
TDD / Testing / Automated testing	S06 S04 S08 S11	S23 S24 S27 S25 S28 S29 S34 S38	S39 S42 S43 S44 S45 S49 S50 S53 S59
Prototype / Experimentation (spikes)	S04 S11 S13	S23 S30 S31 S33 S35 S38	S39 S42 S44 S52 S58 S59
Lean thinking	S08 S14	S22 S23 S27 S31 S36	S41 S44 S51 S52 S54 S56
Incremental value delivery	S07 S11 S14	S23 S27 S34 S35 S36	S39 S40 S42 S43 S54 S57
Refactoring / Continuous Refactoring	S02 S03 S06 S07 S09 S11 S12 S14 S18	S19 S20 S23 S25 S30 S35 S36 S37	S53 S46 S56 S57 S58

Practice	2001-2010	2011-2014	2015-2017
Continuous Architecting / Zipper model	S09 S12 S16	S21 S30 S36 S38	S50 S53 S56 S57 S60
Revision of source code / Code & Sprint review	S06 S08 S14	S19 S24	S47 S49 S52 S53 S56
Evaluation of architecture and design	S08 S14 S15 S16 S17	S19 S21 S24 S25 S29 S30	S39 S44 S52 S56
Multi-level teams / Scrum of Scrums / SAFe / CAFFEA	S06	S28 S29 S35	S41 S49 S53 S57
Continuous Integration	S06	S27 S29 S37 S38	S39 S49 S52 S58
Continuous Learning	S13	S27 S31 S34	S49 S56 S58
Minimum Viable Architecture (MVA) / Walking skeleton	S12 S13 S14	S20 S25 S35 S38	S42 S44 S57
Organizing a team according to Convey's Law	S04	S31 S35	S54 S58 S59
Architectural Runaway	S04	S35 S36	S50 S51 S53
Architectural Roadmap	S08	S25	S46 S51 S56
Deffering architectural and design decisions	S15	S20 S24 S31 S33	S42 S44
Minimum documentation / Realized architecture documented in source code	S13 S18	S20 S30	S47 S50
Pair-programming	S06 S11	S19 S21 S25	S39
Common semantics / Metaphor / Common Language	S08	S35	S58
DevOps		S35	S45 S49 S50 S51 S52 S54 S56 S58 S59 S60
Continuous Delivery		S27 S35 S38	S40 S43 S45 S49 S50 S52 S56 S59 S60
Cloud Computing		S38	S45 S50 S47 S54 S55 S56 S61
Minimum Viable Product (MVP) / Lean Start-Up (build-measure-learn)		S20 S27 S30 S35	S42 S44 S50 S56 S58 S60
Small, autonomous and dedicated teams for work in a bounded context / 'Two-pizza' teams		S35	S39 S57 S58
Continuous Flow of Value (end-to-end)		S27	S41 S56 S59
Resolving interdependences		S23 S36	S39 S42 S51
Combined ecosystem / Dev, Build, Test, Oper, Prod tools & environments support		S27 S34 S35 S38	S45 S60
Design principles (SOLID, KISS, DRY / IDEAL)		S30 S37	S42 S44
RCDD (Risk & Cost Driven Design)		S36	S46 S51
System monitoring		S38	S53 S56
Kanban visualization / WIP limit		S23 S27	S41
Use of Microservices / SOA			S45 S46 S51 S52 S55 S56 S60 S61
Cloud-based services (IaaS, PaaS, SaaS / FaaS, Serverless)			S45 S55 S56 S59 S61
RESTFull API / HTTP			S45 S54 S56 S58 S61
Containerization			S45 S52 S54
API Gateways			S45 S54 S59
DDD (Domain Driven Design) / Bounded Context			S54 S56 S58
Independently deliverable (micro)services			S51 S54 S60
Monitorning of (micro)services			S45 S54 S60
Verzioning of (micro)services			S58 S59 S60

Source: Authors

favors the development of microservices, since each service can be designed, developed and shipped by a different team and on a different technological stack. In addition, the team is in charge of the complete development process of the service including deployment, operations and update.

However, the spread of microservices also increases the complexity of ecosystems (Taibi et al., 2017), so more work is needed on tool development and system-level design. In this regard, *serverless computing* is a new trend that aims to provide infrastructure for deployment and scaling services that are hidden from the developer (Pautasso et al., 2017b).

3.1. Agile architecture practices in the digital era

The results of the analysis of the selected publications are presented in order to get the answer is the question of RQ2: *What are the practices of developing and implementing Agile architecture in a modern digital environment?*

A total set of 40 practices have been identified, which are associated with at least three different sources (Table 5).

It can be noted that in the digital era there are many practices of agile architecture that are available for developing complex software systems in a modern development and production environment, and whose application depends on the particular context.

4. Discussion

In this section, the general considerations will first be discussed, and then the answers to the research questions. After that, the conducted research will be compared with other similar researches, the identified contradictory attitudes will be considered, as well as the possibilities for further research and the limitations of the conducted research.

General considerations: Out of 61 selected primary studies, 18 (30%) is from the period 2001-2010, 20 (33%) from the period 2011-2014 and 23 (37%) from the period 2015-2017, which is designated as a digital era. Out of the total, 32 (52%) studies were published in the magazine, 23 (38%) conference, 5 (8%) workshop and 1 (2%) as a whitepaper. The average grade of the selected primary studies is 8.4 on a scale of 10. Empirical studies are the most numerous and make up 22 (36%), followed by studies based on the experts' experience 21 (34%) and finally the experts' opinion 18 (30%).

Answers to research questions: The *10 key challenges* of agile architecture in the digital era have been identified, where the most important new challenge for the digital era is the application of microservice architecture that follows the challenges associated with new business models of the digital economy. Very significant challenges from the previous periods are: balancing agility and architecture, organization, communication and coordination, as well as the challenges of scaling. In addition, the following challenges are identified as important: interdependence of components, documentation of architecture, preservation of conceptual integrity and consistency of architecture, interdependence of requirements, and product lifecycle management (process optimization and value stream).

There should be noted that the old challenges remain with the emergence of new ones. In the coming period, a growing trend can be expected for the challenges brought about by the interdependence of components, due to the ever-increasing complexity in the conditions of the scaled, distributed environment, as well as the challenges that will bring new business models of the digital economy into future intelligent-connected systems (Woods, 2016).

The *10 key success factors* of agile architecture in the digital era have been identified, of which the most important are: application of continuous practices, evolutionary approach, application of tools and technologies in a combined ecosystem, continuous focus and quality attributes prioritization, understanding of the role, responsibilities and competencies of the architect. Following success factors are identified as important, too: decomposition and granularity, understanding of the context and choice of the implementation strategy, use of architectural styles, design patterns and components, application of lean principles and practices, and traditionalization of the agile approach.

The growing trend of almost all of the identified success factors, especially the importance of tools and technologies in the combined ecosystem, as well as the application of continuous practices, including continuous architecting, is also evident. That can be interpreted as achieving a certain level of maturity of the agile approach traditionalization process, which shows a downward trend.

The *40 practices* of agile architecture in the digital era have been identified, which have been referenced in at least three primary studies.

The most relevant current practices identified in the period (2001 - 2017) are: TDD/testing/ automated testing, prototype/experimentation (spikes), Lean thinking and incremental delivery.

The most significant new practices identified

in the period (2011 - 2017) are: DevOps, Continuous Delivery, Cloud computing and the Minimum Viable Product (MVP)/Lean Start-Up.

The most significant new practices identified in the period (2015-2017) are: Use of microservices/SOA, Cloud-based services (*IaaS, PaaS, SaaS/FaaS, Serverless*), RESTFull API/HTTP, Containerization, API Gateways, DDD (Domain Driven Design)/Bounded Context, independently delivered (micro) services, monitoring (micro) services and versioning (micro) services. It is interesting that two studies identify the need for machine learning, i.e. artificial intelligence (AI) because AI increasingly affects the labor market (Vochozka, Kliestik, Kliestikova & Sion, 2018) and contributes to the expansion of digitally mediated labor in a platform-based economy (Mitea, 2018).

Such a large number of identified challenges, success factors and practices indicate that there is no one solution applicable to each problem. It is necessary to transform, combine and balance different approaches, methods, principles, practices, tools, and technologies in order to give better answers to the challenges that bring a specific context.

Comparison with other similar research: According to available information, there is no SLR that deals with the trends and practices of agile architecture in the digital era. There is a SLR that deals with a similar or related topic (Dikert, Paasivaara & Lassenius, 2016), which explores the challenges and success factors of organizations' transformation in the adoption of an agile and lean process of software development in scaling conditions, citing 35 challenges in 9 categories, and 29 success factors, of which the most important is management support, choosing and customizing the agile model, training and coaching, mindset and alignment.

Also, there is a Systematic Mapping Study (Yang, Liang & Avgeriou, 2016) that combines architectural and agile methods including architectural activities and approaches, agile methods and practices, cost, benefits, challenges, success factors, tools, and lessons learned. The main difference is that the above research focuses on the software development phase, while the realized SLR in this paper focuses on all stages of the life cycle of the product: development, operation and production, i.e. a complete development and production environment, bearing in mind that the agile architecture, by the emergence of CD, has passed the boundaries of the software development phase.

Opposite Attitudes: The development of technology and tools is the main reason that a modern hyper-agile, lean development process in the combined ecosystem is possible at all; therefore, O'Connor et al. (2017) raises the question of whether this observation is in opposition to the Agile Manifesto, i.e. the principle of "*Individuals and interaction, before processes and tools*".

Babar (2009) notes that the responsibility, regarding the specification of the requests, is shifted to the user. However, Mirakhorli & Cleland-Huang (2013) claim that the time has elapsed when the specification of the requests was obtained from users, but it is necessary to be with the user, understand how the system will be used, put the minimum viable product into the user's hands, and evolve into short iterations with continuous measurement and learning.

Opportunities for further research: The identified primary studies have been largely based on the opinions and experience of the experts. Therefore, for future research, case studies of successful and unsuccessful implementation of agile architecture in the digital era are proposed. The development of large distributed software systems is significantly different from the development of small systems, whereby experience in the development of large systems is difficult to obtain, while learning programming on the example of small systems can be problematic. Therefore, future research could study in more detail the problems of acquiring competencies for successful implementation of agile architecture in complex distributed systems.

There is a lack of methods and guidelines for the implementation of agile architecture using microservices in the development of complex distributed systems, so future research could address this problem. The design of complex distributed software systems is inherently demanding, so for the successful implementation of agile architecture using microservices, SOA principles and practices must be combined with modern software development practices (Zimmermann, 2016b), so it is necessary to explore how to combine microservices and SOA principles and practices in the context of hyper-agile, lean development of complex software.

Research Limitations: In order to reduce the risk of bias, more researchers are involved in the development and evaluation of research protocols,

including the inclusion/exclusion criteria, database queries and the selection of primary studies. In order to reduce the risk of the subjectivity of researchers in the selection (coding), analysis and synthesis of data, the Atlas.ti software tool is used, more researchers are involved in evaluating the results of the research, while traceability is enabled by reference to any claims stated in relation to the results of the research.

In order to reduce the risk of omitting essential studies due to limitations regarding database searches (selection of logical operators and query keywords), the query is specifically adapted to each database. In addition, snowballing was applied, based on which relevant studies were added. One should also bear in mind the risk of the bias of the authors of the primary studies since successful examples of the implementation of agile architecture prevail.

Conclusions

The paper presents the results of a systematic literature review related to the trends of challenges and success factors, as well as the practice of agile architecture in the digital era.

The 61 primary studies were selected and analyzed in the period from 2001 to 2017, which can be divided into three characteristic intervals: Large-scale agile period (2001-2010), Continuous Delivery/DevOps period (2011-2014) and Microservices period (2015- 2017).

The key **challenges** of agile architecture in the digital era are: the application of microservices, balancing agility and architecture, the structuring of organization, communication and coordination in order to support context scaling, minimum documentation and dealing with interdependency of requirements and components, while preserving the conceptual integrity and consistency of architecture in conditions of development of new business models of the digital economy and permanent changes.

The digital era, along with the old challenges of software development, including challenges in the development of distributed systems, is characterized by new challenges that arise with the emergence and application of microservices, both in terms of migration of monolithic applications into microservices using agile approach, as well as the development of greenfield software solutions in a distributed and scaled environment.

In response to challenges, the key **success factors** of agile architecture in the digital era are: understanding the context, choosing a strategy of implementation (or combining them) and choosing appropriate tools and technologies in a combined ecosystem, in order to support the application of an evolutionary approach, continuous and lean principles and practices, focusing on quality attributes and their prioritization. In this sense, understanding the role, responsibilities and competencies of the architect is crucial, regardless of whether this role is virtual (i.e. the responsibility of the team), whereby the architect should be given a key contribution in choosing the appropriate architectural style, the design patterns and components, the decomposition of the system to the optimal level of granularity and the application of the necessary architectural practices.

The 40 old and new **practices** of agile architecture in the digital era have been identified, which should be combined depending on the specific context in order to successfully overcome the challenges of agile architecture. Two studies also indicate the need for applying artificial intelligence practices, specifically machine learning.

It is an interesting finding that success factors in the period 2015 - 2017 are essentially the same as in previous periods, with the different significance and influence of individual factors, while new challenges of the digital era are followed by new practices.

A large number of challenges, success factors and available practices indicate that there is neither solution applicable to each problem nor the same solution can be repeated for the same problem in a different context.

In the digital era, agile architecture will mark microservices based on hyper-agile and lean approach, combined with SOA principles and practices, while the development of AI will bring new challenges and practices related to future, intelligently connected systems.

Future research should focus on agile architecture in the development of complex distributed systems, whereby more case studies with successful and unsuccessful implementation examples would be desirable. Research on the problem of acquiring competencies for the successful implementation of agile architecture in complex distributed systems is needed, followed by research that will propose methods and

guidelines for the implementation of agile architecture using microservices, as well as research on the possibilities of combining microservices and SOA principles and practices in the context of hyper-agile, lean development of complex software, especially in the development of complex distributed software systems.

Acknowledgements

This work was supported in part by the Provincial Secretariat for Higher Education and Scientific Research under the Grants 142-451-2477/2018-02.SM

References

Abrahamsson, P., Babar, M. A. & Kruchten, P. (2010). Agility and Architecture: Can They Coexists? *IEEE Software, 27(2),* 16-22. https://doi.org/10.1109/MS.2010.36

Ambler, S. W. (2002). Lessons in agility from internet-based development. *IEEE Software*, *19(2),* 66-73. https://doi.org/10.1109/52.991334

Ambler, S. W. (2009). Scaling agile software development through lean governance. In *Proceedings of the 2009 ICSE Workshop on Software Development Governance, SDG 2009* (pp. 1-2). IEEE. https://doi.org/10.1109/SDG.2009.5071328

Babar, M. A. (2009). An exploratory study of architectural practices and challenges in using agile software development approaches. In *2009 Joint Working IEEE/IFIP Conference on Software Architecture & European Conference on Software Architecture* (pp. 81-90). IEEE. https://doi.org/10.1109/WICSA.2009.5290794

Bellomo, S., Ernst, N., Nord, R. & Kazman, R. (2014). Toward design decisions to enable deployability: Empirical study of three projects reaching for the continuous delivery holy grail. In *Proceedings - 44th Annual IEEE/IFIP International Conference on Dependable Systems and Networks, DSN 2014* (pp. 702-707). IEEE. https://doi.org/10.1109/DSN.2014.104

Bellomo, S., Gorton, I. & Kazman, R. (2015). Towards Agile Architecture: Insights from 15 Years of ATAM Data. *IEEE Software, 32(5)*, 38-45. https://doi.org/10.1109/MS.2015.35

Bellomo, S., Kruchten, P., Nord, R. L. & Ozkaya, I. (2014). How to agilely architect an agile architecture. *Cutter IT Journal of Information Technology Management*, 27(2), 12-17.

Bellomo, S., Nord, R. L. & Ozkaya, I. (2013). A study of enabling factors for rapid fielding combined practices to balance speed and stability. In *35th International Conference on Software Engineering (ICSE)* (pp. 982-991). IEEE Press. https://doi.org/10.21236/ADA591481

Blair, S., Watt, R. & Cull, T. (2010). Responsibility-driven architecture. *IEEE Software, 27(2)*, 26-32. https://doi.org/10.1109/MS.2010.52

Booch, G. (2007). The Economics of Architecture-First. *IEEE Software*, *24*(5), 18-20. https://doi.org/10.1109/MS.2007.146

Booch, G. (2010). An architectural oxymoron. *IEEE Software. 27(5)*, 96-96. https://doi.org/10.1109/MS.2010.117

Britto, R., Šmite, D. & Damm, L. O. (2016). Software Architects in Large-Scale Distributed Projects: An Ericsson Case Study. *IEEE Software, 33(6)*, 48-55. https://doi.org/10.1109/MS.2016.146

Buschmann, F. (2012). A Week in the Life of an Architect. *IEEE Software, 29(3)*, 94-96. https://doi.org/10.1109/MS.2012.55

Buschmann, F. & Henney, K. (2013). Architecture and agility: Married, divorced, or just good friends? *IEEE Software, 30(2)*, 80-82. https://doi.org/10.1109/MS.2013.25

Chen, L. (2015). Towards Architecting for Continuous Delivery. In *Proceedings - 12th Working IEEE/IFIP Conference on Software Architecture* (pp. 131-134). IEEE. https://doi.org/10.1109/WICSA.2015.23

Chen, L. & Babar, M. A. (2014). Towards an evidence-based understanding of emergence of architecture through continuous refactoring in agile software development. In *2014 IEEE/IFIP Conference on Software Architecture* (pp. 195-204). IEEE. https://doi.org/10.1109/WICSA.2014.45

Coplien, J. & Bjørnvig, G. (2010). *Lean Architecture for Agile Software Development*. Cornwall, UK: John Wiley & Sons.

Dikert, K., Paasivaara, M. & Lassenius, C. (2016). Challenges and success factors for large-scale agile transformations: A systematic literature review. *Journal of Systems and Software, 119*, 87-108. https://doi.org/10.1016/j.jss.2016.06.013

Durdik, Z. (2011). Towards a process for architectural modelling in agile software development. In *Proceedings of the joint ACM SIGSOFT conference--QoSA and ACM SIGSOFT symposium--ISARCS on Quality of software architectures--QoSA and architecting critical systems--ISARCS* (pp. 183-192). ACM. https://doi.org/10.1145/2000259.2000291

Dybå, T. & Dingsøyr, T. (2008). Empirical studies of agile software development: A systematic review. *Information and software technology, 50(9-10),* 833-859. https://doi.org/10.1016/j.infsof.2008.01.006

Eckstein, J. (2014). Architecture in large scale agile development. In *International Conference on Agile Software Development* (pp. 21-29). Springer, Cham. https://doi.org/10.1007/978-3-319-14358-3_3

Erder, M. & Pureur, P. (2015). *Continuous Architecture: Sustainable Architecture in an Agile and Cloud-Centric World*. Burlington, US: Morgan Kaufman.

Erder, M. & Pureur, P. (2016). What's the Architect's Role in an Agile, Cloud-Centric World? *IEEE Software, 33(5)*, 30-33. https://doi.org/10.1109/MS.2016.119

Erdogmus, H. (2009). Architecture meets agility. *IEEE Software, 26(5)*, 2-4. https://doi.org/10.1109/MS.2009.121

Faber, R. (2010). Architects as service providers. *IEEE Software, 27(2)*, 33-40. https://doi.org/10.1109/MS.2010.37

Falessi, D., Cantone, G., Sarcia, S. A., Calavaro, G., Subiaco, P., & D'Amore, C. (2010). Peaceful coexistence: Agile developer perspectives on software architecture. *IEEE Software, 27(2)*, 23-25. https://doi.org/10.1109/MS.2010.49

Fontdevila, D. & Salias, M. (2013). Software Architecture in the Agile Life Cycle. *The Advances in Computer Science : an International Journal (ACSIJ), 2(1)*, 48-52.

Ford, N., Parsons, R. & Kua, P. (2017). *Building Evolutionary Architectures - Support Constant Change*, Sebastopol, US: O'Reilly Media, Inc.

Fowler, M. & Lewis, J. (2014). Microservices. Retrieved January 17, 2018 from: https://martinfowler.com/articles/microservices.html

Gartner (2014). Gartner Says in the Digital World CIOs Need Bimodal IT: Rock Solid IT with Ability for Fluidity. Retrieved January 17, 2018 from: https://www.gartner.com/en/newsroom/press-releases/2014-10-06-gartner-says-in-the-digital-world-cios-need-bimodal-it-rock-solid-it-with-ability-for-fluidity

Gerdes, S., Jasser, S., Riebisch, M., Schröder, S., Soliman, M., & Stehle, T. (2016). Towards the essentials of architecture documentation for avoiding architecture erosion. In *Proccedings of the 10th European Conference on Software Architecture Workshops* (p. 8). ACM. https://doi.org/10.1145/2993412.3004844

Hadar, I. & Sherman, S. (2012). Agile vs. plan-driven perceptions of software architecture. In *2012 5th International Workshop on Co-operative and Human Aspects of Software Engineering (CHASE)* (pp. 50-55). IEEE. https://doi.org/10.1109/CHASE.2012.6223022

Harper, K. E. & Dagnino, A. (2014). Agile Software Architecture in Advanced Data Analytics. In *2014 IEEE/IFIP Conference on Software Architecture* (pp. 243-246). IEEE. https://doi.org/10.1109/WICSA.2014.16

Hayata, T., Han, J. & Beheshti, M. (2012). Facilitating agile software development with lean architecture in the DCI paradigm. In *2012 Ninth International Conference on Information Technology-New Generations* (pp. 343-348). IEEE. https://doi.org/10.1109/ITNG.2012.157

Hohpe, G., Ozkaya, I., Zdun, U. & Zimmermann, O. (2016). The Software Architect's Role in the Digital Age. *IEEE Software*, 33(6), 30-39. https://doi.org/10.1109/MS.2016.137

Holmes, B. & Nicolaescu, A. (2017). Continuous Architecting: Just another buzzword? *Full-scale Software Engineering/The Art of Software Testing*, 1-6.

Isham, M. (2008). Agile architecture IS possible - You first have to believe! In *Agile 2008 Conference* (pp. 484-489). IEEE. https://doi.org/10.1109/Agile.2008.16

Jalali, S., & Wohlin, C. (2012). Systematic literature studies: Database searches vs. backward snowballing. In *Proceedings of the 2012 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement* (pp. 29-38). IEEE. https://doi.org/10.1145/2372251.2372257

Kitchenham, B. (2004). Procedures for Performing Systematic Reviews. *Keele, UK, Keele University, 33(2004),* 1-26.

Kitchenham, B. (2007). Guidelines for performing Systematic Literature Reviews in Software Engineering. *EBSE Technical Report EBSE-2007-01, Keele University.*

Kruchten, P. (2010). Software Architecture and Agile Software Development—A Clash of Two Cultures? In *Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering-Volume 2* (pp. 497-498). ACM. https://doi.org/10.1145/1810295.1810448

Kruchten, P. (2013). Agile architecture. Retrieved January 17, 2018 from: https://philippe.kruchten.com/2013/12/11/agile-architecture

Leffingwell, D., Martens, R. & Zamora, M. (2008). *Principles of Agile Architecture*. Leffingwell, LLC. & Rally Software Development Corp.

Madison, J. (2010). Agile-Architecture Interactions. *IEEE Software*, 41-48. https://doi.org/10.1109/MS.2010.35

Madni, A. M. (2008). Agile Systems Architecting (ASA): Placing Agility Where it Counts. *Conference on Systems Engineering Research (CSER)* (pp. 1-7).

Martini, A. & Bosch, J. (2016). A multiple case study of continuous architecting in large agile companies: current gaps and the CAFFEA framework. In *2016 13th Working IEEE/IFIP Conference on Software Architecture (WICSA)*(pp. 1-10). IEEE. https://doi.org/10.1109/WICSA.2016.31

Matković, P., Tumbas, P. & Sakal, M. (2011). The RSX model: traditionalisation of agility. *Strategic Management*, *16(2)*, 74-83.

Mirakhorli, M. & Cleland-Huang, J. (2013). Traversing the twin peaks. *IEEE Software, 30(2)*, 30-36. https://doi.org/10.1109/MS.2013.40

Mitea, D. R. E. (2018). The Expansion of Digitally Mediated Labor: Platform-Based Economy, Technology-Driven Shifts in Employment, and the Novel Modes of Service Work. *Journal of Self-Governance and Management Economics 6(4),* 7-13.

Miyachi, C. (2011). Agile software architecture. *ACM SIGSOFT Software Engineering Notes, 36(2)*, 1-3. https://doi.org/10.1145/1943371.1943388

Moore, E. & Spens, J. (2008). Scaling agile: Finding your agile tribe. *Agile 2008 Conference* (pp. 121-124). IEEE. https://doi.org/10.1109/Agile.2008.43

Newman, S. (2015). *Building Microservices*. O'Reilly Media, Inc.

Nord, R. L., Ozkaya, I. & Kruchten, P. (2014). Agile in Distress: Architecture to the Rescue. In *International Conference on Agile Software Development* (pp. 43-57). Springer, Cham. https://doi.org/10.1007/978-3-319-14358-3_5

Nord, R. L., Ozkaya, I. & Sangwan, R. S. (2012). Making architecture visible to improve flow management in lean software development. *IEEE Software, 29(5)*, 33-39. https://doi.org/10.1109/MS.2012.109

Nord, R. L. & Tomayko, J. E. (2006). Software architecture-centric methods and agile development. *IEEE Software*, *23(2)*, 47-53. https://doi.org/10.1109/MS.2006.54

O'Connor, R. V., Elger, P. & Clarke, P. M. (2017). Continuous software engineering—A microservices architecture perspective. *Journal of Software: Evolution and Process*, 29(11), 1-12. https://doi.org/10.1002/smr.1866

Ozkaya, I., Gagliardi, M. & Nord, R. L. (2013). Architecting for large scale agile software development: A risk-driven approach. *CrossTalk*, *26(3)*, 17-22.

Pautasso, C., Zimmermann, O., Amundsen, M., Lewis, J. & Josuttis, N. (2017). Microservices in Practice, Part 1: Reality Check and Service Design. *IEEE Software*, *34(1)*, 91-98. https://doi.org/10.1109/MS.2017.24

Pautasso, C., Zimmermann, O., Amundsen, M., Lewis, J. & Josuttis, N. (2017). Microservices in Practice, Part 2: Service Integration and Sustainability. *IEEE Software*, *34(2)*, 97-104. https://doi.org/10.1109/MS.2017.56

Poort, E. (2014). Driving agile architecting with cost and risk. *IEEE Software, 31(5)*, 20-23. https://doi.org/10.1109/MS.2014.111

Poort, E. (2016). Just Enough Anticipation: Architect Your Time Dimension. *IEEE Software, 33(6)*, 11-15. https://doi.org/10.1109/MS.2016.134

Poppendieck, M. & Cusumano, M. A. (2012). Lean software development: A tutorial. *IEEE Software, 29(5)*, 26-32. https://doi.org/10.1109/MS.2012.107

Power, K. & Conboy, K. (2015). A Metric-Based Approach to Managing Architecture-Related Impediments in Product Development Flow: An Industry Case Study from Cisco. In *Proceedings of the second international workshop on software architecture and metrics* (pp. 15-21). IEEE Press. https://doi.org/10.1109/SAM.2015.10

Prause, C. R. & Durdik, Z. (2012). Architectural design and documentation: Waste in agile development? In *2012 International Conference on Software and System Process (ICSSP)* (pp. 130-134). IEEE. https://doi.org/10.1109/ICSSP.2012.6225956

Ramakrishnan, S. (2010). On Integrating Architecture Design into Engineering Agile Software Systems Agile Methods in Practice - Combination of Techniques within an Agile Method. *Issues in Informing Science and Information Technology, 7*, 9-25. https://doi.org/10.28945/1229

Richardson, C. & Smith, F. (2016). Microservices: From Design to Deployment. Retrieved January 17, 2018 from: https://www.nginx.com/blog/microservices-from-design-to-deployment-ebook-nginx/

Shadija, D., Rezai, M. & Hill, R. (2017). Microservices: Granularity vs. Performance. In *Companion Proceedings of the10th International Conference on Utility and Cloud Computing* (pp. 215-220). ACM. https://doi.org/10.1145/3147234.3148093

Taibi, D., Lenarduzzi, V., Pahl, C. & Janes, A. (2017). Microservices in agile software development: a workshop-based study into issues, advantages, and disadvantages. In *Proceedings of the XP2017 Scientific Workshops* (p. 23). ACM. https://doi.org/10.1145/3120459.3120483

Tumyrkin, R., Mazzara, M., Kassab, M., Succi, G. & Lee, J. Y. (2016). Quality attributes in practice: Contemporary data. In *Agent and Multi-Agent Systems: Technology and Applications* (pp. 281-290). Springer, Cham. https://doi.org/10.1007/978-3-319-39883-9_23

Villamizar, M., Garcés, O., Castro, H., Verano, M., Salamanca, L., Casallas, R., & Gil, S (2015). Evaluating the Monolithic and the Microservice Architecture Pattern to Deploy Web Applications in the Cloud. In *2015 10th Computing Colombian Conference (10CCC)* (pp. 583-590). IEEE. https://doi.org/10.1109/ColumbianCC.2015.7333476

Vochozka, M., Kliestik, T., Kliestikova, J. & Sion, G. (2018). Participating in a Highly Automated Society: How Artificial Intelligence Disrupts the Job Market. *Economics, Management, and Financial Markets 13(4),* 57-62.

Waterman, M., Noble, J. & Allan, G. (2012). How much architecture? Reducing the up-front effort. In *2012 Agile India* (pp. 56-59). IEEE. https://doi.org/10.1109/AgileIndia.2012.11

Waterman, M., Noble, J. & Allan, G. (2015). How much up-front? A grounded theory of agile architecture. In *Proceedings of the 37th International Conference on Software Engineering-Volume 1* (pp. 347-357). IEEE Press. https://doi.org/10.1109/ICSE.2015.54

Webster, J. & Watson, R. T. (2002). Analyzing the Past to Prepare for the Future: Writing a Literature Review. *MIS Quarterly, 26(2),* Xiii-Xxiii.

WEF & Accenture (2017). Digital Transformation Initiative. Retrieved March 12, 2018 from: https://www.accenture.com/t20170116T084450__w__/us-en/_acnmedia/Accenture/Conversion-Assets/WEF/PDF/Accenture-DTI-executive-summary.pdf

Woods, E. (2015). Aligning Architecture Work with Agile Teams. *IEEE Software, 32(5)*, 24-26. https://doi.org/10.1109/MS.2015.119

Woods, E. (2016). Software Architecture in a Changing World. *IEEE Software, 33(6),* 94-97. https://doi.org/10.1109/MS.2016.149

Yang, C., Liang, P. & Avgeriou, P. (2016). A systematic mapping study on the combination of software architecture and agile development. *Journal of Systems and Software, 111*, 157-184. https://doi.org/10.1016/j.jss.2015.09.028

Zimmermann, O. (2016). Designed and delivered today, eroded tomorrow? In *Proccedings of the 10th European Conference on Software Architecture Workshops* (p. 7). ACM. https://doi.org/10.1145/2993412.3014339

Zimmermann, O. (2016). Microservices tenets: Agile approach to service development and deployment. *Computer Science - Research and Development, 32(3-4)*, 301-310. https://doi.org/10.1007/s00450-016-0337-0

✉ Correspondence

Zoran Dragičević

Company Boksit
Trg rudara 1, 75446, Milići,
Republic of Srpska, Bosnia and Herzegovina

E-mail: zoran.dragicevic021@gmail.com

STRATEGIC MANAGEMENT, Vol. 24 (2019), No. 2, pp. 034-044

DOI:10.5937/StraMan1902034N

Received: March 13, 2019
Accepted: May 10, 2019

Top management remuneration in a post-transition economy: does company ownership make a difference?

Ivana Načinović Braje
Faculty of Economics and Business, University of Zagreb, Zagreb, Croatia
Lovorka Galetić
Faculty of Economics and Business, University of Zagreb, Zagreb, Croatia

Abstract
Executive remuneration is considered among most important mechanisms to align interests of managers and company owners. This paper examines the role of company ownership as a determinant of top management compensation. The aim of the research was to determine the impact of ownership origin, domestic or foreign, on top management remuneration practices in a post-transition economy country. The research is based on a survey of top management remuneration practices among 60 medium and large sized Croatian companies. Research results indicate that foreign owned companies provide more annual bonuses, long-term compensation and additional benefits to higher percentages of top managers than domestically owned companies. Companies with domestic owners provide annual bonuses at higher ratios of base pay compared to foreign owned companies and position managerial pay at higher levels relative to comparative firms in the sector with foreign owners. Top managers, investors and firm owners should be aware that in post-transition economies compensation practices greatly differ between domestic and foreign owned companies.

Keywords
company ownership, post-transition, top management compensation

Introduction

The separation of ownership and control in contemporary organizations creates a context where top managers coordinate and control company's activities. However, in case they pursue specific behaviour that brings damage to the owners' interests they will not bear any personal financial loss except possible job loss and lost pay. This problem of managerial power and discretion, also known as the agency problem, creates prerequisites for potentially conflicting interests of top managers and owners (Pepper & Gore, 2015). Due to the fact that managerial actions cannot be perfectly observed by shareholders, agency theory predicts that under such circumstances compensation policy for top management must provide incentives to select and implement actions that increase shareholder wealth (Pereira & Esperança, 2015).

The amount of top management compensation rose dramatically during the 1980s and 1990s, which initiated much debate on the determinants and consequences of managerial pay (Frydman & Saks, 2010). Due to these extremely high levels of compensation, the topic of executive remuneration had a strong proliferation both with the popular press and the academic literature, with many critics claiming that amounts paid to executives are excessive (e.g. Kaplan, 2008). Abundant top management compensation academic literature covers numerous theoretical and practical issues within top management compensation. However, most of these contributions are based on data from Anglo-Saxon countries with Anglo-American system of corporate governance. Still, the issue of top management compensation is very country specific and dependent upon the country-specific regulation and level of separation of ownership

and control (Rampling, Eddie & Liu, 2013, Pereira & Esperança, 2015).

Very little is known about top management compensation among countries employing continental system of corporate governance, especially among European post-transition economies, although there has been growing interest to understand these practices (e.g. Berber, Morley, Slavić & Poór, 2017). Central and Eastern European (CEE) economies have undergone transition processes which have established new ownership structure, a change in managers' profile and change in the reward system. The controlled wages of the centrally planned systems were liberalized, which resulted in stronger wage differences between employees (Festing & Sahakiants, 2013). With respect to top managers, a key feature of the new reward system was abandoning egalitarian compensation practices and introducing higher levels of compensation for top managers relative to other wage earners (Eriksson, 2005, p. 660).

Existing studies on general trends in compensation management in transition economies emphasize some differences in compensation practices with respect to ownership structure with foreign owned companies offering higher levels of compensation (e.g. Eriksson, 2005). Studies on compensation management in Croatia support this finding. Out of the 20 companies with highest salaries in Croatia in 2017, 16 are owned by foreign owners (FINA, 2018). Based on these findings, the focus of this research was to answer the following research questions: RQ1: What are the most important determinants of top management compensation in post-transition economies? RQ2: What is the structure of top management compensation in post-transition economies? RQ3 Are there any differences in the determinants and structure of top management compensation between companies with domestic and/or foreign owners.

The purpose of this paper is to provide new insight into the practices of top management compensation in post-transition economies. For this purpose, two hypotheses were set:

H1: Determinants of top management remuneration in Croatian companies in domestic and foreign ownership differ greatly.

H2: Foreign owned companies use variable compensation more often than domestic owned companies.

The paper first presents a theoretical background on the structure and determinants of top management compensation. This is followed by a description of methodology, an analysis of current practices of top management compensation among domestic and foreign owned companies and discussion and conclusion of findings.

1. Theoretical background

1.1. Structure of top management remuneration

Top management compensation packages include several components, where each of these components has differing effects on employee motivation as well as different costs for the organization (Agarwal, 2010). Most common components of compensation are salary, bonus, long term incentives such as stock options and stock grants, pensions, benefits and perks. Among these, base pay will have the greatest impact on attracting and retaining top managers, while short-term incentives will be important for top management's motivation and as a form of recognition. Long-term incentives will have an impact on retaining top managers. Benefits are the most important as the form of recognition (Ellig, 2007). A well-designed compensation plan must make trade-offs between the components to maximize the net benefit to both the corporation and the top management.

In publicly traded companies, top management compensation package is determined by the compensation committee. The committee's task is to propose the content of executive directors' compensation package, which is then to be confirmed by the full board. Research has found that the overall compensation package can depend upon the number of factors related to the committee and the corporate governance such as size and composition of the compensation committee (board of directors), board member independence, types of shareholders, ownership structure or executive directors' share ownership (e.g. Vafeas, 2003; Gregory-Smith, 2012).

The processes of structuring top management compensation packages in transition economies does not necessarily follow all theoretical expectations established within Anglo-American system of corporate governance, especially with respect to equity-based compensation in the form of stock options that has caused rapid growth of the overall amounts received by top executives in such countries (Farid, Conte & Lazarus, 2011). Furthermore, Beer & Katz (2003) found that the

egalitarian social values of Europeans cause them to have negative views of executive incentive systems known in the USA.

1.2. Determinants of top management remuneration

Empirical research into the determinants of executive remuneration has accumulated many individual factors that can have an impact on executives' compensation packages. These include firm performance (Conyon & Sadler, 2001; Combs & Skill, 2003; McKnight & Tomkins, 2004), company size (Singh & Agarwal, 2003; Chalmers, Koh, & Stapledon, 2006; Sakawa & Watanabel, 2008), level of growth (Firth, Tam, & Tang, 1999), job complexity (Santalo & Knock, 2009), company complexity (diversification) (Matolcsy & Wright, 2006) or strategy (Singh & Agarwal, 2003). Some determinants are related to top management tenure or age (McKnight & Tomkins, 2004), internal/external promotion to the position (Johnston, 2005), education (Pereira & Esperança, 2015), work experience (Bragaw & Misangyi, 2017) or gender (Kulich, Trojanowski, Ryan, Haslam, & Renneboog, 2011).

Although academic literature recognizes an abundance of top management remuneration determinants, some of them have been more often emphasized. The size construct, either in terms of sales, assets, number of employees or market share, has been a unanimously confirmed predictor of compensation by many authors (e.g. Finkelstein & Boyd, 1998; Rahman & Mustafa, 2018). Tosi, Werner, Katz & Gomez-Mejia (2000) show that firm size accounts for more than 40% of the variance in total CEO pay, while firm performance accounts for less than 5% of the variance.

Firm performance is also an important determinant of top management compensation, directly following from the agency theory perspective. It is probably the most researched determinant of top management remuneration with still lacking finite conclusions. Research on different data sets and different measures of performance (e.g. aggregate/relative financial performance, non-financial performance etc., see Perry & Zenner, 2001; Epstein & Roy, 2005, Rahman & Mustafa, 2018) produced sometimes contradictory conclusions.

Ownership structure has been an often-researched determinant of top management remuneration as well (e.g. Sakawa & Watanabel, 2008). However, the focus of such research was on the dispersion of ownership (Jones & Mygind, 2011), institutional ownership (Victoravich, Xu & Gan, 2012), family ownership (Cheng, Lin & Wei, 2015) or employee ownership (Jones & Mygind, 2011) and its impact on aspects of remuneration. Research on the impact of the foreign ownership on executive remuneration is very scarce. To the best of the authors' knowledge, only a few studies analyse the effects of ownership origin (private/foreign) on the compensation system (Aitken, Harrison & Lipsey, 1996; Almeida, 2007; Shinozaki, Moriyasu & Uchida, 2016; Kang & Nanda, 2017). These studies all tend to find a wage premium in foreign owned firms. Except for higher total remuneration among foreign owned firms, some authors study the relationship between foreign ownership and the structure of compensation package (e.g. Cho, Huang & Padmanabhan (2014) did not found a relationship between ownership structure and long term executive compensation; Yoshikawa, Rasheed & Del Brio (2010) found that foreign owned firms reduce cash bonus payments, but are more likely to use equity compensation in the form of stock options (Shinozaki et al., 2016)).

1.3. The role and growth of foreign ownership in transition economies

A common characteristic of all post-transition countries is a shift from social to private ownership. Privatization, accompanied with the inflow of foreign direct investment, resulted with a number of companies with a proportion of shares owned by foreign entities (Apostolov, 2013) and modern working arrangements (Chessell, 2018; Nica, 2018). Following such ownership structure, companies can be categorized based on their dominant owners as domestic or foreign owned. Foreign ownership is expected to have a positive impact on firm performance (Desender, Aguilera, López puertas--Lamy & Crespi, 2016; Ciftci, Tatoglu, Wood, Demirbag & Zaim, 2019) due to both resources and knowledge transfer. In the context of the finding that companies from Central and Eastern Europe (CEE) lag behind their western counterparts (World Economic Forum, 2014), it is interesting to explore the level of implementation of western practices within top management remuneration and the differences between domestic and foreign owned companies with respect to top management remuneration in post-transition CEE countries.

2. Methodology

2.1. Sample and data

The population for the primary research were large and medium-sized Croatian companies since those are expected to have more sophisticated HRM practices in general and reward practices in specific. The population of Croatian companies that employ more than 100 employees was obtained through Croatian Chamber of Commerce (CCC), where it was revealed that approximately 1700 companies in Croatia (excluding banking and finance sector) employ more than 100 people, out of which 386 companies employ more than 250 people (labelled as "large companies"). This research is based on a sample of 60 companies.

With respect to ownership structure, the sample consisted of 56.7% of companies with majority private domestic ownership (n=34), 33.3% of companies with majority private foreign ownership (n=20) and 10% of companies with either state (public) ownership or mixed ownership. Since the objective of this research was to compare companies with private domestic and foreign ownership, companies with mixed ownership were omitted from further research, so that research sample included 54 remaining companies.

The independent characteristics of the companies in the sample are given in a summary table below (Table 1). The statistical analysis of the primary data was conducted by using IBM SPSS 21 software.

Table 1 Data distribution by sample characteristics

Company characteristic	Total sample (n=60)	Private domestic companies (n=34)	Private foreign-owned companies (n=20)
Industry	Manufacturing – 52.54% Services – 47.46%	Manufacturing – 52.9% Services – 47.1%	Manufacturing – 42.86% Services – 57.14%
Year of establishment	Before 1990 – 46.70% After 1990 – 53.30%	Before 1990 – 44.1% After 1990 – 55.9%	Before 1990 – 35.00% After 1990 – 65.00%
Number of employees	Less than 250 – 51.70% More than 250 – 48.30%	Less than 250 – 50.00% More than 250 – 50.00%	Less than 250 – 65.00% More than 250 – 35.00%
Legal form	Joint stock company – 33.30% Limited liability company – 66.70%	Joint stock company – 29.40% Limited liability company – 70.60%	Joint stock company – 30.00% Limited liability company – 70.00%
Profitability in the last 5 years	Cannot assess – 1.70% Unprofitable – 5.00% Around or below average – 23.30% Profitable – 70.00%	Cannot assess – 0% Unprofitable – 5.90% Around or below average – 20.60% Profitable – 73.50%	Cannot assess – 5.00% Unprofitable – 5.00% Around or below average – 20.00% Profitable – 70.00%

Source: Authors' work

As shown in Table 1, research sample included companies with long tradition established before 1990 (46.7%) and those established during or after the transition period that started in 1990 (53.3%). Among foreign owned companies, the sample included more companies that were established during 1990 or later (65.0%). The sample had similar proportion of companies with fewer than 250 employees (51.7%) and more than 250 employees (48.3%). Among foreign owned companies, most of them employed fewer than 250 employees (65%). This research covered both joint stock companies (33.3%) and limited liability companies (66.7%). According to the companies' self-reported profitability in the last 5 years, 70% of companies were profitable, 23.3% were of average or below average profitability and 5% were unprofitable.

2.2. Research instrument

A questionnaire containing 46 questions was designed by the authors for the purpose of primary data collection. This research is part of a larger project aimed at exploring reward practices is Croatia. Majority of key questions about different reward management strategies were found or adapted in different journal articles as well as *Chartered Institute for Personnel Development* internal materials. An e-mail with cover letter and link to the questionnaire was sent to managers of HR departments of all companies in the CCC database in April 2017. Reminders were sent out in May and June, followed by personal reminders to HR managers of different project members using professional networks. The allotted time for completing the questionnaire was approximately 30 to 45 minutes. The respondents, HR managers, were asked to provide information on whether each examined pay practice existed in their organization and its features. Most variables

of interest were assessed on a Likert type scale, e.g. the importance of several determinants of top management remuneration was assessed on a 5-point Likert-type scale (1= no impact, 5= dominant impact). Some variables were of nominal character and control variables were designed almost exclusively as closed-ended questions, such as ownership type, profitability in the last five years and legal form of the company. Several open-ended questions were present as well (e.g. year of establishment, industry, number of employees).

2.3. Statistical analysis

Arithmetic means were used to describe the impact of several compensation determinants. The non-parametric Mann-Whitney U test was used to compare two independent groups (foreign owned and domestic owned companies) for the importance of compensation determinants. Fisher's exact test was used to test the difference between foreign owned and domestic owned companies for distribution of compensation components and ratio of yearly bonus to annual pay due to categorical data.

3. Results

According data from Table 2, the most important determinant of top management compensation is managers' personal characteristics. It is even more important for companies in domestic ownership ($\bar{x}$=4.3, s.d.=.68) than for those in foreign ownership ($\bar{x}$=4.05, s.d.=.89). Except for personal characteristics, domestic owned companies rated skills important for the position ($\bar{x}$=3.85, s.d.=.82) and economic situation in the industry ($\bar{x}$=3.41, s.d.=.86) as relatively important determinants. Foreign owned companies reported that, besides personal characteristics, they also find skills important for the position as an important determinant of top management compensation ($\bar{x}$=3.45, s.d.=1.1), equally important as company size and complexity ($\bar{x}$=3.45, s.d.=1.0). Mann-Whitney U test showed statistically significant difference between foreign and domestic owned companies only for the determinant position attractiveness (at $p<0.1$). This determinant was more important for foreign owned companies.

Table 2 Determinants of top management remuneration in a post-transition country

	Private domestic ownership N=34 Mean (Standard deviation)	**Private foreign ownership N=20 Mean (Standard deviation)**
Benchmark at the industry level	2.529 (1.2119)	2.900 (1.1192)
Company size and complexity	3.088 (0.9331)	3.450 (0.9987)
Market position and status	3.029 (0.9996)	3.200 (1.0563)
Position attractiveness*	2.500 (1.1612)	3.100 (1.1653)
General economic situation	2.882 (1.0080)	3.000 (1.1698)
Skills important for the specified position	3.853 (0.8214)	3.450 (1.0990)
Personal characteristics (e.g. qualifications, work experience, work outcomes)	4.324 (0.6840)	4.050 (0.8870)
Current economic situation in the industry	3.412 (0.8570)	3.350 (1.2258)

*p<0,1
Source: Authors' work

The occurrence of different forms of compensation for top managers is shown in Table 2. An earlier research into top management remuneration in Croatia by Načinović (2012) revealed that almost ¼ (23.68%) of companies do not use any form of variable compensation. On average, compensation package included 82.92% of fixed pay and 17.08% of variable pay. Furthermore, the same research showed that, although a very popular form of compensation among the developed countries, equity compensation lags in popularity in transition economies (offered by only 18.42% of sampled companies).

This research found several differences comparing domestic and foreign owned companies: (1) annual bonus is more often used by foreign companies (a high proportion of 29.4% of domestic companies still do not offer it to its top managers, whereas 80% of foreign firms provide it to most or all top managers); (2) long term bonus is very rarely offered to top managers, it is slightly more often found in foreign owned companies but rates of use are very low; (3) equity based compensation is just sporadically used by companies in this post-transition

economy country; (4) benefits are more often used by foreign owned companies, since a high proportion of 44.1% domestic owned companies do not offer additional perks to top managers.

Results presented in Table 3 suggest that top management remuneration practices in (post)transition economy countries differ from those adopted by companies in Anglo-Saxon countries. Although this was expected considering different corporate governance systems and ownership structures, research results indicate absence of any convergence of practices in a post-transition economy and practices in developed countries. As the basic form of variable remuneration for managers, annual bonus is for more than half of sampled domestic-owned companies either non-existent or offered to just 1-20% of top managers (very likely just the CEO). More sophisticated reward practices (e.g. equity-based compensation) are almost non-existent among Croatian companies although, as explained in study limitations, this might be the consequence of sampled companies' profile. However, a general conclusion that can be drawn from table 3 is that foreign owned companies have slightly more developed top management compensation practices since they offer all examined forms of compensation to a higher percentage of top managers.

Table 3 Distribution of compensation components among private and foreign owned companies

Component		% of companies				
		Not offered	1-25% managers	26-50% managers	51-75% managers	76-100% managers
Annual bonus	Domestic	29.4	32.4	2.9.	2.9	32.4
	Foreign	10.0	10.0	0	0	80.0
Long term bonus	Domestic	91.2	5.9	0	0	2.9
	Foreign	75.0	5.0	10.0	0	10.0
Shares, options and other forms of equity	Domestic	85.3	5.9	0	0	8.8.
	Foreign	75.0	10.0	5.0	0	10.0
Additional benefits	Domestic	44.1	17.6	11.8	5.9	20.6
	Foreign	10.0	25.0	0	5.0	60.0

Source: Authors' work

In the following step the ratio of top management annual bonus was compared to annual base pay. Table 2 showed that many companies in domestic ownership do not offer annual bonus to its employees, however, according to Table 4, it seems that companies in domestic ownership tend to use higher relative amounts of annual bonus. This finding was somewhat surprising, since it could be expected that foreign owners due to their inability for direct supervision use some form of pay for performance schemes. However, as shown in Table 3, foreign owned firms offer other forms of compensation (especially long-term incentives and benefits) and thus possibly offer lower relative amounts of annual bonuses. Also, it must be emphasized that ownership concentration might moderate the amount of annual bonus but it was not controlled as a part of this research.

Table 4 The approximate ratio of yearly bonus to annual base pay for companies offering annual bonus

Yearly bonus to annual base pay	Majority ownership	
	Domestic	Foreign
Up to 10%	13.6%	20.0%
10-20%	18.2%	30.0%
20-50%	18.2%	30.0%
50-100%	22.7%	10.0%
Double or more than double salary	27.3%	10.0%

Source: Authors' work

Since research data confirms that foreign owned firms offer higher salaries than companies with majority domestic ownership, companies' intended positioning of managerial compensation relative to comparative firms in the sector was examined next.

Table 5 Positioning of managerial compensation relative to comparative firms in the sector

Positioning of managerial compensation	Majority ownership	
	Domestic	Foreign
Within the bottom 10% (10th percentile) of sectoral comparators	2.9%	0%
Within the lower quartile (25th percentile) of sectoral comparators	0%	5.0%
At or close to the relevant market median (e.g. mid-point of sectoral range for group)	38.2%	65.0%
Within the upper quartile (75th percentile) of sectoral comparators	20.6%	10.0%
Within the top 10% (90th percentile) of sectoral comparators	26.5%	20.0%
Don't know/do not collect this information	11.8%	0%
Total	100%	100%

Source: Authors' work

Table 5 indicates that majority of foreign owned companies (65%) aim at paying their top managers around relevant market median. Among domestic companies many of them aim at paying top managers above average amounts. Such finding might result from the fact that foreign owned firms have a more systematic approach to top management remuneration and use salary surveys and benchmark information when determining compensation packages. Additional reason for this might be that foreign owned firms have an image of more attractive employer thus domestic companies must increase offered compensation amounts to attract top-talent top managers. Also, foreign owned firms offer as a part of the compensation package long term incentives and benefits that are sometimes neglected by companies in domestic ownership.

Descriptive analyses showed some clear differences in top management remuneration practices between sampled foreign and domestic companies in Croatia. As a part of the research it was examined weather these can be generalized to the population of medium sized and large companies.

Table 6 List of statistically significant differences in compensation between majority foreign and domestic owned companies

Feature	Significant differences	Test used	Implication
Distribution of compensation components	Annual bonus (p=0.009)	Fisher's exact test	Foreign owned companies provide these forms of compensation to a higher percentage of top managers.
	Benefits (p=0.007)		
The approximate ratio of yearly bonus to annual base pay for companies offering annual bonus	Statistically significant difference (p=0.030)	Fisher's exact test	Private companies with domestic owners tend to provide annual bonuses that are at higher percentages of base salary for top managers
Positioning of managerial compensation relative to comparative firms in the sector	Statistically significant difference (p=0.017)	Fisher's exact test	When compared with foreign owned companies, private companies with domestic owners tend to position compensation higher than sectoral comparators

Source: Authors' work

After using Fisher's exact test some statistically significant differences were found in the distribution of compensation packages in foreign and domestic companies, precisely annual bonus (p=0.009) and benefits (p=0.007). The same test was used to test the difference in the ratio of yearly bonus to annual base pay between domestic and foreign owned companies and it showed a statistically significant difference (p=0.030). Furthermore, Fisher's exact test confirmed statistically significant difference with positioning of managerial compensation relative to comparative firms in the sector (p=0.017) among domestic and foreign owned companies.

Discussion and conclusion

Top management remuneration is an often-researched topic. However, possibilities for generalizing conclusions globally are somewhat limited. The practice of top management remuneration depends upon country-specific factors such as corporate governance system, ownership concentration, legal and tax system etc. Current knowledge on top management remuneration in European transition economies is highly limited. During the transition period many of these countries supported foreign investments which resulted in increased number of companies being owned by foreign investors. In most of these countries companies in majority foreign ownership are usually known for paying higher compensation levels compared to companies in domestic ownership. The purpose of this paper was to determine the patterns of top management remuneration in a post-transition economy, and

specifically to compare practices in domestic and foreign owned companies. For this purpose, we used results of a primary research conducted in Croatia.

When making decisions about compensation, the first research question was to identify the important determinants of top management compensation in (post)transition economies. Among the determinants researched as a part of this study, the most important determinant of top management compensation for Croatian companies is managers' personal characteristics. Managers' personal characteristics such as age, education, work experience etc. have been an often-recognized determinant of top management remuneration (McKnight & Tomkins, 2004; Pereira & Esperança, 2015 etc.). Considering that top managers negotiate on their salaries and receive a unique compensation package, such finding does not come as a surprise. Research results indicate that besides formal qualifications, companies also emphasized the importance of skills necessary for the job position. On the other hand, benchmark at the industry level was rated as a determinant of minor importance. Other determinants which have been empirically proved to impact overall compensation such as company size and market position (performance) in the researched post-transition economy have only moderate importance for the overall compensation package.

When comparing determinants of top management compensation in companies with domestic and foreign ownership, it can be concluded that companies in domestic ownership give more attention to managers' attributes and skills than companies in foreign ownership. Companies in foreign ownership value company size and complexity, market position and economic situation in the company more than companies with domestic owners. Despite these differences in the importance of compensation determinants, additional testing did not provide many statistically significant differences among domestic and foreign owned companies. The only compensation determinant that has proven statistical difference between companies in domestic and foreign ownership is position attractiveness. This determinant is perceived by companies in domestic ownership as just moderately important, whereas companies in foreign ownership rated it as slightly more important. However, these results are statistically significant and therefore it can be generalized that in the population of Croatian companies those companies in foreign ownership acknowledge more position attractiveness as a determinant of top management remuneration ($p=0.061$). All other determinants did not show any statistically significant difference with respect to ownership origin. These findings provide only partial support to H1.

The second research question was to identify the structure of top management compensation in (post)transition economies. The exploration of distribution of compensation components among top managers has revealed that foreign owned companies more often combine different forms of compensation. Similarly to research by Načinović (2012), it has been confirmed once again that there are still quite a few companies that do not use any form of variable compensation for their top managers. For example, for companies in domestic ownership, 29.4% do not provide annual bonuses, 91.2% do not provide long-term bonuses, 85.3% do not provide equity compensation and 44.1% of sampled companies do not provide additional benefits.

The final research question aimed at exploring differences in the determinants and structure of top management compensation between companies with majority domestic and/or foreign owners. Research findings suggest that there is still a large gap between top management remuneration in companies in post-transition economies and those in more developed countries. Although some of these differences can be the result of country-specific systems of corporate governance, research results indicate very low usage of variable compensation practices in companies with majority domestic ownership. Foreign owned companies provide other forms of compensation at slightly higher rates, but even these rates are much lower than among developed countries. The differences in the utilization of selected compensation components are statistically significant (annual bonus $p=0.009$ and additional benefits $p=0.007$). These results provide support for H2, since foreign owned firms use variable compensation more often than domestic owned firms.

There are some additional differences between domestic and foreign owned companies. For example, although foreign owned firms usually pay higher salaries, this research has shown that foreign owned firms initially aim at paying compensation at or close to the relative market median, whereas majority of domestic companies

aim either at market median or above.

This research has confirmed that the origin of ownership, either domestic or foreign, is an influential determinant of the top management remuneration practices. There are several limitations to this study. Sampled firms were classified as foreign-owned if more than 50 percent of the firm's capital was in foreign hands. In case companies had a smaller foreign capital share they were included either in the category domestic ownership or mixed ownership although they might have transferred compensation practices from the foreign owner. This research included both joint stock companies and limited liability companies so some forms of compensation (e.g. equity remuneration) are more often applicable by public limited companies.

Acknowledgement

This research was funded by Croatian Science Foundation, project CompCroEU.SM

References

Agarwal, A. S. (2010), Motivation and Executive Compensation. *IUP Journal of Corporate Governance*, *9*(1-2), 27-46.

Aitken, B., Harrison, A., & Lipsey, R. E. (1996). Wages and foreign ownership A comparative study of Mexico, Venezuela, and the United States. *Journal of International Economics*, *40*(3-4), 345-371. https://doi.org/10.1016/0022-1996(95)01410-1

Almeida, R. (2007). The labor market effects of foreign owned firms. *Journal of International Economics*, *72*(1), 75-96. https://doi.org/10.1016/j.jinteco.2006.10.001

Apostolov, M. (2013). Governance and enterprise restructuring in Southeast Europe. *International Journal of Social Economics*, *40*(8), 680-691. https://doi.org/10.1108/IJSE-07-2012-0124

Beer, M., & Katz, N. (2003). Do incentives work? The perceptions of a worldwide sample of senior executives. *Human Resource Planning*, *26*(3), 30-44.

Berber, N., Morley, M. J., Slavić, A., & Poór, J. (2017). Management compensation systems in Central and Eastern Europe: a comparative analysis. *The International Journal of Human Resource Management*, *28*(12), 1661-1689. https://doi.org/10.1080/09585192.2016.1277364

Bragaw, N. A., Misangyi, V. F. (2017). The Value of CEO Mobility: Contextual Factors That Shape the Impact of Prior CEO Experience on Market Performance and CEO Compensation.*Human Resource Management*, *56* (2), 243-265. https://doi.org/10.1002/hrm.21737

Chalmers, K., Koh, P. S., & Stapledon, G. (2006). The determinants of CEO compensation: Rent extraction or labour demand?. *The british accounting review*, *38*(3), 259-275. https://doi.org/10.1016/j.bar.2006.01.003

Cheng, M., Lin, B., & Wei, M. (2015). Executive compensation in family firms: The effect of multiple family members. *Journal of Corporate Finance*, *32*, 238-257. https://doi.org/10.1016/j.jcorpfin.2014.10.014

Chessell, D. (2018). The Jobless Economy in a Post-Work Society: How Automation Will Transform the Labor Market. *Psychosociological Issues in Human Resource Management, 6*(2), 74-79. https://doi.org/10.22381/pihrm6220187

Cho, K. R., Huang, C. H., & Padmanabhan, P. (2014). Foreign ownership mode, executive compensation structure, and corporate governance: Has the literature missed an important link? Evidence from Taiwanese firms. *International Business Review*, *23*(2), 371-380. https://doi.org/10.1016/j.ibusrev.2013.06.005

Ciftci, I., Tatoglu, E., Wood, G., Demirbag, M., & Zaim, S. (2019). Corporate governance and firm performance in emerging markets: Evidence from Turkey. *International Business Review*, 28(1), 90-103. https://doi.org/10.1016/j.ibusrev.2018.08.004

Combs, J. G., & Skill, M. S. (2003). Managerialist and human capital explanations for key executive pay premiums: A contingency perspective. *Academy of Management Journal*, *46*(1), 63-73. https://doi.org/10.5465/30040676

Conyon, M. J., & Sadler, G. V. (2001). Executive pay, tournaments and corporate performance in UK firms. *International Journal of Management Reviews*, *3*(2), 141-168. https://doi.org/10.1111/1468-2370.00060

Desender, K. A., Aguilera, R. V., Lópezpuertas-Lamy, M., & Crespi, R. (2016). A clash of governance logics: Foreign ownership and board monitoring. *Strategic Management Journal*, *37*(2), 349-369. https://doi.org/10.1002/smj.2344

Ellig, B. R. (2007). *The complete guide to executive compensation*. New York, NY: McGraw-Hill.

Epstein, M. J., & Roy, M. J. (2005). Evaluating and monitoring CEO performance: evidence from US compensation committee reports. *Corporate Governance: The international journal of business in society*, *5*(4), 75-87. https://doi.org/10.1108/14720700510616604

Eriksson, T. (2005). Managerial pay and executive turnover in Czech and Slovak republic. *Economics of Transition*, *13*(4), 659–677. https://doi.org/10.1111/j.0967-0750.2005.00236.x

Farid, M., Conte, V., & Lazarus, H. (2011). Toward a general model for executive compensation. *Journal of Management Development*, *30*(1), 61-74. https://doi.org/10.1108/02621711111098370

Festing, M., & Sahakiants, I. (2013). Path-dependent evolution of compensation systems in Central and Eastern Europe: A case study of multinational corporation subsidiaries in the Czech Republic, Poland and Hungary. *European management journal*, *31*(4), 373-389. https://doi.org/10.1016/j.emj.2013.01.005

Fina (2018). Prosecna placa zaposenih kod poduzetnika. Retrived December 2018, from at https://www.fina.hr/novosti/-/asset_publisher/pXc9EGB2gb7C/content/prosjecna-placa-zaposlenih-kod-poduzetnika-5-372-kune-a-u-tri-podrucja-djelatnosti-veca-od-7-500-ku-1

Finkelstein, S., & Boyd, B. K. (1998). How much does the CEO matter? The role of managerial discretion in the setting of CEO compensation. *Academy of Management Journal*, *41*(2), 179-199. https://doi.org/10.5465/257101

Firth, M., Tam, M., & Tang, M. (1999). The determinants of top management pay. *Omega*, *27*(6), 617-635. https://doi.org/10.1016/S0305-0483(99)00021-3

Frydman, C., & Saks, R. E. (2010). Executive compensation: A new view from a long-term perspective, 1936–2005. *The Review of Financial Studies*, *23*(5), 2099-2138. https://doi.org/10.1093/rfs/hhp120

Gregory-Smith, I. (2012). Chief Executive Pay and Remuneration Committee Independence. Oxford Bulletin of Economics and Statistics, 74, 510-531. https://doi.org/10.1111/j.1468-0084.2011.00660.x

Johnston, J. (2005). Reward design and CEO succession in the UK. *Applied Economics*, *37*(13), 1535-1541. https://doi.org/10.1080/00036840500193914

Jones, D. C., & Mygind, N. (2011). Majority ownership and chief executive compensation. In *Advances in the Economic Analysis of Participatory and Labor-Managed Firms* (pp. 115-141). Emerald Group Publishing Limited. http://dx.doi.org/10.1108/S0885-3339(2011)0000012009

Kang, L. S., & Nanda, P. (2017). How is managerial remuneration determined in India?. *Journal of Accounting in Emerging Economies*, *7*(2), 154-172. https://doi.org/10.1108/JAEE-03-2015-0017

Kaplan, S. N. (2008). Are US CEOs Overpaid?. *Academy of Management Perspectives*, 22(2), 5-20. https://doi.org/10.5465/amp.2008.32739755

Kulich, C., Trojanowski, G., Ryan, M. K., Alexander Haslam, S., & Renneboog, L. D. (2011). Who gets the carrot and who gets the stick? Evidence of gender disparities in executive remuneration. *Strategic Management Journal*, *32*(3), 301-321. https://doi.org/10.1002/smj.878

Matolcsy, Z. P., & Wright, A. P. (2006). Are we paying our CEOs too much?. *JASSA*, *4*, 27-31.

McKnight, P., & Tomkins, C. (2004). The implications of firm and individual characteristics on CEO pay. *European Management Journal*, *22*(1), 27-40. https://doi.org/10.1016/j.emj.2003.11.013

Načinović, I. (2012). An exploration of executive compensation in Croatia-what are its implications within corporate governance?. In *Proceedings of 1 st International Conference Corporate governance–new experiences: Implementation in South Eastern Europe, Zagreb.*

Nica, E. (2018). Gig-based Working Arrangements: Business Patterns, Labor-Management Practices, and Regulations, *Economics, Management, and Financial Markets, 13*(1), 100–105. https://doi.org/10.22381/emfm13120185

Pepper, A., & Gore, J. (2015). Behavioral agency theory: New foundations for theorizing about executive compensation. *Journal of Management*, *41*(4), 1045-1068. https://doi.org/10.1177/0149206312461054

Pereira, I. N., & Esperança, J. P. (2015). Top executive compensation in less developed capital markets. *Corporate Governance*, *15*(1), 122-133. https://doi.org/10.1108/CG-11-2014-0128

Perry, T., & Zenner, M. (2001). Pay for performance? Government regulation and the structure of compensation contracts. *Journal of Financial Economics*, *62*(3), 453-488. https://doi.org/10.1016/S0304-405X(01)00083-6

Rahman, M., & Mustafa, M. (2018). Determining total CEO compensation of selected US public companies. *International Journal of Managerial Finance*, *14*(2), 170-187. https://doi.org/10.1108/IJMF-03-2017-0047

Rampling, P., Eddie, I., & Liu, J. (2013). Executive remuneration in China: a literature review. *Asian Review of Accounting*, *21*(2), 128-143. https://doi.org/10.1108/ARA-10-2012-0056

Sakawa, H., & Watanabel, N. (2008). Relationship between managerial compensation and business performance in Japan: New evidence using micro data. *Asian Economic Journal*, *22*(4), 431-455. https://doi.org/10.1111/j.1467-8381.2008.00285.x

Santalo, J. & Kock, J. C. (2009). Division Director Versus CEO Compensation: New Insights Into the Determinants of Executive Pay. Journal of Management, 35 (4), 1047-1077. https://doi.org/10.1177/0149206308329965

Shinozaki, S., Moriyasu, H., & Uchida, K. (2016). Shareholder composition and managerial compensation. *Journal of Financial and Quantitative Analysis*, *51*(5), 1719-1738. https://doi.org/10.1017/S0022109016000636

Singh, P., & Agarwal, N. C. (2003). Executive compensation: Examining an old issue from new perspectives. *Compensation & Benefits Review*, *35*(2), 48-54. https://doi.org/10.1177/0886368703251169

Tosi, H. L., Werner, S., Katz, J. P., & Gomez-Mejia, L. R. (2000). How much does performance matter? A meta-analysis of CEO pay studies. *Journal of Management*, *26*(2), 301-339. https://doi.org/10.1016/S0149-2063(99)00047-1

Vafeas, N. (2003). Further evidence on compensation committee composition as a determinant of CEO compensation. *Financial Management*, *32*, 53-70. https://doi.org/10.2307/3666336

Victoravich, L. M., Xu, P., & Gan, H. (2012). Institutional ownership and executive compensation: Evidence from US banks during the financial crisis. *Managerial Finance*, *39*(1), 28-46. https://doi.org/10.1108/03074351311283559

World Economic Forum (2014), *The Global Competitiveness Report 2014-2015*, World Economic Forum, Geneva

Yoshikawa, T., Rasheed, A. A., & Del Brio, E. B. (2010). The impact of firm strategy and foreign ownership on executive bonus compensation in Japanese firms. *Journal of Business Research*, *63*(11), 1254-1260. https://doi.org/10.1016/j.jbusres.2010.06.012

✉ **Correspondence**

Ivana Načinović Braje

Faculty of Economics and Business (FEB), University of Zagreb
Trg J.F. Kennedy 6, HR-10 000 Zagreb, Croatia

E-mail: ivana.nacinovic@efzg.hr

STRATEGIC MANAGEMENT, Vol. 24 (2019), No. 2, pp. 045-057

DOI:10.5937/StraMan1902044A

Received: January 15, 2019
Accepted: April 02, 2019

A Set of Factors Related to the Opportunity Motivation: Analysis of Early-stage Entrepreneurs from SEE

Renata Amidžić
National Health Insurance Fund, Serbia

Abstract
This paper focuses on a set of factors related to the opportunity motivations of early-stage entrepreneurs, such as entrepreneur's perceptions and socio-demographic factors. The research area of this paper includes: fear of failure, social networking, entrepreneur's knowledge, skills and experience, and perception of business opportunity; and socio-demographic characteristics of entrepreneurs, such as the age, gender, level of education and household income. The data has been provided by Adult Population Survey, as part of the Global Entrepreneurship Monitor. The sample includes data collected in 2014, from 12,023 adults by interview methods, which implies valid answers of 692 early-stage entrepreneurs, i. e. a total of 415 early-stage entrepreneurs driven by opportunity motivation. The respondents are located in the Southeast Europe (SEE); and settled in six countries: Greece, Hungary, Romania, Croatia, Bosnia and Herzegovina and Slovenia. According to SPSS Statistics, the empirical research was processed using the Binomial Logistics Regression. Two hypotheses were set up to test the conceptual model. According to the theory and research results, the model consisted of determinants related to the opportunity motivations of early-stage entrepreneurs, has been developed. Motivation as a dependent variable has been measured by the TEA Opportunity index. Thus, the opportunity motivation is found to be related to the entrepreneur's perception, and socio-demographics factors. Determinants such as the fear of failure and perception of business opportunity contribute to a higher likelihood in the modelling opportunity motivation. The age, gender, level of education and household income also contributed to the developed model. The lower and middle household income of entrepreneurs, secondary degree education, gender as a male, and the entrepreneurs' age about 45-64 significantly added to the model prediction. Social networking and KSE's did not have a significant role on the entrepreneur's motivation according to the empirical results and the developed model. In addition to improving theoretical material from the field of entrepreneurship, the model also contributes to this work.

Keywords
Early-stage entrepreneurs, opportunity motivations, entrepreneur's perception, socio-demographic factors, Southeast Europe.

Introduction

Motivation for business is the main prerequisite for a successful venture. Starting from Maslow's Theory of needs to the recent research (e.g. by Baum & Locke, 2004; Puente, Cervilla, Gonzalez, & Auletta, 2017; Lecuna, Cohen, & Chavez, 2017 and etc.), it has been noticed that the motivation theories have been developing predominantly as a process. The Global Entrepreneurship Monitor (GEM) has provided a wide range of aspects for empirical analysis by distinguishing two categories of motivations that can drive entrepreneurs, i. e. opportunity and necessity (Reynolds, Camp, Bygrave, Autio, & Hay, 2001). Opportunity entrepreneurs are increase-wealth-motivated. They are looking for independence or new opportunity in business, by creating opportunities that can provide a wide range of business ventures on the market (Shane, Locke, & Collins, 2003; Pinillos & Reyes, 2011; Block & Sandner, 2009). According to the motivation

theories, they are ”pulled” into business, in contrast to necessity entrepreneurs that are ”pushed” (Stoner & Fry, 1982; Gilad & Levine, 1986; Reynolds et al., 2001; Bijaoui, 2012). Opportunity-motivated entrepreneurs have a higher chance of survival on the market, and they are better prepared for business entry than necessity entrepreneurs, because they start up business voluntarily (Block & Sandner, 2009). Opportunities are also found to be a generator of maturity of entrepreneurial venture (Bobera, Leković & Berber, 2017) or product of technological intensive environment that encourages entrepreneurial activity (Leković & Marić, 2017). Furthermore, Verheul, Thurik, Hessels, and Zwan (2010) quote that the necessity motivated entrepreneurs differ from opportunity entrepreneurs in many ways; the difference arises from their socio-economic characteristics as well as motivation, which affect their business performance. Entrepreneurs differ in their abilities and willingness to achieve opportunities. They are wrapped in a variety of motivational factors that occur on their individual characteristics (Shane et al., 2003; Verheul et al., 2010). Theory and empirical knowledge about determinants related to the motivations are not unified; they vary over time. In addition, it has been noticed that many studies have explored the above mentioned topics during the past and the present century.

Therefore, following the mentioned field of research, the main purpose of this paper is to identify the determinants related to the motivation of early-stage entrepreneurs, who are seeking new chances and opportunities in business.

The aim of this paper is to conduct an exploratory analysis to evaluate the potential factors contributing to a higher likelihood of opportunity motivations. The advantage of the developed model is the sum of individual variables that have been included, which proves a wide range of conclusions. Regarding the available literature and recent empirical research, it has been noticed that the established models predominantly represent a view according to a particular country or country context, not the SEE; or it represents a majority of individual or contextual drivers related to the entrepreneurial motivations, applied also to specific industry sectors, products or services. The present research was created to overcome the limitations of previous research and thus to extend our knowledge of determinants related to the opportunity motivated entrepreneurs.

In this paper, we examined the following question: Do the individual characteristics such as perceptions (social networking, perception of business opportunity, knowledge, skill and experiences (KSE’s) and fear of failure) and socio-demographic characteristics (age, gender, level of household income and education) related to the opportunistic motivation, in the case of early-stage entrepreneurs; do they contribute to a higher likelihood in the modelling opportunity motivation?

The Adult Population Survey (APS) as part of GEM project has provided the research data, which was collected in 2014, by the interviewing method. The respondents are located in the SEE region, including six countries. The Binomial Logistics Regression model, processed by SPSS Statistics, was used to prove the set of hypotheses. According to theory, past empirical research, and the results of the empirical analysis, the model was developed, consisting of determinants related to the opportunity-motivated entrepreneurs.

This paper consists of several parts. The first, based on the theory and recent research investigates the sum of individual determinants, such as entrepreneurial perception and socio-demographic factors, related to the motivation of entrepreneurs driven by motives of opportunities. Two hypotheses were set up for the purpose of testing the conceptual model. In the last sections, the model was developed and some limitations and recommendations were presented in the end.

1. Literature review

Individual characteristics of entrepreneurs such as their perception (Bosma, Jones, Autio, & Levie, 2008; Cacciotti & Hayton, 2014; Block, Sandner, & Spiegel, 2015; Rusu & Roman, 2018) and socio-demographic characteristics, have been related to the factors of entrepreneurial motivation (DeTienne & Chandler, 2007; Kautonen, 2008; Block & Sander, 2009; Robichaud, 2010; Verheul et al., 2010; Wagner, 2005; Stephan, Hart, Mickiewicz, & Drews, 2015). The next section presents a literature review of these factors.

1.1. Factors of entrepreneur’s perception related to the opportunity-motivated entrepreneurs

Entrepreneur's perception has a significant role in the modelling of entrepreneurial motivations. In addition, perception relies on the entrepreneur's mechanism to interpret the reality (Giacomin, Janssen, & Guyot, 2011).

The fear of failure is one of the most frequently mentioned fears in the theory of entrepreneurship (Bosma et al., 2008). There are many definitions about the fear of failure through literature, but it is all different in one point of view: First, the fear of failure could be a crucial motivator for business, incorporated in the decision making of business. In contrast, it can be a barrier to entrepreneurial action, making entrepreneurs vulnerable and less adapted to unpredictable and risky situations. This restrictive approach can wrongly suggest that the fear of failure is not or should not be a part of entrepreneur's motivations (as a result of conceptual and methodological confusions), but recent observations suggest that both concepts should be accepted (Cacciotti & Hayton, 2014). Therefore, the fear of failure must be considered as an interesting phenomenon and essential part of the entrepreneurial journey (Baron, 2008). Many authors that have been occupied with cognitive and behavioural responses (Sponte, 2018; Hardingham, Vrbka, Kliestik, & Kliestikova, 2018), through the theory and empirical research have noticed that the fear of failure is an attitude toward risk (Verheul & Mil, 2011; Hessels, Grilo, Thurik, & van der Zvan, 2011). Similarly, the fear of failure has been defined as an attitude toward risk determined by high uncertainty of avoidance (Sandhu, Sidique, & Shoaib, 2011). Some authors who advocate psychological approaches consider that the fear of failure is a negative emotion (Patzelt & Shepherd, 2011) or negative anticipated emotions (Welpe, Sporrle, Grichnik, Michl, & Audretsch, 2012). It can also be a feeling that leaves a decision maker discouraged about succeeding even before attempting (Ekore & Okekeocha, 2012).

According to fear of failure and its relationship with motivation, Block et al. (2015) have analysed how the risk attitude differs among the opportunity and necessity entrepreneurs, and how the entrepreneurial motivation for work is associated with a risk attitude. They found that both types of entrepreneurs are motivated by opportunity and necessity motives to start their ventures; and their motivation sources are strongly associated with their attitude towards risk (i. e. fear of failure). In addition, opportunity motivated entrepreneurs that are also motivated by a high level of creativity are less risk averse than other entrepreneurs (Block et al., 2015). Similarly Wagner (2005), investigate how the fear of failure related to the nascent entrepreneurs motivated by opportunities, and nascent entrepreneurs motivated by necessity motives, for starting up a business. The empirical results showed that both types of entrepreneurs were hindered by risk aversion, but the nascent entrepreneurs motivated by opportunities and willingness to start their own business are more risk tolerant. Amit and Muller (1995), found that "pull" motivated entrepreneurs are risk averse, but their risk attitudes are similar to "push" motivated entrepreneurs even when variables like the age, gender or education of entrepreneurs were included. Furthermore, Morgan and Sisak (2015) suggest that the fear of failure can have motivating effects on a highly ambitious entrepreneur (i. e. opportunity motivated entrepreneurs), but it can also have demotivating effects on someone less ambitious.

According to the above, we suggest that the fear of failure can explain motivation of entrepreneurs, with special emphasis on opportunity-motivated entrepreneurs.

Since the mid-eighties, the recognition of the importance of involving entrepreneurs in social networks has experienced a revival (Hansen, 1995; Cooper, Folta, & Woo, 1995; Christensen & Peterson, 1990). The approach of social networks as a dynamic process has provided the researchers with a variety of fields for exploration. Christensen and Peterson (1990) argue that social networks are an important source of new ideas. The social networks approach also showed that individual entrepreneurs are socially embedded entrepreneurs and the fact is that individuals may differ in terms of social contacts (Barnes, 1975). However, the latest study explores how social networks affect the various entrepreneurial issues, but less explains whether they affect it; the study explored either a specific sector of industries; or the impact of social networks in different country context (Arenius & Clerck, 2005; Klyver & Hindle, 2014).

Social networks can help entrepreneurs to provide business success by achieving their goals, and valuable resources, that they do not yet possess (Jenssen & Greve, 2002; Jenssen & Koenig, 2002; Klyver & Hindle, 2014). The development of social networks opens new opportunities (Slavić, Bjekić & Berber, 2017). Thus, through the connection of different social relations, the social networks can provide different resources to entrepreneurs, such as information, access to finance, access to skills, knowledge or access to social legitimacy (Klyver

& Hindle, 2014). Earlier research showed that the social networks were the leading path for achieving the opportunities (Hills, Limpkin, & Singh, 1997, Ardichvii & Cordozo, 2000), and also a bridge of strong ties in the process of achieving information resources (Granovetter, 1973). Hills et al. (1997) conclude that entrepreneurs will achieve more opportunities only in situations when they work on developing social networks according to business (i. e. opportunity entrepreneurs), contrary to entrepreneurs who avoid or have a lack of networks (i. e. necessity entrepreneurs). According to the previous research, Ardichvili and Cordozo (2000) have a hypothesis that successful identifications in business are associated with extending social networking. The result of their research supports a strong relationship between these two observed parameters. In addition, they conclude that the opportunity motivation (i. e. recognition) has been determined by entrepreneurial networks, entrepreneurial alertness, and prior knowledge of markets and customer problems. Furthermore, Arenius and Clerck (2005) have examined in their study how social networks affect entrepreneurial opportunities according to the type of network and to the extent to which entrepreneurs have been potentially exposed to social networks. They found that the nature of living area such as a big city can provide more opportunities and new ideas (vs. rural area), by connecting with various institutions (universities, research facilities etc.) and individuals. Furthermore, according to current research that observes early-stage entrepreneurs involved in TEA stage, it is noteworthy to mention the research by Klyver and Hindle (2014), who found that structural diversity in social networks differs during the different stages of the entrepreneurial process. It is most important for entrepreneurs in the discovery stage, less important in the start-up stage and moderately important for entrepreneurs in the young business stage.

Therefore, according to the literature review about social networks and the willingness of the entrepreneur to embed it, we suggest that positive perception about social networking is crucial for performing the opportunity motivation.

Arenius and Minnity (2005) in their study that implies the nascent entrepreneurs have demonstrated that there is a high correlation between entrepreneurial skill, knowledge of other entrepreneurs, existence of opportunities, and entrepreneurial motivation to start a new business. They also argue that entrepreneurs tend to rely relatively more on perception than on objective features.

Boudreaux, Nikolaev, & Klein (2019) found that entrepreneurs with a higher level of self-efficacy are more motivated to start-up a business. Thus, the psychology literature has established the importance of entrepreneurial confidence and perception, based on entrepreneur's own skills (i. e., Social Learning Theory), also named the concept of self-efficacy (Arenius & Minnity, 2005; El-Hadary, 2018). El-Hadary (2018) argues that self-efficacy can affect the persistence of entrepreneurs to establish or manage a new venture. In addition, according to their previous engagement in business, the self-efficacy referred to opportunity-motivated entrepreneurs (Suchart, 2017), contrary to necessity entrepreneurs that have lower knowledge, skills and experience. The entrepreneurs' perception of possessing certain skills is in correlation with the level of their self-confidence. Possession of different skills is important to an entrepreneur in order to be more successful. Opportunity entrepreneurs have more confidence in their skills, because they voluntarily entered the job, and were more prepared for new ventures. According to Genty, Idris, Wahat, & Kadir (2015), entrepreneurial experience refers to "the previous number of years and role played by entrepreneurs in their former ventures". The experience includes the time during which the entrepreneur was a manager of the firm, and made decisions that are important for business. The experience can be gained both in the initial phase of the business, or in the mature age of firms. According to the presented, we suggest that the entrepreneur's knowledge, skills and experience can explain the motivation of early-stage entrepreneurs, with special emphasis on opportunity-motivated entrepreneurs

The omnibus of literature considers entrepreneurship as a creative process (Shane & Venkataraman, 2000; Shane et al., 2003) in which entrepreneurs tend to achieve the opportunities from business (Linan, Santos, & Fernandez, 2011; Suchart, 2017; Boudreaux et al., 2019). Perception of business opportunity as one of the entrepreneurial capabilities is based on the Theory of Planned Behaviour which implies various consequences on the entrepreneur's behaviour. Thus, entrepreneurs differ from each other in a situation while they need to recognize the opportunities of the business (Suchart, 2017).

Suchart (2017) explored the relationship between the individual characteristics of nascent opportunity and nascent necessity entrepreneurs, and found that opportunity recognition can enhance the likelihood of becoming the nascent entrepreneurs, motivated by opportunity determinants. Boudreaux et al. (2019) found that entrepreneur's alertness to perceive business opportunities can promote entrepreneurial action and entrepreneur's motivation to start up a business. The notice can be applied to countries where the economy system is at the higher level of development. Thus, the perception of business opportunity is a cognitive process, whereas the perception of entrepreneurs relies on their capabilities to perceive the opportunities of business (Linan, Santos, & Fernandez, 2011).

According to presented data, we assume that:

H1: Entrepreneur's perception related to the opportunity motivation of early-stage entrepreneurs; entrepreneur's perception contributes to a higher likelihood in the modelling opportunity motivation.

1.2. Socio-demographic characteristics of entrepreneurs related to the opportunity-motivated entrepreneurs

The aim of the next section of the literature review is to analyse recent empirical research, about socio-demographics factors related to the opportunity-motivated entrepreneurs, such as entrepreneur's age, gender, and the level of education and household income.

Verheul et al. (2010) confirmed that the opportunity entrepreneurs vs. necessity entrepreneurs are in a negative correlation according to age. Thus, young entrepreneurs at the beginning of their career tend to manage business driven by opportunity motives. Young entrepreneurs have low commitments (family, financial etc.), and they are more likely to search for good career and business opportunities. Entrepreneurs in their mid-40s are less opportunity-oriented than the older entrepreneurs aged over 50, who have a strong willingness to seek new opportunities and business advantage. Older entrepreneurs have less commitment (i. e. family and childcare obligations tend to be less intensive) than young entrepreneurs, and their focus is mainly on business by seeking opportunities (Stephan et al., 2015). Block and Sander (2009) found that: 1) opportunity entrepreneurs are slightly younger than the necessity entrepreneurs; 2) chances that an entrepreneur is opportunity motivated decrease with age. Furthermore, Robichaud, LeBresseur, and Nagarajan (2010), have shown that the opportunity entrepreneurs are younger, but also more educated, have good skills and a high level of propensity to anticipate future opportunities. Kautonen (2008) in their study also confirm that the older entrepreneurs are motivated by opportunity motives. On the other hand, some research has shown that the older entrepreneurs are less motivated than young entrepreneurs, i. e. older entrepreneurs are less likely to engage in business (Curran & Blackburn, 2001).

Recent research shows that a woman's motives for entrepreneurship rely on the relationship between her working conditions and work-family conflict (Greve & Salaff, 2003). Women have more preferences for correlating family and job, compared, as opposed to men (DeMartino & Barbato, 2003). Therefore, if a woman is not satisfied with settled terms and conditions, she is more able to search for a new job by engaging in new business. Buttner and Moore (1997) suggest that women are seeking new opportunities in business, in order to create a more pleasant working environment. Women also tend to control their working environment to achieve the advancement opportunities. Carter, Shaw, Lam, & Wilson (2003) found that men are more motivated for financial success than women, who are more driven by independence motives. DeTienne and Chandler (2007) argue that men and women use different opportunity identification according to the business process. Men have higher expectations than women do (Gatewood, Shaver, & Gartner, 1995). Similarly, men have considered that they are suitable candidates for entrepreneurship, i. e. opposite to woman views (Malach-Pines & Schwartz, 2008). Pulled motives for a man reported higher income and profit than women (Watson, 2002). In general, research findings suggest that women are more necessity oriented, than men, who are more opportunity oriented.

Socio-demographic characteristics, especially education, show association with a range of motivations. Verheul et al. (2010) found that the level of education has positively related to engagement in opportunity-driven entrepreneurial activities. They suggest that education can be important for pursuing business opportunities, and, according to research parameters, the level of education has been found to be reducing odds of failure in case of opportunity entrepreneurs. Thus,

Stephan et al. (2015) add that the influence of education on entrepreneurial motivation is very complex, and it depends on gender and age. Block and Sandner (2009) found that opportunity entrepreneurs are well educated in the field in which they set up a business. Higher educated entrepreneurs have lower chance to be necessity motivated. Verheul et al. (2015) have noticed that opportunity entrepreneurs are more specific than the necessity entrepreneurs are. Entrepreneurs that have higher level of education such as secondary degree or graduate experience have more alternatives for work, and more chances to be opportunity motivated. Wagner (2005) also highlights that there is a significant and positive relationship between the opportunity nascent entrepreneurs and the level of education. The higher the level of education is the more likely is an entrepreneur to be opportunity-motivated.

In conditions of start-ups, women have been motivated by less capital than men (Boden & Nucci, 2000; Watson, 2002). Thus, recent research has shown that women have a significantly lower household income than men (Jones & Tullous, 2002; Jennings & Mc Dougald, 2007; Cron, Gilly, Graham, & Slocum 2009). Entrepreneurs with higher household income are more likely to seek new opportunities from business, and pursue more opportunities. By contrast, entrepreneurs with lower household income are more likely to be necessity motivated. Higher income allows entrepreneurs more financial independence in the process of gaining opportunities from business. Necessity motivated entrepreneurs are more concerned about contributing the money to households (Stephan et al., 2015).

According to the presented data, we assume that:

H2: Socio-demographic factors such as age, gender, level of education and the level of household income related to the opportunity motivation of early-stage entrepreneurs; socio-demographic factors contribute to a higher likelihood in the modelling opportunity motivation.

2. Methodology

The data for the empirical research has been provided by Global Entrepreneurship Monitor (GEM), Adult Population Survey (APS). The GEM is one of the largest international academic research projects of entrepreneurship. GEM has a wide range of views on entrepreneurship and primarily considers the extent to which individuals are involved in entrepreneurial activities within the country, identifying different types and stages of entrepreneurship (Puente et al., 2017). The GEM project includes the monitoring of entrepreneurial activities, using three main indicators: Total early-stage entrepreneurial activity (TEA), the proportion of established businesses among the respondents and entrepreneurial employee activity (GEM, 2018). TEA is the key phase for the most entrepreneurs (Ciravegna, Kuivalainen, Kundu, & Lopez, 2018), and according to GEM methodology implies: entrepreneurs in the phase that combines the stages before the start of a new firm, nascent entrepreneurs that settled a business, and pay the wages at least 3 months; entrepreneurs as owning managers of a new business that paid wages in continuity of 42 months (Reynolds et al. 2001; Reynolds, Carter, Gartner, & Greene, 2004; Wagner, 2004; Stephan et al., 2015). Nascent entrepreneurs make initiation activities, while the new business owners are entrepreneurs involved in the stage directly after the start of a new firm. The sample includes data collected in the year 2014, from 12,023 adults by interview methods, which implies valid answers of 692 early-stage entrepreneurs, i. e. total 415 early-stage entrepreneurs driven by opportunity motivation. Research data implies individual answers from a random sample of adults aged 18-64. The respondents are located in the SEE region, settled in the following six countries: Greece, Hungary, Romania, Croatia, Bosnia and Herzegovina and Slovenia. Thus, Serbia, Montenegro, Macedonia and Bulgaria did not participate in GEM project in 2014.

Furthermore, the empirical model has been made for the purpose of empirical research. Models obtain the predictive categorical variables (social networking, perception of business opportunity, fear of failure, KSE's, age, gender, household income and education) and one dichotomous dependent variable. TEA: opportunity (in a sample of early-stage entrepreneurs) as dependent variable represents the percentage of adults aged 18-64 who are involved in business driven by opportunity motives.

In order to research a set of hypotheses, SPSS Statistics and Binomial Logistics Regression has been used to analyse the data - it predicts the explanation or probability that observations fall into one of two categories of dichotomous

criterion variable based on a set of predicting variables (Hosmer & Lemeshow, 2000). In addition, this method enabled us to identify which determinants were the most important in categorizing opportunity motivations. Dependent variable has been measured on a dichotomous scale. Social networking has been measured on a dichotomous scale, which takes value 0 for No, and 1 for Yes, according to the answers to the question: Do you personally know someone who started a business in the past 2 years? The perception of business opportunity has been measured on a dichotomous scale, which takes value 0 for No, and 1 for Yes, according to the answers to the question: In the next six months, will there be good opportunities for starting a business in the area where you live? KSE's has also been measured on a dichotomous scale, according to the question: Do you have the knowledge, skills and experience required to start a new business? Fear of failure has also been measured on a dichotomous scale, according to the question: Would fear of failure prevent you from starting a business? Household income is set as the average variable, which takes the value 1 for the lowest, 2 for middle and 0 for the upper household income. Furthermore, education as predicted and ordinary variable, takes the value 1 for none, 2 for some secondary, 3 for secondary degree and 4 for graduate experience. Gender as a dichotomous variable takes the value 1 for male and 0 for female. The age as predicted variable, measures the age of adults that are recoded into the groups 0 (18-24), 1 (25-34), 2 (35-44), 3 (45-54) and 4 (55-64).

3. Results and discussion

The first step of the research involves the observation of all the variables in the model in order to achieve the explanation, and probability of the TEA: opportunity. A Binomial Logistic Regression has been performed to determine the effects of the entrepreneur's perception and socio-demographic characteristics on the likelihood that early-stage entrepreneurs are motivated by opportunities. Table 1, contain correlation matrix, and none of correlations appear to be large; thus the multicollinearity is not present. Table 2, contain estimates of the logistic coefficient, identified as predictors in block one (column B). In the same column, Constant is specified. Asymptotic standard errors for individual logistic coefficients have been represented in column "S.E". The column "Wald" contains the results of the Wald statistics and chi-square test, column "df" as the degrees of freedom and the column "Sig" represents the probability from the Wald test hypothesis that the logistic coefficient for the predictor variable is equal to zero. The column "Exp (B)" contains all exponential logistic coefficients that are important for the interpretation of logistics regression.

The logistic regression model was statistically significant, $\chi 2$ (8) = 103.480, $p < .0005$. The explained variation in the dependent variable was based on ranges from 13.9 % to 18.8% according to Cox & Snell R2 or Negelkerke R2 methods. Respectively, Negelkerke is a modification of Cox & Snell, so in this study we report Negelkerke R2. Therefore, the model explained 18.8% of the variance in opportunity motivations and correctly classified 66.9% of the cases. According to the Wald test (which is used to determine statistical significance, for each of the independent variables), the statistical significance of the test was found. 1) Determinants such as the lower household income (p=.000), middle household income (p=.041), secondary degree (p=.017), perception of business opportunity (p=.033), fear of failure (p=.004), male gender (p=.015), and age between 55 and 64 (p=.010), added significantly to the model. 2) Other determinants such as social networking or KSE's did not significantly add to the model. According to the probability predicting of an event occurring, based on a one-unit change in an independent variable, we can emphasize that the odds of opportunity motivations are 1.561 times higher for males than for females. Increasing age and the household income are more likely to be associated with a reduction in the likelihood of opportunity motivations. Opportunity entrepreneurs have a 1.471 times higher perception of business opportunity than non-opportunity entrepreneurs. The fear of failure was associated with a reduction in the likelihood of opportunity motivation.

Table 1 Correlations matrix

Variables	1	2	3	4	5	6	7	8	9
Opportunity motivation	1								
Social networks	,133**	1							
Perception of business opp.	,136**	,155**	1						
KSE's	,094**	,222**	,070**	1					
Fear of failure	-,162**	-,070**	-,094**	-,108**	1				
Household income	,234**	,155**	,074**	,124**	-,100**	1			
Education	,200**	,145**	,066**	,169**	-,012	,304**	1		
Age	-,060	-,092**	-,052**	-,006	-,004	-,064**	-,106**	1	
Gender	-,077*	-,098**	-,041**	-,168**	,094**	-,084**	-,017	,023*	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Source: Authors analysis in SPSS, based on GEM data

Table 2 Results of the Binomial Logistics Regression

Predicted variables	B	S.E.	Wald	df	Sig.	Exp(B)
Entrepreneurs perception						
Social networking	,204	,176	1,334	1	,248	1,226
Perception of business opportunity	,386	,181	4,552	1	,033	1,471
KSE's	,278	,231	1,447	1	,229	1,321
Fear of failure	-,516	,178	8,384	1	,004	,597
Socio-demographic factors						
Upper household income			18,422	2	,000	
Lower household income	-,931	,218	18,279	1	,000	,394
Middle household income	-,432	,212	4,178	1	,041	,649
Gradual exp. Education			24,950	4	,000	
None education	-,528	,715	,545	1	,460	,590
Some secondary education	-,557	,441	1,597	1	,206	,573
Secondary degree education	-,858	,360	5,672	1	,017	,424
Postsecondary degree	,060	,363	,027	1	,870	1,061
Gender(male)	,445	,183	5,936	1	,015	1,561
Age 18-24			13,423	4	,009	
Age 25-34	-,249	,270	,856	1	,355	,779
Age 35-44	-,390	,271	2,070	1	,150	,677
Age 45-54	,234	,299	,613	1	,434	1,264
Age 55-64	-,908	,354	6,585	1	,010	,403
Constant	,906	,495	3,350	1	,067	2,474
Statistical information						
-2 log likelihood			823,130[a]			
$\chi 2$			103.480			
(df)			8			
Negelkerke R2			18,8			
Overall predicted accuracy %			66,9%			
Case processing summary			692			
Number of observations			415			

Source: Authors analysis in SPSS, based on GEM data

See Table 1 and Table 2 for the previous discussion. The second step of the research might imply the observation of the significant determinants as pronounced and defined in Table 2. The model can include a lower number of significant predictors, and it can be simpler than the previous one (Hosmer & Lemeshow, 2000).

In this analysis, we did not run a further step of the binomial logistics regression.

Conclusion and recommendations

Following the results of the research, and apart from the fact that only a limited number of authors have examined the individual determinants related to the opportunity motivations in the case of early-stage entrepreneurs (Arenius & Minnity, 2005; Wagner,

2005; Suchart, 2017; Rusu & Roman, 2018), this paper has a few important contributions.

Firstly, research results showed that entrepreneurial perception plays a relatively significant role in modelling entrepreneurial motivation of early-stage entrepreneurs. Thus, social networking and KSE's did not have a significant role in modelling entrepreneur's motivation, as opposed to the results of determinants such as fear of failure and perception of business opportunities that contribute to a higher likelihood in the modelling opportunity motivation. In addition, the hypothesis H1 was partially confirmed, and two determinants, out of four, related to the motivation. Fear of failure as predictor's variable related to the opportunity motivation, was confirmed once more in an empirical research (Wagner, 2005; Morgan & Sisak, 2015; Block, 2015), showing that the role of fear of failure is not negligible. In addition, the business environment of the SEE has specific business conditions (i. e. countries with predominantly lower development economy), so it is important to mention that an increasing number of small and medium-size entrepreneurs tend to find their business chances pursuing opportunities. But, the past legacy and the long period of reforms, has left a mark on the entrepreneur's perception of the fear of failure. Thus, the fear of failure can also be a positive cognition, making entrepreneurs alert and prepared for different business terms. It would be desirable to include governments in the business environment of small and medium-sized enterprises in order to provide their support programs (e.g. about start-ups, decision support, logistic and administrative support etc.). Thus, early-stage entrepreneurs would perceive greater affiliation and social cohesion, thanks to having less fear of failure in business.

Secondly, the results of empirical research suggest that early-stage entrepreneurs, motivated by opportunities, have a greater perception of business opportunities. Thus, the results of research show that opportunity motivated entrepreneurs, such as nascent and new business owners, have initial cognitive ability to recognize opportunity that enables them to seek new chances in business. They are motivated by the motives of independence (i. e. autonomy), and also have the abilities and willingness to achieve the opportunities. Perception of business opportunities seems to be a more desirable characteristic of entrepreneur's perception than the fear of failure is, but both have an important role, according to empirical research of this paper. Perception of business opportunities tends to have a wide range of views, but generally speaking it reflects the entrepreneur's alertness (Linan, Santos, & Fernandez, 2011; Suchart, 2017; Boudreaux et al., 2019) and confidence to grab the opportunities from business.

Thirdly, the results of Logistics Regression did not show contribution of determinants, such as social networking and KSE's, on early-stage entrepreneurs that are forced by opportunity motivation. These two determinants did not add significantly to the model. It does not necessarily mean that those two determinants are not related to the motivation of entrepreneurs, or do not relate to the necessity entrepreneurs, the results showed that no relation exists in the case of the opportunity entrepreneurs in TEA stage, that are involved in business in the area of SEE. We leave that dilemma and discussion for someone new researching, with recommendation to run regression, including opportunity motivation separately for nascent opportunity entrepreneurs, and also for opportunity new business owner's entrepreneurs. Some further research should also include statistics analysis with time flow i. e. more than a year.

Fourthly, research results showed that socio-demographic factors play a significant role in modelling entrepreneurial motivation of early-stage entrepreneurs. Four determinants were set up, and all four added significantly to the model prediction. They successfully explained the probability of the tested model. Thus, the hypothesis H2, that: socio-demographic factors related to the opportunity motivation of early-stage entrepreneurs, and also contribute to a higher likelihood in the modelling opportunity motivation, have been confirmed. Thus, the early-stage entrepreneurs, predominantly male, aged about 55-64, with secondary degree education, who have lower or middle household income, are driven by opportunity motivations according to empirical results. It may be unusual that older entrepreneurs aged 55-64 added significantly to the model prediction, but if we take into consideration that older entrepreneurs have less commitment (i. e. family and childcare obligations tend to be less intensive), the conclusion seems to be found. Perhaps the discouraging results are that men are mostly driven by opportunity motivation, and the role of a woman in this case does not seem to be

recognizable. The recommendation observes more encouragement for the entrepreneurship lead by a woman.

Recent research has shown the significant role of the higher level of education in modelling the opportunity motivation of entrepreneurs (Wagner, 2005; Sandner, 2009; Verheul et al., 2015). In addition, a higher level of education means that an entrepreneur is more likely to be opportunity-motivated. Our findings showed different results. Thus, the level of education, such as secondary degree according to our findings, has a significant role in modelling the opportunity motivation. That seems to tell us that the entrepreneurs with higher level of education should be more opportunity motivated, in line with findings in developed countries. The recommendations according to this part of research should be to include (for someone doing further research), education should be used as a prediction variable in the case of nascent opportunity entrepreneurs, as well as new business owners, motivated by opportunities. The results may be more specified.

The level of household income, such as lower and middle income, added significantly to the model prediction. The recent results have shown that the entrepreneurs with higher household income are more likely to seek new business chances, and to pursue more opportunities (Stephan et al., 2105). Our findings differ from the previous one. It can be explained with generally lower development economy of SEE region, where the wages are at the lower level. So, the entrepreneurs with lower and middle income tend to be opportunity motivated, which could be interpreted as an advantage.

The developed model contains a set of factors that added significantly to the model's prediction. Thus, the entrepreneur's perception (fear of failure and perception of business opportunities), and socio-demographics factors (such as age, gender, household income and the level of education) related to the opportunity motivation of early-stage entrepreneurs, and also contribute to a higher likelihood in the modelling opportunity motivation. In addition to improving theoretical material from the field of entrepreneurship, the developed model also contributes to this work.

Recommendations for further empirical research rely on: 1) including more determinants related to the opportunity motivation, such as entrepreneurial attitudes and intentions; or organizational factor, environmental factors etc. 2) empirical analysis should include other entrepreneurial stage of activity, such as established entrepreneurial stage 3) research can be extended to the necessity entrepreneurs, including all presented determinants; determinants related to opportunity motivations might be compared with necessity.SM

References

Amit, R., & Muller, E. (1995). „Push" and „Pull" Entrepreneurship. *Journal of Small Business Entrepreneurship, 12*(4), 64-80. https://doi.org/10.1080/08276331.1995.10600505

Ardichvili, A., & Cordozo, N. R. (2000). A model of the entrepreneurial opportunity recognition process. *Journal of Enterprising Culture,* (2), 103-119. https://doi.org/10.1142/S0218495800000073

Arenius, P., & Clercq, D. (2005). A Network-based Approach on Opportunity Recognition. *Small Business Economics, 24,* 249-265. https://doi.org/10.1007/s11187-005-1988-6

Barnes, J. (1972). Social Networks. Philippines: Addison-Wesley.

Baron, R. (2008). The role of affect in the entrepreneurship process. *Academy of Management Review, 33,* 328-340. https://doi.org/10.5465/amr.2008.31193166

Baum, J. R., & Locke, E. A. (2004). The Relationship of Entrepreneurial Traits, Skill, and Motivation to Subsequent Venture Growth. *Journal of applied Psychology, 89*(4), 587-598. https://doi.org/10.1037/0021-9010.89.4.587

Bijaoui, I. (2012). From necessity business entrepreneurship: The case of the Songhai centre, Porto Novo, Benin. *African Journal of Business Management, 6*(18), 5872-5878. https://doi.org/10.5897/AJBM12.302

Block, J., Sandner, P., & Spiegel, F. (2015). How do Risk Attitudes Differ within the Group of Entrepreneurs? The role of Motivation and Procedural Utility. *Journal of Small Business Management, 53*(1), 183-206. https://doi.org/10.1111/jsbm.12060

Block, J. H., & Sandner, P. (2009). Necessity and opportunity entrepreneurs and their duration in self-employment: evidence from German micro data. *Journal of Industry, Competition and Trade, 9*(2), 117-137. https://doi.org/10.1007/s10842-007-0029-3

Bobera, D., Leković, B., & Berber, N. (2017). The relationship between motives of entrepreneurial behaviour and venture maturity. *Industrija 45*(1), 81-97. https://doi.org/10.5937/industrija45-11201

Boden, R. J., & Nucci, A. R. (2000). On the survival prospects of men's and women's new business ventures. *Journal of Business Venturing, 15*(4), 347-362. https://doi.org/10.1016/S0883-9026(98)00004-4

Bosma, N. S, Jones, K., Autio, E., & Levie, J. (2008).Global Entrepreneurship Monitor; 2007 Executive Report. Babson College, London Business School, and Global Entrepreneurship Research Association.

Boudreaux, J. C., Nikolaev, B. N, & Klein, P. (2019). Socio-cognitive traits and entrepreneurship: The moderating role of economic institutions. *Journal of Business*

Venturing, 34(1),178-196. https://doi.org/10.1016/j.jbusvent.2018.08.003

Buttner, E. H., & Moore, D. P.(1997). Women's organizational exodus to entrepreneurship: self-reported motivations and correlates with success. *Journal of Small Business Management, 35*(1), 34-46.

Caccioti, G., & Heyton, C. J. (2014). Fear of Failure and Entrepreneurship: A review and Direction for Future research. Enterprise Research Centre. *Research paper, 24.*

Carter, S., Shaw, E., Lam,W., & Wilson, F. (2007).Gender, entrepreneurship and bank leading: the criteria and process used by bank loan officers in assessing applications. *Entrepreneurship, Theory and Practice, 31*(3), 427-444. https://doi.org/10.1111/j.1540-6520.2007.00181.x

Christensen, P., S. & Petrson, R. (1990). Opportunity Identification: Mapping the Sources of New Venture Ideas. *Frontiers of Entrepreneurship Research. Wellesley, MA: Babson College,* 567-581.

Ciravegna, L., Kuivalainen, O., Kundu, K.S., & Lopez, E. L. (2018). The antecedents of early internationalization: A configurationally perspective. *International Business Review*, 1-13. https://doi.org/10.1016/j.ibusrev.2018.05.002

Cooper, A. C., Folta, T. B., & Woo, C. (1995). Entrepreneurial information search. *Journal of Business Venturing, 10*(2), 107-120. https://doi.org/10.1016/0883-9026(94)00022-M

Cron, W. L., Gilly, M.C, Graham, J. L., & Slocum, J. W. (2009). Gender differences in pricing of professional services: implications for income and customer relationships. *Organizational Behaviour and Human Decision Process, 109*(1), 93-105. https://doi.org/10.1016/j.obhdp.2008.11.004

Curran, J., & Blackburn, R. (2001). Older people and the enterprise society: Age and self-employment propensities. *Work, Employment and Society, 15,* 889-902. https://doi.org/10.1177/095001701400438279

De Martino, R., & Barbato, R. (2003). Differences between woman and man MBA entrepreneurs: exploring family flexibility and wealth creation as career motivators. *Journal of Business Venturing, 18*(6), 815.832. https://doi.org/10.1016/S0883-9026(03)00003-X

DeTienne, D. R., & Chandler, G. N. (2007). The role of gender in opportunity identification. *Entrepreneurship, Theory and Practice, 31*(3), 365-386. https://doi.org/10.1111/j.1540-6520.2007.00178.x

Ekore, J. O., & Okekeocha, O. C. (2012). Fear of entrepreneurship among university graduates: a psychological analysis. *International Journal of Management, 29*(2), 515-524.

El-Hadary, E. T.(2018). Gender, Perceptual factors, and Entrepreneurisl Intention: Evidence from Egypt. School og global Affairs and Public policy: The American University in Cairo.

Gatewood, E. J., Shaver, K. G., & Gartner, W. B. (1995). A longitudinal study of cognitive factors influencing start-up behaviours and success at venture creation. *Journal of Business Venturing, 10*(5), 371-391. https://doi.org/10.1016/0883-9026(95)00035-7

Global entrepreneurship Monitor (2018). Global Report 2017/2018. Babson college.

Genty, K. Idris, K., Wahat, N. W., & Kadir, S. (2015). Demographic Factors and Entrepreneurial Success: A Conceptual Review. *International Journal of Management Sciences, 6*(8), 366-374.

Giacomin, O., Janssen, F., & Guyot, J. (2011). Opportunity and/or necessity entrepreneurship? The impact of the socio-economic characteristics of entrepreneurs. Munich Personal RePEc Archive. Paper No. 29506.

Gilad, B., & Levine, P. (1986). A behavioural model of entrepreneurial supply. *Journal of small business management, 24*(4), 45-54.

Granovetter, M. (1973). The Strength of Weak Ties. *American Journal of Sociology. 78*(6), 1360-1380. https://doi.org/10.1086/225469

Greve, A., & Salaff, J. W. (2003). Social networks and entrepreneurship. *Entrepreneurship, Theory and Practice, 28*(1), 1-22. https://doi.org/10.1111/1540-8520.00029

Hansen, E. L. (1995). Entrepreneurial network and new organization growth. *Entrepreneurship: Theory & practice, 19*(4), 7-19. https://doi.org/10.1177/104225879501900402

Hardingham, E., Vrbka, J., Kliestik, T., & Kliestikova, J. (2018). Will Cognitive Technology-Driven Automation Lead to Economic Growth?*Journal of Self-Governance and Management Economics 6*(4),13-18. https://doi.org/10.22381/JSME6420182

Hessels, J., Grilo, I., Thurik, R., & van der Zvan, P. (2011). Entrepreneurial exit and entrepreneurial engagement. *Journal of Evolutionary Economics, 21,*447-471. https://doi.org/10.1007/s00191-010-0190-4

Hills, G. E., Limpkin, G. T., & Singh, R. P. (1997). Opportunity recognition. Perception and Behaviours of Entrepreneurs. *Frontiers of Entrepreneurs Research.* Wellesley, MA: Babson College.

Hosmer, D. W., & Lemeshow, S. (2000). Applied logistic regression (2nd ed.). New York: Wiley. https://doi.org/10.1002/0471722146

Jennings, J. E. & McDougald, M. S. (2007). Work- family interface experiences and coping strategies:implictions for entrepreneurship research and practice. *Academy of Management Rewiev, 32*(3), 747-760. https://doi.org/10.5465/amr.2007.25275510

Jenssen, J. I., & Grave, A. (2002). Does the degree of redundancy in social networks influence the success of business starts-ups? *International Journal of Entrepreneurial Behaviour and Research, 8*(5), 254-267. https://doi.org/10.1108/13552550210448357

Jenssen, J. I., & Koenig, H. F. (2002). The effects of social networks on resource access and business starts-ups. *European Planning Studies, 10*(8), 1039-1046. https://doi.org/10.1080/0965431022000031301

Jones, K., & Tullous, R. (2002). Behaviour of preventive entrepreneurs and perceptions of their financial needs. *Journal of Small Business Management, 40*(3), 233-249. https://doi.org/10.1111/1540-627X.00053

Kautonen, T. (2008). Understanding the older entrepreneur: Comparing third age and prime age entrepreneurs in Finland. *International Journal of Business Science and Applied management, 3*(3), 3-13.

Klyver, K., & Hindle, K. (2014). The Role of Social Networks at Different Stages of Business Formation. *Small Enterprise Research, 15*(1), 22-38. https://doi.org/10.1080/13215906.2007.11005830

Lecuna, A., Cohen, B., & Chavez, R. (2017). Characteristics of high growth entrepreneurs in Latin America.

International Entrepreneurship Management Journal, *13,* 141-159. https://doi.org/10.1007/s11365-016-0402-y

Leković, B., & Marić, S. (2017). The technological Availability: Incente for Opportunity Entrepreneurship. *Strategic Management, 22*(3), 11-18. https://doi.org/10.1002/sej.1238

Linan, F, Santos, F.J., & Fernandez, J. (2011). The influence of perception on potential entrepreneurs. *International Enterreneurship Management Journal,7*, 373-390. https://doi.org/10.1007/s11365-011-0199-7

Malach-Pines, A., & Schwartz, D. (2008). Now you see them, now you don't: gender differences in entrepreneurship. *Journal of Management in Psychology, 23*(7), 811-832. https://doi.org/10.1108/02683940810896358

Morgan, J & Sisak, D. (2015). The Power of Negative Thinking: A Model of Entrepreneurship, Aspirations, and Fear of Failure. *SSRN Electronic Journal,* 1-36. https://doi.org/10.2139/ssrn.2547727

Patzelt, H., 6 Shepherd, D.A. (2011). Negative emotions of an entrepreneurial career: Self-employment and regulatory coping behaviours. *Journal of Business Venturing, 26, 226-238.* https://doi.org/10.1016/j.jbusvent.2009.08.002

Pinillos, M.J, & Reyes, L. (2011). Relationship between individualist-collectivist culture and entrepreneurship activity: evidence from Global Entrepreneurship Monitor data. *Small Business Economics, 37*, 23-37. https://doi.org/10.1007/s11187-009-9230-6

Puente, R., Cervilla, M., Gonzalez, C., & Auletta, N. (2017). Determinants of the growth aspiration: A quantitative study of Venezuela's entrepreneurs. *Small Business Economics, 48*, 699-726. https://doi.org/10.1007/s11187-016-9791-0

Reynolds, P.D., Camp, S.M., Bygrave, W.D., Autio, E., & Hay, M. (2001). Global Entrepreneurship Monitor, 2001 Executive Report. Kauffman Centre for Entrepreneurial Leadership.

Reynolds, P.D., Carter, N.M., Gartner, W. B., & Greene, P. G. (2004). The Prevalence of Nascent Entrepreneurs in the United States: Evidence from the Panel Study of Entrepreneurial Dynamics. *Small Business Economics*, 23, 263-284. https://doi.org/10.1023/B:SBEJ.0000032046.59790.45

Robichaud,Y, LeBresseur, R., Nagarajan, K.V. (2010). Necessity and Opportunity - driven entrepreneurs in Canada: An Investigation into their Characteristics and an Appraisal of the Role of Gender. *Journal of Applied Business and economics, 11* (1), 59-80.

Rusu, V.D., & Roman, A. (2018). Entrepreneurial Motivation in the European Union Countries: An Empirical Approach. *Management Dynamics in the Knowledge Economy,* 6(1) 9-31. doi 10.25019/MDKE/6.1.01

Sandhu, M.S., Sidique, S.F., and Shoaib, R. (2011). Entrepreneurship barriers and entrepreneurial inclination among Malaysian postgraduate students. *Journal of Entrepreneurial Behaviour & Research, 17,* 428-449. https://doi.org/10.1108/13552551111139656

Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *Academy of Management Review, 25*(1), 217-226. https://doi.org/10.2307/259271

Shane, S., Locke, E., & Collins, C. J. (2003). Entrepreneurial motivation. *Human Resource Management Review*, *13*(2), 257–280. https://doi.org/10.1016/S1053-4822(03)00017-2

Shane, S., Locke, E.A., & Collins, C.J.(2012). Entrepreneurial Motivation. *Human Resource Management Review, 13* (2), 257-279.

Slavić, A., Bjekić, R., & Berber, N. (2017). The Role of the Internet and Social Networks in Recuirement and Selection process. *Strategic Management, 22*(3), 36-43.

Sponte, P. M. (2018). Cognitive Performance and Labor Market Outcomes: Evidence from the U.S. *Economics, Management, and Financial Markets 13*(2): 70-75. https://doi.org/10.22381/EMFM13220185

Stephan, U., Hart, M., Mickiewicz, T., & Drews, C. C. (2015). Understanding motivation for entrepreneurship. Enterprise Research Centre and Aston Business School: London. UK.

Stoner, C. R., & Fry, F. L. (1982). The entrepreneurial decision: Dissatisfaction or opportunity. *Journal of Small Business Management*, 39-44.

Suchart, T. (2017). Factors Influencing Opportunity Driven Nascent Entrepreneurs in Europe and Asia. *European Research Studies Journal, 20*(3A), 774-782.

Verheul, I, & Mil, L. (2011). What determinants the growth ambition of Dutch early-stage entrepreneurs? *International Journal of Entrepreneurial Venturing 3,* 183-207. https://doi.org/10.1504/IJEV.2011.039340

Verheul, I., Thurik, R., Hessels, J., & Zwan, P. (2010). Factors Influencing the Entrepreneurial Engagement of Opportunity and Necessity Entrepreneurs. Scales Research Reports H201011. EIM Business and Policy Research.

Wagner, J. (2004). Nascent entrepreneurs. The life cycle of entrepreneurial ventures Boon. Germany: Institute for the study of labour.

Wagner, J. (2005). Nascent Necessity and Opportunity Entrepreneurs in Germany. Evidence from the Regional Entrepreneurship Monitor (REM). *Working Paper Series in Economics, 10,* 1-25.

Watson, J. (2002). Comparing the performance of male and female controlled business: relating outputs to inputs. *Entrepreneurship, Theory and Practice, 26*(3), 91-100. https://doi.org/10.1177/104225870202600306

Welpe, I. M., Sporrle, M.,Grichnik, D., Michl, T., & Audretsch, D.B. (2012). Emotions and Opportunities: The Interplay of Opportunity Evaluation, Fear, Joy, And Anger as antecedent of Entrepreneurial Exploitation. *Entrepreneurship: Entrepreneurship Theory and Practice, 36,* 69-96. https://doi.org/10.1111/j.1540-6520.2011.00481.x

✉ **Correspondence**

Renata Amidžić

National Health Insurance Fund, Serbia

E-mail: renata.amidzic@rfzo.rs

STRATEGIC MANAGEMENT, Vol. 24 (2019), No. 2, pp. 058-064

DOI:10.5937/StraMan1902056R

Received: January 08, 2019
Accepted: Maj 06, 2019

Empirical Study on Spreadsheet Quality: Case of Serbian SMEs

Lazar Raković
University of Novi Sad, Faculty of Economics in Subotica, Subotica, Serbia
Marton Sakal
University of Novi Sad, Faculty of Economics in Subotica, Subotica, Serbia
Predrag Matković
University of Novi Sad, Faculty of Economics in Subotica, Subotica, Serbia
Vuk Vuković
University of Novi Sad, Faculty of Economics in Subotica, Subotica, Serbia
Veselin Pavlićević
University of Novi Sad, Faculty of Economics in Subotica, Subotica, Serbia

Abstract
This paper presents the results of a research which involved analysis of spreadsheets collected from 40 Serbian SMEs. Based on related research, the collected spreadsheets were analysed for presence of errors and assessed in terms of quality criteria, defined in line with the literature review. The final results are consistent with related research and point to various aspects of spreadsheet use that should be improved by the respondents for the purpose of reducing risk associated with development and use of spreadsheets.

Keywords
spreadsheet errors, spreadsheet quality, error-rate

Introduction

Spreadsheets are amongst most frequently used commercial software by a majority of organizations. Records, reports, charts, various analyses used in operations and decision making are most likely to be developed or adapted using a spreadsheet software. The fact that export into Excel files has become a standard feature of business software has only contributed to the popularity of spreadsheets.

Owing to a fast learning curve of wide range of functionality, an average user quickly becomes adept at using spreadsheets. However, due to their ease of use, careless users are usually unaware of error-proneness of different spreadsheet applications. The records on negative consequences of inappropriate development and use of spreadsheets have grown immensely over the last years ("The European Spreadsheet Risks Interest Group," n.d.).

This paper provides an overview of a subset of results from a more comprehensive research on spreadsheet use. Operational spreadsheets gathered form Serbian SMEs were analysed with the intent to estimate the degree to which they comply with the defined quality criteria and test the claim prevalent in related research on the discrepancy between the actual proportion of spreadsheets containing errors and the end users' estimates of this proportion. After a literature review, based primarily on a previous research by Raković (2014), the paper continues with research results, followed by concluding remarks.

1. Literature review

The proportion of human error is similar among different areas of human activities. Panko (2007) presented the data on the degree of accuracy of mechanical, simple tasks, as well as more complex actions in text editing, programming and spreadsheet development (Table 1). When it

comes to mechanical actions (data entry or cell selection), the degree of accuracy of text, program code and spreadsheets ranges between 99.5% to 99.8%. However, with formulas (that is, more complex actions), this degree drops by several percent. In Table 1, presenting Panko's results, complex thought is signified with C, whereas a greater number of complex thoughts is designated as "the product", and signified with C^n. At the level of a more complicated document, program, worksheet or workbook, the degree of accuracy declines to a 0%. In other words, more complex texts, programmes and spreadsheets will, most certainly, contain errors.

Table 1. Comparrison of accuracy in spreadsheet editing, development, and programming

	Text editing	Programming	Spreadsheet	Accuracy
Mechanical action	Text input Spelling	Code editing Parentheses	Input Cell selection	99,5% - 99,8%
Complex thought (C)	Grammar Meaning	Statement Code line	Formula	95% - 98%
Product (C^n)	Document	Program module	Spreadsheet module	0%

Source: Panko, 2007

In a 2013 paper, Panko and Port (R. R. Panko & Port, 2013) systematised the results of studies concerned with spreadsheet errors conducted after 1995 they deemed most significant. Their results are presented in Table 2.

Table 2. Spreadsheet-related studies

Authors	Number of spreadsheets analysed	Percentage of Spreadsheet Models Containing Errors
Hicks (1995)	1	100%
Coopers & Lybrand (1997)	23	91%
KPMG (1998)	22	91%
Lukasic (1998)	2	100%
Butler (2000)	7	86%
Clemont, Hanin i Mattermeler (2002)	3	100%
Lawrence and Lee (2001)	30	100%
Powell, Baker and Lawson (2009a)	50	86%
Powell, Baker and Lawson (2009b)	25	44%
Average after 1995	163	84%

Source: adapted from: Panko & Port, 2013

With the intent to achieve a greater quality of description of errors present in spreadsheets, Panko and Halverson (R. Panko & Halverson, 1996) proposed new indicators to complement the Percentage of Spreadsheet Models Containing Errors—Number of Errors per Model and Error Magnitude (indicates how the error affects the model outputs). However, the proposed indicators did not become widely accepted, which is why the authors later introduced the term Cell Error Rate (CER), based on a programming concept of Fault per thousand lines of (noncomment) source code (fault/KLOC). Almost 15 years after its introduction, Panko and Aurigemma (2010) realised that the term was used ambiguously among researchers, which rendered comparison impossible. While some researchers compared the number of errors with a total number of cells containing formulas, others used the total number of filled-in cells as the denominator. Therefore, Panko and Aurigemma (2010) defined 5 quantifiers of erroneous cells (Table 4), based on the type of cell content:

1. numbers and formulas (Cell Error Rate Value cells - CERV)
2. solely formulas (Cell Error Rate Formula cells - CERF)
3. solely numbers (Cell Error Rate Number cells - CERN)
4. solely text (Cell Error Rate Text cells - CERT) or
5. taking in consideration all nonempty cells (Cell Error Rate Value All nonempty cells - CERA)

Table 4. Different quantifiers of erroneous cells

Acronym	Denominator	Use
CERV	Value cells (cells containing numbers or formulas)	Indicator of the proportion of erroneous cells containing numbers and formulas, excluding text. CERV is identical to the previously introduced CER.
CERF	Formula cells	Focuses on the proportion of erroneous formula cells, which is generally higher than CERV.
CERN	Number cells	Indicator of errors in content entry.

CERT	Text cells	Indicator of errors in labelling and documentation.
CERA	All nonempty cells	Several studies use this indicator as well, although it is not considered useful enough.

Source: Panko & Aurigemma, 2010

In the research concerned with the percentage of erroneous cells revived by R. Panko (2005), CERF ranged from 4.3% to 21.0%, while CERV ranged from 1.1% to 11.9%.

The risk of spreadsheet errors is closely related to their creators' overconfidence, which is a manifestation of the gap between their self-perceived and actual knowledge and skills (M. Grant, D. Malloy, & C. Murphy, 2009; Takaki, 2005). Inadvertence of errors was corroborated by results of several studies (Caulkins, Morrison, & Weidemann, 2008; R. Panko, 1998). Panko (2009) reports that errors were discovered in spreadsheets developed by 86% respondents, whereas only 18% of respondents expected their spreadsheets to contain errors.

Reaction in occurrence of errors and minimisation of other risks associated with the use of spreadsheets is the primary focus of frameworks for spreadsheet development and use. Based on research on spreadsheet errors, inferred guidelines, positive experiences, and best practices in spreadsheet development (Baker, Powell, Lawson, & Foster-Johnson, 2006; Bewig, 2005; Colver, 2010; Dunn, 2010; Ferreira & Visser, 2012; Grossman & Özlük, 2004; Kulesz & Zitzelsberger, 2012; Powell, Baker, & Lawson, 2008b, 2008a; Powell, Baker, Lawson, McDaid, & Rust, 2009; Read & Batson, 1999; Weber, 2006), as well own research results (Rakovic, 2014), Rakovic (Raković, 2014; 2019) developed a framework for spreadsheet development and use (Figure 1). Guidelines for the design, implementation and documentation phases proposed by the framework were used as a basis for defining criteria for assessment of collected spreadsheets, results of which are presented in the next chapter. With its particular emphasis on the significance of spreadsheet documentation, the aforementioned framework suggests that each spreadsheet contains an additional worksheet titled "Documentation", with the following information:

- A brief description of the purpose of the spreadsheet
- Description and specification of all inputs (units of measurement and the range of values for each individual cell)
- Specification of all formulas
- Data on the developer: full name, organisational unit, contact information (email, telephone)
- Data on the responsible person
- Creation date
- Records on modifications (with dates and descriptions)
- Records on verification, person that verified the spreadsheet, verification date
- Instructions for use

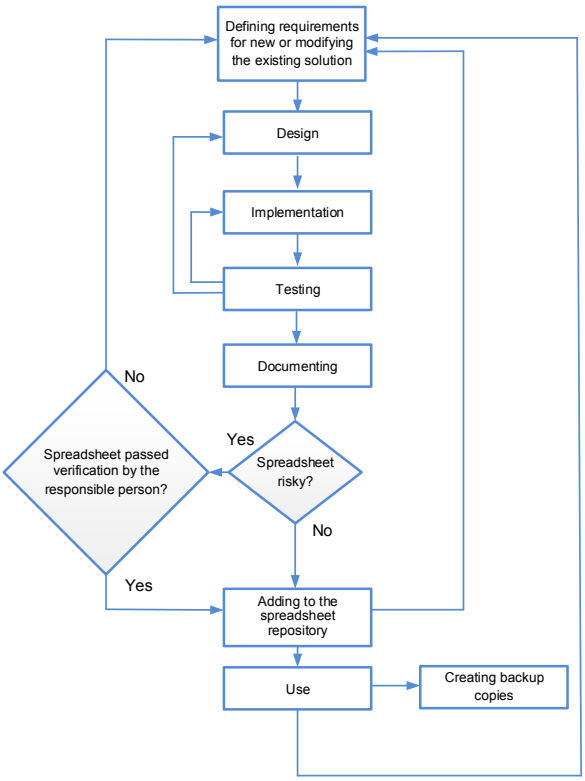

Figure 1. Framework for spreadsheet end-user development
Source: Raković, 2014; 2019

2. Research results

A total of 40 spreadsheets were collected from micro, small and medium Serbian businesses. The collected spreadsheets were not specially developed for this research, but rather operational, used by the respondents in their everyday tasks. The spreadsheets were not trivial, but at a sufficient level of complexity to be considered a Product (C^n), referenced in Table 1.

Each respondent also submitted a questionnaire which, among other things, served

to gather the information whether the respondent expected errors to be discovered in their spreadsheets. 90% of respondents expected their spreadsheets to be free of errors.

The following criteria for spreadsheet assessment were defined, in line with the framework proposed by Raković (2014):

Crit1 Adherence to a predefined convention for naming workbooks, worksheets, cell labels, cells, and ranges
Crit2 Use of descriptive, suggestive workbook names
Crit3 Use of descriptive, suggestive worksheet names
Crit4 Use of descriptive, suggestive cell names
Crit5 Use of descriptive, suggestive range names
Crit6 Workbook password protection
Crit7 Worksheets password protection
Crit8 Presence of table heading rows
Crit9 Separation of inputs, calculations, and outputs
Crit10 Different background colouring of cells containing inputs, calculations, and outputs
Crit11 Existence of data validation rules in input cells
Crit12 Use of conditional formatting
Crit13 More frequently used input cells clearly different from other input cells
Crit14 Simplicity of formulas
Crit15 Constants in special cells
Crit16 Dependent formulas positioned as close as possible
Crit17 Formula arguments positioned above and/or left from the formula
Crit18 Use of formula protection feature against inadvertent changes

Analysis of "physical" characteristics of collected spreadsheets indicated that the majority of workbooks contained no more than 3 worksheets (Figure 2), up to 1000 filled-in cells (Figure 3), and up to 100 unique formulas (Figure 4).

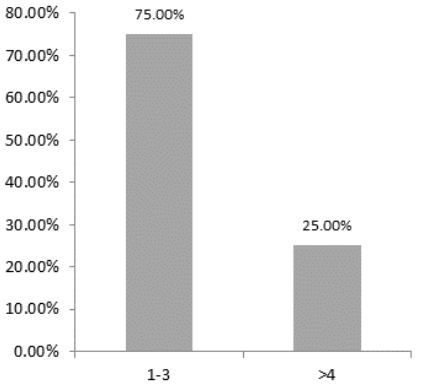

Figure 2. Number of worksheets in a workbook
Source: Authors.

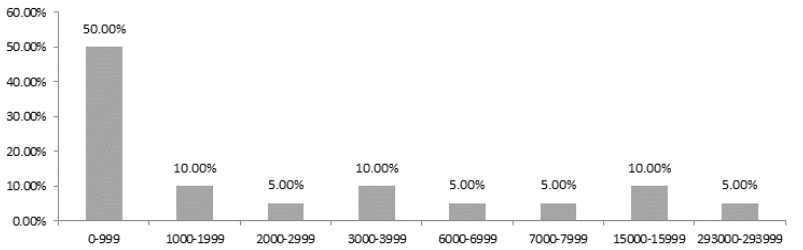

Figure 3. Number of filled-in cells in a workbook
Source: Authors.

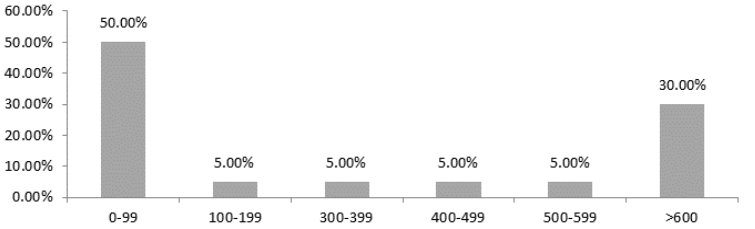

Figure 4. Number of unique formulas in a workbook
Source: Authors.

The proportion of compliance with criterial 1 through 18, expressed in percents, is presented in Figure 5.

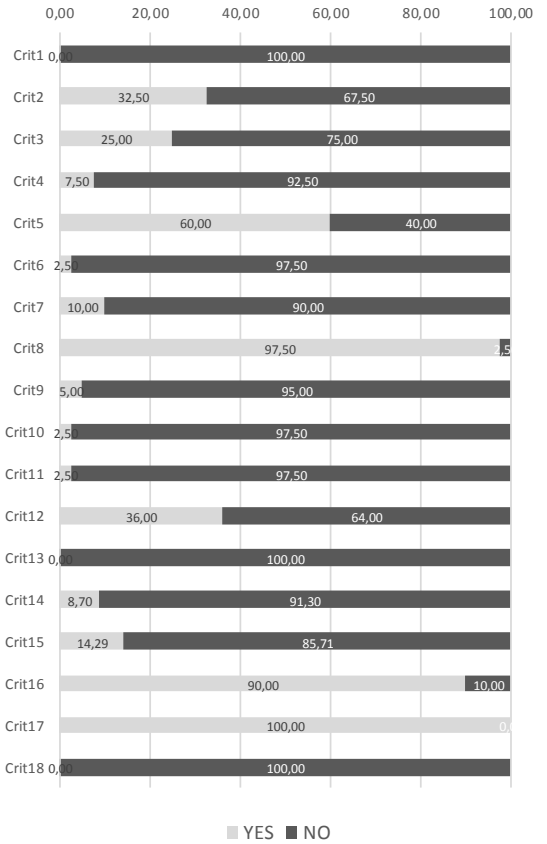

Figure 5. Proportion of compliance with criterial 1-18
Source: Authors.

Note: Compliance with criteria Crit 5 and Crit 13 could be tested on only 5 spreadsheets, while compliance with Crit12, Crit14 i Crit15 could be tested on 25, 23, and 14 spreadsheets, respectively.

Formula arguments were positioned above and/or left from the formula in all analysed spreadsheets (Crit 17). Criteria with a high degree of compliance also included Crit 8–Presence of table heading rows (97.5%) and Crit 16–Dependent formulas positioned as close as possible (90%). Ranges were named in three out of five spreadsheets they were used in (Crit 5, 60%).

Results indicated a complete lack of predefined convention for naming workbooks, worksheets, cell labels, cells, and ranges (Crit 1), visual distinction of frequently used input cells (Crit 13) and formula protection (Crit 18). Majority of analysed spreadsheets did not employ suggestive, descriptive cell names (Crit 4, 92.5%), separation of inputs, calculations, and outputs (Crit 9, 95%) and visual distinction (Crit 10, 97.5%) of input, calculation, and output cells, data validation (Crit 11, 97.5%), formula simplicity (Crit 14, 91.3%) and separation of constants into special cells (Crit 15, 85.71%). Only 32.5% of analysed workbooks and 25% of worksheets had descriptive, suggestive names (Crit 2 and Crit 3), while out of 25 spreadsheets where it was deemed meaningful to use conditional formatting, only 9 employed this feature (Crit12, 36%).

None of the analysed spreadsheets contained any form of documentation.

85% of analysed spreadsheets contained errors, with the total number of errors varying from 1 to 3650 (original and copied errors). The following errors were detected: use of constants in formulas, references to a non-existent cell, division by zero, use of text as formula argument, errors in VLOOKUP function arguments, and references to workbooks not supplied. The proportion of erroneous cells to all nonempty cells (CERA) was 2.18%, to cells containing numbers and formulas (CERV) was 3.12%, while the proportion of erroneous cells to a total of cells containing formulas (CERF) was 7.25%. It was not possible to compute CERN and CERT.

Conclusion

The research results show similarity with a number of related studies. The proportion of spreadsheets containing errors in total analysed spreadsheets (85%) is close to the average value among related researches (84%), while computed values of CERF (7.25%) and CERV (3.12%) are lean towards the lower brackets of reference ranges (CERF: 4.3%–21%, CERV: 1.1%–11.9%).

According to questionnaire data, only 10% of the respondents acknowledged the possibility of their spreadsheets containing errors. The discrepancy between their estimates and the actual number of spreadsheets containing errors (85%) points to overconfidence among the respondents.

Assessment of quality of analysed spreadsheets clearly suggests that frameworks and best practices are not employed to guide correct development and to ease the use of spreadsheets, and in turn reduce spreadsheet-related risks. On average, analysed spreadsheets received positive

assessment in only 4 out of 18 criteria. The greatest reason for concern is the prevalence of negative assessments in relation to criteria directly linked to spreadsheet errors and spreadsheet-related risks: non-use of data validation, complex formulas, use of constants in formulas, unprotected formulas, worksheets, workbooks, etc.SM

References

Baker, K., Powell, S., Lawson, B., & Foster-Johnson, L. (2006). The Spreadsheet Engineering Research Project (SERP) - Results of On-line Survey of Spreadsheet Usage. Retrieved November 1, 2017, from http://faculty.tuck.dartmouth.edu/serp/

Bewig, P. L. (2005). How do you know your spreadsheet is right? In *Proceedings of EuSpRIG 2005*. London: EuSpRIG.

Caulkins, J. P., Morrison, E. L., & Weidemann, T. (2008). Spreadsheet Errors and Decision Making. In S. Clarke (Ed.), *End-User Computing* (pp. 856–874). Hershey: IGI Global. https://doi.org/10.4018/9781599049458.ch061

Colver, D. (2010). Spreadsheet good practice: is there any such thing. In *Proceedings of EuSpRIG 2010*. London: EuSpRIG.

Dunn, A. (2010). Spreadsheets – the Good, the Bad and the Downright Ugly. In *Proceedings of EuSpRIG 2010*. London: EuSpRIG.

Ferreira, M. A., & Visser, J. (2012). Governance of Spreadsheets through Spreadsheet Change Reviews. In *Proceedings of EuSpRIG 2012*. London: EuSpRIG.

Grossman, T. A., & Özlük, Ö. (2004). A Paradigm for Spreadsheet Engineering. In *Proceedings of EuSpRIG 2004*. London: EuSpRIG.

Kulesz, D., & Zitzelsberger, S. (2012). Investigating Effects of Common Spreadsheet Design Practices on Correctness and Maintainability. In *Proceedings of EuSpRIG 2012*. London: EuSpRIG.

M. Grant, D., D. Malloy, A., & C. Murphy, M. (2009). A Comparison of Student Perceptions of their Computer Skills to their Actual Abilities. *Journal of Information Technology Education: Research*, *8*, 141–160. https://doi.org/10.28945/164

Panko, R. (1998). What We Know About Spreadsheet Errors. *Journal of Organizational and End User Computing*, *10*(2), 15-21. https://doi.org/10.4018/joeuc.1998040102

Panko, R. (2005). Errors During Spreadsheet Development Experiments. Retrieved from http://panko.shidler.hawaii.edu/SSR/devexpt.htm

Panko, R. (2007). Thinking is bad: Implications of human error research for spreadsheet research and practice. In *European Spreadsheet Risk Interest Group Conference* (pp. 69–80). Retrieved from https://arxiv.org/ftp/arxiv/papers/0801/0801.3114.pdf

Panko, R. (2009). Two Experiments in Reducing Overconfidence in Spreadsheet Development. In S. Clarke (Ed.), *Evolutionary Concepts in End User Productivity and Performance: Applications for Organizational Progress* (pp. 131–149). Hershey: IGI Global. https://doi.org/10.4018/978-1-60566-136-0.ch009

Panko, R., & Aurigemma, S. (2010). Revising the Panko–Halverson taxonomy of spreadsheet errors. *Decision Support Systems*, *49*(2), 235–244. https://doi.org/10.1016/j.dss.2010.02.009

Panko, R., & Halverson, R. (1996). Spreadsheets on Trial: A Survey of Research on Spreadsheet Risks. In *Proceedings of the 29th Annual Hawaii International Conference on System Sciences - 1996* (pp. 326-335). Washington: IEEE Computer Society.

Panko, R. R., & Port, D. N. (2013). End User Computing: The Dark Matter (and Dark Energy) of Corporate IT. *Journal of Organizational and End User Computing*, *25*(3), 1-19. https://doi.org/10.4018/joeuc.2013070101

Powell, S. G., Baker, K. R., & Lawson, B. (2008a). A critical review of the literature on spreadsheet errors. *Decision Support Systems*, *46*(1), 128-138. https://doi.org/10.1016/j.dss.2008.06.001

Powell, S. G., Baker, K. R., & Lawson, B. (2008b). An auditing protocol for spreadsheet models. *Information & Management*, *45*(5), 312-320. https://doi.org/10.1016/j.im.2008.03.004

Powell, S. G., Baker, K. R., Lawson, B., McDaid, K., & Rust, A. (2009). Errors in Operational Spreadsheets. *Journal of Organizational and End User Computing*, *21*(3), 24–36. https://doi.org/10.4018/joeuc.2009070102

Raković, L. (2014). *Programi za tabelarne kalkulacije u funkciji korisničkog razvoja aplikacija (The function of spreadsheet programs in end user application development) korisničkog razvoja aplikacija*. Univerzitet u Novom Sadu, Ekonomski fakultet u Subotici.

Raković, L. (2019). A framework for managing spreadsheet-based end user applications. *International Journal of Management and Decision Making*, *18*(1), 62-78. https://doi.org/10.1504/IJMDM.2019.096695

Raković, L., Sakal, M., & Vuković, V. (2019). Improvement of Spreadsheet Quality through Reduction of End-User Overconfidence: – Case Study. *Periodica Polytechnica Social and Management Sciences*, *27*(2). https://doi.org/10.3311/PPso.12392

Read, N., & Batson, J. (1999). Spreadsheet Modelling Best Practice. Retrieved January 18, 2018, from http://www.eusprig.org/smbp.pdf

Takaki, S. T. (2005). *Self-efficacy, confidence, and overconfidence as contributing factors to spreadsheet development errors*. Honolulu: University of Hawaii at Manoa.

The European Spreadsheet Risks Interest Group. (n.d.). Retrieved January 5, 2018, from http://www.eusprig.org/index.htm

Weber, B. (2006). Strategies for Addressing Spreadsheet Compliance Challenges. In *Proceedings of EuSpRIG 2006* (pp. 17–32). London: EuSpRIG.

✉ **Correspondence**

Predrag Matković

University of Novi Sad, Faculty of Economics in Subotica
Segedinski put 9-11, 24000, Subotica, Serbia

E-mail: predrag.matkovic@ef.uns.ac.rs

Manuscript Requirements

A paper must be written in text processor Microsoft Word. Paper size: A4. Margins: 3.0 cm on top and bottom, and 2.5 cm on left and right sides. As a guide, articles should be no more than 5.000 words in length. In case the paper exceeds the normal length, the Editors' consent for its publication is needed. Articles submitted for publication in Journal should include the research aim and tasks, with detailed methodology, presenting literature overview on the research object, substantiation of the achieved results and findings, conclusions and a list of references. Manuscripts should be arranged in the following order of presentation.

First page: Title (no more that 10 words), subtitle (if any), autobiographical note (the author's full name, academic affiliation, telephone, fax and e-mail address and full international contact). Respective affiliations and addresses of co-authors should be clearly indicated. Please also include approximately 50 words of biographical information on each author of the submitted paper.

Second page:

- A self-contained abstract/summary/resume of up to 150 words, describing the research objective and its conclusions
- Up to ten keywords, which encapsulate the principal subjects covered by the article; and
- A self-contained summary of up to 200 words, describing the article and its conclusions.

Subsequent pages: Main body of the text with headings, footnotes, a list of references, appendices, tables and illustrations. The paragraph parameters are:

- Font: Times New Roman, 10 pt, regular
- Spacing: Before: 0, After: 0
- Line Spacing: Single
- Alignment: Justified
- Indentation: Left: 0, Right: 0, Special: 0.
- Style: Normal (**not Title, Heading1, Heading2,...,Body Text, etc!**)

Leave an empty line between paragraphs.

Headings: Headings must be short, clearly defined and numbered, except for Introduction and Conclusions. Apply at most three levels of headings. Please, leave two empty lines before headings and one empty line after. Font: Times New Roman, bold, 16 pt, centered.
Section headings should be in **bold** with Leading Capitals on Main Words, Times New Roman, 14pt, bold, centered.
Sub-section headings should be in *italics*, with Leading Capitals on Main Words, Times New Roman, 12 pt, bold.

All tables, graphs and diagrams are expected to back your research findings. They should be clearly referred to and numbered consecutively in Arabic numerals. They should be placed in the text at the appropriate paragraph (just after its reference).

Tables should be centered. All tables must have captions. The title of your table should follow the table number. Tables should not be wider than the margins of the paper. Skip two lines before and after each table.

Figures should be centered. All figures must have captions. The title of figures should appear immediately below the figure. The title of the figure should follow the figure number. Figures should not be wider than the margins of the paper. Skip two lines before and after each figure. Figures will not be redrawn by the publisher. Figures should be high-quality **grayscale** graphics (please, do not use colors): vector drawings (with text converted to curves) or 300 dpi bitmaps. Please do not supply any graphics copied from a website, as the resolution will be too low. In all figures taken or adapted from other sources, a brief note to that effect is obligatory, below the figure. One sentence at least referring to the illustration is obligatory.

Mathematical expressions should be numbered on the right side, while all variables and parameters must be defined.

Copyright

Articles submitted to the Journal should be authentic and original contributions and should have never been published before in full text, nor be under consideration for any other publication at the same time. Authors submitting articles for publication warrant that the work is not an infringement of any existing copyright and will indemnify the publisher against any breach of such warranty. For use of dissemination and to ensure proper policing of use, papers and contributions become the legal copyright of the publisher unless otherwise agreed.

Proof

Authors are responsible for ensuring that all manuscripts (whether original or revised) are accurately typed before final submission. One set of proof will be sent to authors, if requested, before the final publication, which must be returned promptly.

Referencing Guide

The references should specify the source (such as book, journal article or a web page) in sufficient detail to enable the readers to identify and consult it. The references are placed at the end of the work, with sources listed alphabetically (a) by authors' surnames or (b) by the titles of the sources (if the author is unknown). Multiple entries by the same author(s) must be sequenced chronologically, starting from the earliest, e.g.:

Ljubojević, T.K. (1998).
Ljubojević, T.K. (2000a).
Ljubojević, T.K. (2000b).
Ljubojević, T.K., & Dimitrijević, N.N. (1994).

Here is a list of the most common reference types:

A. PERIODICALS

Authors must be listed by their last names, followed by initials. Publication year must be written in parentheses, followed by a full stop. Title of the article must be in sentences case: only the first word and proper nouns in the title are capitalized. The periodical title must be in title case, followed by the volume number, which is also italicized:

Author, A. A., Author, B. B., & Author, C. C. (Year). Title of article. *Title of Periodical, volume number*(issue number), pages.

➲ Journal article, one author, paginated by issue

Journals paginated by issue begin with page 1 in every issue, so that the issue number is indicated in parentheses after the volume. The parentheses and issue numbers are not italicized, e.g.

Tanasijević, V. (2007). A PHP project test-driven end to end. *Management Information Systems, 5* (1), 26-35.

➲ Journal article, one author, paginated by volume

Journals paginated by volume begin with page 1 in issue 1, and continue page numbering in issue 2 where issue 1 ended, e.g.

Perić, O. (2006). Bridging the gap: Complex adaptive knowledge management. *Strategic Management, 14*, 654-668.

➲ **Journal article, two authors, paginated by issue**

Strakić, F., & Mirković, D. (2006). The role of the user in the software development life cycle. *Management Information Systems, 4* (2), 60-72.

➲ **Journal article, two authors, paginated by volume**

Ljubojević, K., & Dimitrijević, M. (2007). Choosing your CRM strategy. *Strategic Management, 15*, 333-349.

➲ **Journal article, three to six authors, paginated by issue**

Jovanov, N., Boškov, T., & Strakić, F. (2007). Data warehouse architecture. *Management Information Systems, 5* (2), 41-49.

➲ **Journal article, three to six authors, paginated by volume**

Boškov, T., Ljubojević, K., & Tanasijević, V. (2005). A new approach to CRM. *Strategic Management, 13*, 300-310.

➲ **Journal article, more than six authors, paginated by issue**

Ljubojević, K., Dimitrijević, M., Mirković, D., Tanasijević, V., Perić, O., Jovanov, N., et al. (2005). Putting the user at the center of software testing activity. *Management Information Systems, 3* (1), 99-106.

➲ **Journal article, more than six authors, paginated by volume**

Strakić, F., Mirković, D., Boškov, T., Ljubojević, K., Tanasijević, V., Dimitrijević, M., et al. (2003). Metadata in data warehouse. *Strategic Management, 11*, 122-132.

➲ **Magazine article**

Strakić, F. (2005, October 15). Remembering users with cookies. *IT Review*, *130*, 20-21.

➲ **Newsletter article with author**

Dimitrijević, M. (2009, September). MySql server, writing library files. *Computing News, 57,* 10-12.

➲ **Newsletter article without author**

VBScript with active server pages. (2009, September). *Computing News,57,* 21-22.

B. BOOKS, BROCHURES, BOOK CHAPTERS, ENCYCLOPEDIA ENTRIES, AND BOOK REVIEWS

Basic format for books

Author, A. A. (Year of publication). *Title of work: Capital letter also for subtitle*. Location: Publisher.

Note: "Location" always refers to the town/city, but you should also include the state/country if the town/city could be mistaken for one in another country.

➲ **Book, one author**

Ljubojević, K. (2005). *Prototyping the interface design*. Subotica: Faculty of Economics.

➲ **Book, one author, new edition**

Dimitrijević, M. (2007). *Customer relationship management* (6th ed.). Subotica: Faculty of Economics.

➲ **Book, two authors**

Ljubojević, K., Dimitrijević, M. (2007). *The enterprise knowledge portal and its architecture*. Subotica: Faculty of Economics.

➲ **Book, three to six authors**

Ljubojević, K., Dimitrijević, M., Mirković, D., Tanasijević, V., & Perić, O. (2006). *Importance of software testing*. Subotica: Faculty of Economics.

➲ **Book, more than six authors**

Mirković, D., Tanasijević, V., Perić, O., Jovanov, N., Boškov, T., Strakić, F., et al. (2007). *Supply chain management*. Subotica: Faculty of Economics.

➲ **Book, no author or editor**

Web user interface (10th ed.). (2003). Subotica: Faculty of Economics.

➲ **Group, corporate, or government author**

Statistical office of the Republic of Serbia. (1978). *Statistical abstract of the Republic of Serbia*. Belgrade: Ministry of community and social services.

➲ **Edited book**

Dimitrijević, M., & Tanasijević, V. (Eds.). (2004). *Data warehouse architecture*. Subotica: Faculty of Economics.

➲ **Chapter in an edited book**

Boškov, T., & Strakić. F. (2008). Bridging the gap: Complex adaptive knowledge management. In T. Boškov & V. Tanasijević (Eds.), *The enterprise knowledge portal and its architecture* (pp. 55-89). Subotica: Faculty of Economics.

➲ **Encyclopedia entry**

Mirković, D. (2006). History and the world of mathematicians. In *The new mathematics encyclopedia* (Vol. 56, pp. 23-45). Subotica: Faculty of Economics.

C. UNPUBLISHED WORKS

➲ **Paper presented at a meeting or a conference**

Ljubojević, K., Tanasijević, V., Dimitrijević, M. (2003). *Designing a web form without tables*. Paper presented at the annual meeting of the Serbian computer alliance, Beograd.

➲ **Paper or manuscript**

Boškov, T., Strakić, F., Ljubojević, K., Dimitrijević, M., & Perić, O. (2007. May). *First steps in visual basic for applications*. Unpublished paper, Faculty of Economics Subotica, Subotica.

➲ **Doctoral dissertation**

Strakić, F. (2000). *Managing network services: Managing DNS servers*. Unpublished doctoral dissertation, Faculty of Economics Subotica, Subotica.

➲ **Master's thesis**

Dimitrijević, M. (2003). *Structural modeling: Class and object diagrams*. Unpublished master's thesis, Faculty of Economics Subotica, Subotica.

D. ELECTRONIC MEDIA

The same guidelines apply for online articles as for printed articles. All the information that the online host makes available must be listed, including an issue number in parentheses:

Author, A. A., & Author, B. B. (Publication date). Title of article. *Title of Online Periodical, volume number*(issue number if available). Retrieved from http://www.anyaddress.com/full/url/

➲ **Article in an internet-only journal**

Tanasijević, V. (2003, March). Putting the user at the center of software testing activity. *Strategic Management*, *8* (4). Retrieved October 7, 2004, from www.ef.uns.ac.rs/sm2003

➲ **Document from an organization**

Faculty of Economics. (2008, March 5). *A new approach to CRM*. Retrieved July 25, 2008, from http://www.ef.uns.ac.rs/papers/acrm.html

➲ **Article from an online periodical with DOI assigned**

Jovanov, N., & Boškov, T. A PHP project test-driven end to end. *Management Information Systems*, 2 (2), 45-54. doi: 10.1108/06070565717821898.

➲ **Article from an online periodical without DOI assigned**

Online journal articles without a DOI require a URL.

Author, A. A., & Author, B. B. (Publication date). Title of article. *Title of Journal, volume number*. Retrieved from http://www.anyaddress.com/full/url/

Jovanov, N., & Boškov, T. A PHP project test-driven end to end. *Management Information Systems*, 2 (2), 45-54. Retrieved from http://www.ef.uns.ac.rs/mis/TestDriven.html.

REFERENCE QUOTATIONS IN THE TEXT

➲ **Quotations**

If a work is directly quoted from, then the author, year of publication and the page reference (preceded by "p.") must be included. The quotation is introduced with an introductory phrase including the author's last name followed by publication date in parentheses.

According to Mirković (2001), "The use of data warehouses may be limited, especially if they contain confidential data" (p. 201).

> Mirković (2001), found that "the use of data warehouses may be limited" (p. 201). What unexpected impact does this have on the range of availability?

If the author is not named in the introductory phrase, the author's last name, publication year, and the page number in parentheses must be placed at the end of the quotation, e.g.

> He stated, "The use of data warehouses may be limited," but he did not fully explain the possible impact (Mirković, 2001, p. 201).

➲ **Summary or paraphrase**

> According to Mirković (1991), limitations on the use of databases can be external and software-based, or temporary and even discretion-based. (p.201)

> Limitations on the use of databases can be external and software-based, or temporary and even discretion-based (Mirković, 1991, p. 201).

➲ **One author**

> Boškov (2005) compared the access range…
>
> In an early study of access range (Boškov, 2005), it was found...

➲ When there are **two authors**, both names are always cited:

> Another study (Mirković & Boškov, 2006) concluded that…

➲ If there are **three to five authors**, all authors must be cited the first time. For subsequent references, the first author's name will cited, followed by "et al.".

> (Jovanov, Boškov, Perić, Boškov, & Strakić, 2004).

In subsequent citations, only the first author's name is used, followed by "et al." in the introductory phrase or in parentheses:

> According to Jovanov et al. (2004), further occurences of the phenomenon tend to receive a much wider media coverage.
>
> Further occurences of the phenomenon tend to receive a much wider media coverage (Jovanov et al., 2004).

In "et al.", "et" is not followed by a full stop.

➲ **Six or more authors**

The first author's last name followed by "et al." is used in the introductory phrase or in parentheses:

> Yossarian et al. (2004) argued that…
>
> … not relevant (Yossarian et al., 2001).

➲ **Unknown author**

If the work does not have an author, the source is cited by its title in the introductory phrase, or the first 1-2 words are placed in the parentheses. Book and report titles must be italicized or underlined, while titles of articles and chapters are placed in quotation marks:

> A similar survey was conducted on a number of organizations employing database managers ("Limiting database access", 2005).

If work (such as a newspaper editorial) has no author, the first few words of the title are cited, followed by the year:

> ("The Objectives of Access Delegation," 2007)

Note: In the rare cases when the word "Anonymous" is used for the author, it is treated as the author's name (Anonymous, 2008). The name Anonymous must then be used as the author in the reference list.

➲ **Organization as an Author**

If the author is an organization or a government agency, the organization must be mentioned in the introductory phrase or in the parenthetical citation the first time the source is cited:

> According to the Statistical Office of the Republic of Serbia (1978), …

Also, the full name of corporate authors must be listed in the first reference, with an abbreviation in brackets. The abbreviated name will then be used for subsequent references:

> The overview is limited to towns with 10,000 inhabitants and up (Statistical Office of the Republic of Serbia [SORS], 1978).

> The list does not include schools that were listed as closed down in the previous statistical overview (SORS, 1978).

➲ When citing **more than one reference from the same author**:

> (Bezjak, 1999, 2002)

➲ When several **used works by the same author were published in the same year**, they must be cited adding a, b, c, and so on, to the publication date:

> (Griffith, 2002a, 2002b, 2004)

➲ **Two or more works in the same parentheses**

When two or more works are cited parenthetically, they must be cited in the same order as they appear in the reference list, separated by a semicolon.

> (Bezjak, 1999; Griffith, 2004)

➲ **Two or more works by the same author in the same year**

If two or more sources used in the submission were published by the same author in the same year, the entries in the reference list must be ordered using lower-case letters (a, b, c…) with the year. Lower-case letters will also be used with the year in the in-text citation as well:

> Survey results published in Theissen (2004a) show that…

➲ To **credit an author for discovering a work**, when you have not read the original:

Bergson's research (as cited in Mirković & Boškov, 2006)…

Here, Mirković & Boškov (2006) will appear in the reference list, while Bergson will not.

➲ When **citing more than one author**, the authors must be listed alphabetically:

(Britten, 2001; Sturlasson, 2002; Wasserwandt, 1997)

➲ When there is **no publication date**:

(Hessenberg, n.d.)

➲ **Page numbers must always be given for quotations**:

(Mirković & Boškov, 2006, p.12)

Mirković & Boškov (2006, p. 12) propose the approach by which "the initial viewpoint…

➲ **Referring to a specific part of a work**:

(Theissen, 2004a, chap. 3)

(Keaton, 1997, pp. 85-94)

➲ **Personal communications, including interviews, letters, memos, e-mails, and telephone conversations**, are cited as below. (These are *not* included in the reference list.)

(K. Ljubojević, personal communication, May 5, 2008).

FOOTNOTES AND ENDNOTES

A few footnotes may be necessary when elaborating on an issue raised in the text, adding something that is in indirect connection, or providing supplementary technical information. Footnotes and endnotes are numbered with superscript Arabic numerals at the end of the sentence, like this.[1] Endnotes begin on a separate page, after the end of the text. However, Strategic Management journal **does not recommend the use of footnotes or endnotes.**

COPYRIGHT AND USE AGREEMENT

Articles submitted to the Journal should be authentic and original contributions and should have never been published before in full text, nor be under consideration for any other publication at the same time. Authors submitting articles for publication warrant that the work is not an infringement of any existing copyright and will indemnify the publisher against any breach of such warranty. For use of dissemination and to ensure proper policing of use, papers and contributions become the legal copyright of the publisher unless otherwise agreed.

All contributors are required to sign the Transfer of Copyright Agreement before the article may be published. The transfer of copyright encompasses the exclusive right to reproduce and circulate the article, including photographic reproductions, reprints or any other similar reproductions and translation. If the copyright exists either for the entire article or any part of it, it is the contributor's responsibility to obtain permission to reproduce it from the copyright holder.

CIP - Каталогизација у публикацији
Библиотека Матице српске, Нови Сад

005.21

STRATEGIC managament : international journal of strategic managament and decision support systems in strategic managament / editor-in-chief Aleksandar Grubor. - Vol. 14, no. 1 (2009) - . - Subotica: University of Novi Sad, Faculty of Economics, 2009-. - 30 cm

Tromesečno. - Nastavak publikacije: Strategijski menadžment = ISSN 0354-8414
ISSN 1821-3448

COBISS.SR-ID 244849927

Rešenjem Ministarstva za informisanje Republike Srbije, časopis "Strategijski menadžment" upisan je u registar javnog informisanja pod brojem 2213, od 7. avgusta 1996. Rešenjem Ministarstva za nauku i tehnologiju Republike Srbije br. 413-00-435/1/96-01 časopis je oslobođen opšteg poreza na promet proizvoda kao publikacija od posebnog interesa za nauku.

ISSN 1821-3448