CONTEMPORARY INFORMATION SYSTEM DEVELOPMENT METHODOLOGIES IN TOURISM ORGANIZATIONS[1]

Brankica Pazun[2]; Zlatko Langovic[3];

Abstract

The modern business environment requires new methodologies for development of information resources of a business systems. They represent the basis for development of information systems in industrial sector, telecommunications sphere, and other socio-economic structures. From technological point of view development directions of information systems can be defined in the form of Cloud computing, Big Data system, Internet of Things, 5G, process virtualization, agile methods and DevOps concept. The new platform DevOps enables a stronger interaction between development team and operations in business system. It provides more attention to minimizing the impact of barriers between potential users and development team.

The aim of this study is to show that development concepts provide flexibility and rapid implementation of new business solutions, ie, a positive impact on productivity and efficiency enhancement in companies. It is essential that tourism organizations in Serbia become aware of contemporary IT trends in order to improve their own business.

Key Words: *agile methods, Big Data, IoT, development methodologies, DevOps, virtualization*
JEL classification: *D83, M15, Z32*

[2] Brankica Pazun, Ph.D., Associate Professor, University Union Nikola Tesla, Faculty of Engineering Management, Bul. vojvode Mišića, Street no. 43, 11000 Belgrade, Serbia, E-mail: bpazun@gmail.com
[3] Zlatko Langovic, Ph.D., Associate Professor, University of Kragujevac, Faculty of Hotel Management and Tourism, Vojvodjanska bb, 36210 Vrnjacka Banja, Serbia, E-mail: zlangovic@kg.ac.rs

Introduction

The success of projects in every business, including software engineering, is conditioned by a regular organization. Project management aims at the efficient use of resources, the equal distribution of jobs, i.e. the plan creating in order to implement the project well. The important concept of managing information technology projects is the software development process. This paper examines the traditional, as well as agile, i.e. DevOps methodologies of software development.

Due to applying development methodologies in process of software development, the percentage of failed projects is not small. This fact defines the need to improve existing methodologies.

Basic concepts of development methodologies

Basic concepts of information system architecture are common to the most software system development methods. The concepts that influence the process of development of software architecture are the static and dynamic structure of the system, the characteristics of the information system (IS), the primary elements of the given architecture, as well as stakeholders and documentation.

The development of software architecture requires the analysis or description of system features at a high level of abstraction, validation of software requirements of users, development costs estimation, a possibility of re-use of software, and creating the basis for system design.

The concept based on description, i.e. software architecture documentation, is provided by using documents, modeling languages, code, etc. A set of interconnected models defines the software architecture of complex systems. The model sets make views that describe certain aspects of architecture.

Back to 2001 Nuseibeh suggested the Twin Peaks model to develop both requirements and architecture iteratively and parallel. The term Twin Peaks model which consists of dilemma: what is "older", the requirements or the architecture? According to Stal (2016), drafting about 30 % of the most important system requirements rudimentarily has been suggested.

Figure 1: *The Twin Peaks model*
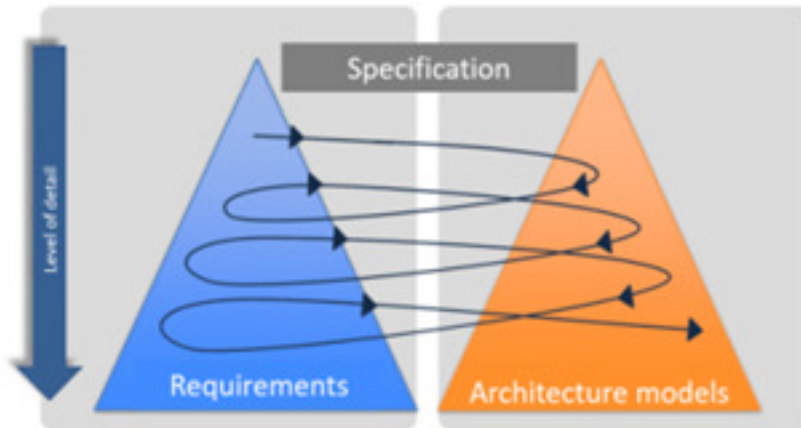
Source: *Nuseibeh, 2011*

A relatively large number of different methods, processes of software architecture development are in use. The application of a particular method is in the function of IS type, the organization size, the size of the development company, and so on. The development of complex systems through functional and non-functional requirements cannot be defined by a unique model. The development of these systems is based on a certain number of views that are in a certain interaction with each other.

Figure 2: *4+1 Architectural View Model*
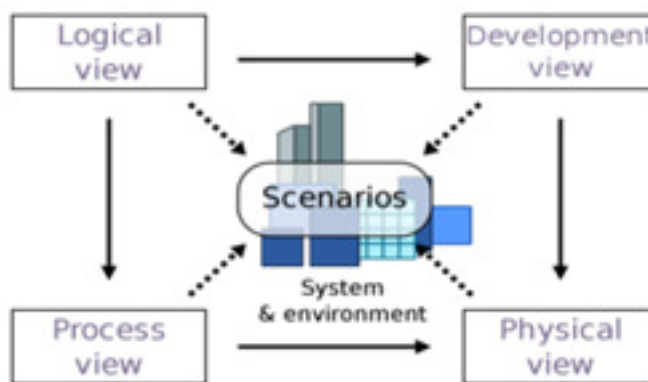
Source: *Kruchten, 1995*

Kruchten 4+1. The 4+1 view model describes the software architecture using five simultaneous views, each of which deals with a specific set of requirements: the logical representation describes the object model of the

design; the process view describes the aspects of competitiveness and design synchronization; the physical view describes the mapping of software to hardware and shows the distributed aspects of the system, and the development view describes the static organization of the software in the development environment. (Kruchten, 1995; Kontio, 2005)

RUP. RUP development framework, developed by Rational Software company, is an object-oriented development process, based on the unified software development process.

It represents well defined i.e. structured traditional software development process. RUP is a working framework that contains a set of recommendations and guidelines for the development of software solutions. RUP has found its application in the development of large and complex projects, but also small and medium-sized projects.

Companies in a dynamic business environment with the impact of rapidly developing technology cannot effectively apply traditional approaches. RUP framework enables the development of high-quality complex software solutions. Conceptuality on information system architecture, iterative and incremental, and demand management are basic RUP principles. RUP is realized through two variables: time and content.

This concept is effective. By applying the time and content aspect, development is enabled through a large number of iterations. The four phases of the software development, such are lifecycle, introduction, elaboration, construction and transition, constitute a time dimension. The substantive dimension consists of six basic and three auxiliary disciplines.

In the analysis of architecturally significant activities, the following RUP disciplines differ:
1. Discipline business modeling that defines the relationship between business architecture and architecture of the developed system;
2. Discipline requirements define the process of collecting requests from the stakeholders of the future system as well as their mapping into a set of software requirements;
3. Discipline analysis and design collects system requirements and maps them into classes and sub-systems;
4. Discipline implementation defines the process of testing and integration. (Shuja & Krebs, 2008)

ADD method. ADD development method is based on non-functional requirements of the system, which are in function of the business goals of an organization. The ADD development method is analogous to the RUP platform. It does not go to the formal level in relation to RUP, and it does not deal with implementation. Given method has a high-quality approach to defining architecture. It is useful to implement ADD method in RUP analysis and design in the initial stage of elaboration. RUP's behavior analysis is in relation to certain ADD activities (Hofmeister et al., 2005).

RUP is mapping defined requirements into the set of software elements, and the ADD defines functionality based on the architecture structure. Certain RUP activities are not part of the ADD method and are realized singly (Kazman et al., 2004).

Contemporary development processes

Rapid development realization and, consequently, the production of quality business software, has influenced the development platforms. The variability of the requirements over the entire life cycle of software development is an important aspect in the development of a business solution. In the new environment, traditional development processes do not fully meet modern business requirements. Well-defined processes, with a large number of roles, as well as extensive documentation, were not effective in developing small business solutions. For example, establishing a RUP development process is a more demanding task than a business solution (Cockburn, 2001).

Agile processes are based on an iterative and incremental development model. The development is realized through a large number of small iterations, which last about four weeks. Iteration is a rounded cycle of software development. The result of the iteration is the new functionality of the software.

The appearance of agile processes generates changes in software development. As a result of these changes the agility of the dominant RUP platform appears. Agilization process is enabled through a common iterative incremental principle. The following methodologies appear: Agile Unified Process (AUP), Essential Unified Process (EssUP) and Open UnifiedProcess (OpenUP).

The observed methodologies have retained the basic RUP structure, but they have implemented certain agile methods: Test Driven Development (TDD), Agile Model Driven Development (AMDD), Agile Change Management (ACM) and Database Refactoring.

Users are involved in the entire development process, which enables quick definition of the necessary changes, as well as new software requirements, as inputs for the next iteration. Such an organization allows the flexibility of the project, through rapid adaptation to change (Ambler, 2001; Jacobson et al., 2006).

On the other hand, the Scrum framework contains a set of managerial recommendations, and does not have the activities of the development process itself, therefore is often used in combination with RUP and Extreme Programming development process (XP), with its basic proclaimed values as simplicity and communication (Sato et al., 2007).

Furthermore, Womack and Jones considered that general Lean principles can be applied in almost all types of organizations, with some adjustments to the specific context of application. (Womack & Jones, 2003) Different authors dealt with the general principles of Lean's software development domain.

Finally, DevOps methodology includes the entire development process: programme development (developers, software engineers), quality control (QA), as well as operations in information technology (IT operations or system administration). Following figure 3 shows the place in software development process, as well as role and description of each phase.

Figure 3: *Where agile and DevOps fits in SDLC*
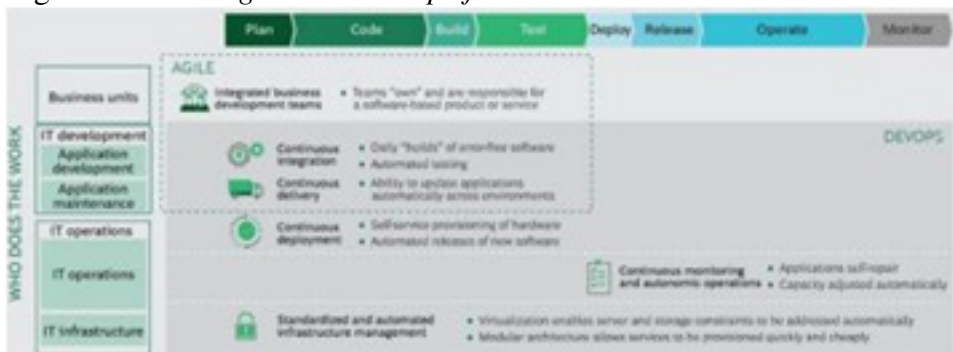
Source: *BCG analysis, 2018*

DevOps can be viewed from three aspects: people, processes and technology. It is a philosophy that seeks to overcome traditional organizational systems, that is, to bring development and administration teams closer. DevOps integrates the principles of agile development.

This concept automates development processes by using the Gerrit, as a free, web-based team code collaboration tool, as well as Puppet, SaltStack, etc, for configurations managing. Furthermore, some of the tools for quick and modest adjustment of the development environment are Vagrant, as well as Jenkins, the tool that enables the creation of so-called tasks for continuous integration, delivery, testing, and so on.

For example, considering a web application, it is simple to monitor the server's work and, if necessary, run scale-up/ down in order to maintain the desired response with minimal costs.

The DevOps practice has been adopted in the management of network services. Hardware, configuration tools, and application modes have facilitated configuration programming and automatization of network devices and functions (Hoda & Noble, 2017).

IoT (Internet of Things) is something that comes into play with automated security testing (continuous testing), as well as integration testing (continuous integration) and continuous introduction.

The IoT system testing process uses DevOps methodology. During testing, it is necessary to consider the security of the information collected through the sensors. These are simply compromised entries. DevOps security testing tools allow you to see the weaknesses and benefits of a given system (Langovic & Pazun, 2016).

Software-defined networking (SDN) and virtualization of network functions (NFV) represent the backbone of the 5G network, enabling providers to deliver better quality services (Stallings, 2016). SDN makes the network programmable and centrally controlled, while NFV replaces dedicated network devices with software systems (Langovic & Pazun, 2016; Pazun et al., 2015a; Pazun et al., 2015b; Langovic et al., 2014). More important, a cloud-based approach allows virtualization of the network by service providers in order to use DevOps (continuous implementation and integration) methods for automating the process of developing network resources within information systems (Pazun, 2018).

Finally, comparing characteristics of both, agile and traditional methodologies, following table is given.

Table 1: *Comparison between agile and traditional methodologies*

Features	Traditional approach	Agile approach
Organizational structure	Linear	Iterative
Scale of projects	Large-scale	Small and medium scale
Development model	Life cycle	Evolutionary delivery
Involvement of clients	Low	High
User requirements	Clearly defined before implementation	Interactive input
Customer involvement	Customers get involved early in the project	Customers are involved from the time work is being performed
Reviews and approvals	Excessive reviews and approvals by leaders	Reviews are done after each iteration

Development concepts and the tourism sector

Agile methods continue to be predominate approach used for software development. According to research done by Reifer & Hastie in 2017, most of companies have adopted agile development within period 2009-2014 (bellow expressed by EM Adoption Stage), then there is so called early adoption (EA) – period within 2004-2009, as well as LM stage, after 2014. Last set of data refers to firms which consider, but not currently use agile methods.

Figure 4: *World wide agile introduction in period 2004-2017*
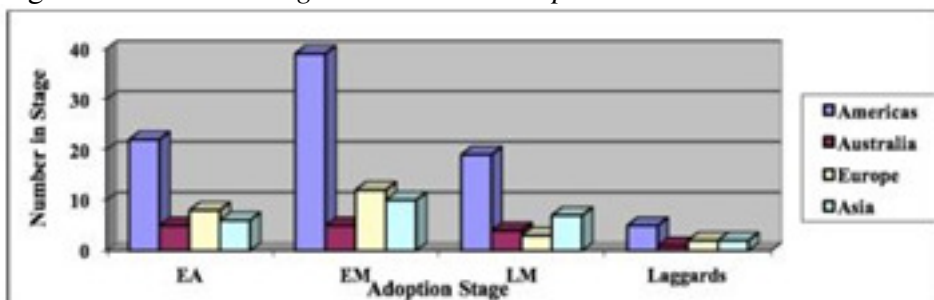
Source: *Reifer & Hastie, 2017*

Some of DevOps's usage features in the tourism sector are reflected in cost optimization, improving company loyalty, as well as insuring business continuity. Lately, companies have been applying given methodology to automate business processes due to increasing productivity.

Figure 5: *DevOps benefits for tourism industry*

Some of examples using DevOps and agile development methodology are following.

Online P2P platforms have become very popular in recent years. One of the most popular and fast-growing platforms is Airbnb established in 2008 with idea to enable owners to offer their house or rooms for short term rental (Kuzmanovic & Langovic, 2018). It acts as third party between these two groups. It is growing and currently operates in cca 65,000 cities across 191 countries and currently offers 4 million listings. As it grows rapidly, as well as acording to latest reports and job announcement (Frank, 2018), human resource, which would be part of DevOps development team for system operations, is needed.

The other case is the cloud application on Amadeus company, leading IT provider headquarted in Madrid, and one of the most renowned travel operators in the world. Their systems are linked to 90% of all passenger transactions, serving more than 700 airlines and about 600,000 hotels, and fixing about 55,000 operations per second (Amadeus, 2018).

The company has used a private cloud with virtual machines interacting with Vagrant and vSphere. The high intensity of computer resource loads used to work on the hypervisor was high, while processing speed was not optimal. Given company has chosen the company Docker instead of Vagrant and has decided to move to cloud systems running through OpenShift, Docker and Kubernetes. By using DevOps systems for

development management, they were able to efficiently use their entire IT infrastructure. That was about 20% of their computing power, and the company has received several million computing systems.

Figure 6: *Docker system (retrieved from https://www.docker.com/produ cts/orchestration)*
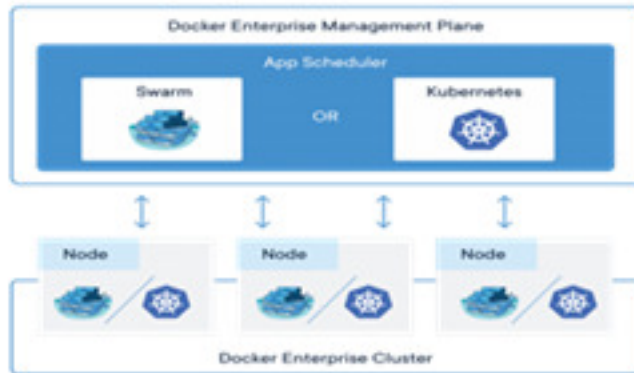
Another case in tourist sector is the Pan-Australian tourist platform which uses DevOps. In previous year, in 2018, the Australian Tourism Data Warehouse (ADTW) has started to work. It is a joint venture of the Australian Tourism Association, Rackspace Cloud Provider and DevOps, as well as the consulting company for digital marketing SapientNitro. The platform supports more than 40,000 passenger processes in 10 categories and provides multiple travel opportunities of all sizes, from multinational companies to small family businesses.

Working on a centralized platform, that is, using cloud technology and DevOps processes, during the first day of launch, ADTV-Online has processed more than 1.6 million requests, therefore has provided more than 350,000 unique visitors and served around 1,800 business travel operators.

According to previous analyses, it can be pointed out that examples define the successful implementation of given developed methodologies.

Conclusion

Most companies point to the need for using agile practices in business, where implementation is not broad or deep. From the technological aspect

organisations have advantages in terms of process automation, high-quality software implementation, larger reliability of infrastructure, a shorter reaction time, therefore the solution of requirements.

The tourism industry can benefit from using the DevOps platform that enables cost optimization, minimizing the time for placement of new products or services, then creating more stable business processes, better control, that is enabling high-quality business continuity.

According to Institute for Project Management'S Pulse of the Profession (Institute for Project Management - PMI, 2018) 46% of surveyed organizations use or have used Agile or hybrid Agile approach in 2017. The KPMG research on the agile implementation of projects in 2017 states that 76% of respondents in Belgium and the Netherlands believe that the agile methodology will prevail over the waterfall method by 2020, while 85% of companies believe that the waterfall will not gradually disappear and will survive.

The importance of the computerization of the tourism sector, as well as following the latest developments in the field of information technologies, can be seen through the fact of increasing the share of this industry in the global GDP. According to the WTTC (World Travel & Tourism Council) from 2019 (WTTC, 2019) contribution to total world GDP amounted to 10.4% in 2018, with 319 million jobs, that is, for every eleven one position belongs to the tourism sector. It also states the fact that in this field today is present the fastest growth, compared with i.e. the automotive industry, the financial sector, the health care industry, etc. (according to WTTC report, in 2018, the Travel & Tourism industry experienced 3.9% growth, compared to the global economy (3.2%); one in five new jobs were created by the industry over the last five years)

Considering domestic tourism market, according to Statistical Office of the Republic of Serbia, there has been the trend of increasing income (from tourists, both domestic and foreign). In February 2019, compared to February 2018, number of tourist arrivals was by 5,0% greater, while number of tourist overnight stays was by 4,1%. The domestic number of overnights was increased by 2,8%, and foreign by 7,0%, as well (RZS, 2019).

Finally, we can emphasize the importance of computerization of the tourism sector, and hence the development of information system. Given

methodologies represent the managing framework in the IS development process of tourist organizations. The fact is that both methodologies, traditional as well as agile, consist of many disadvantages and advantages. This is another in a series of information that indicates the necessity of keeping track of the world trends in the field of information technologies, that is information system development.

References

1. Ambler, S.W. (2001). Agile Modeling (AM) Overview. Ronin International, available on: https://www.researchgate.net/publication/242647698_Agile_Modeling_AM_Overview.

2. BCG analysis. (2018). *Going All in with DevOps*, available on: https://www.bcg.com/

3. Cockburn, A. (2001). Agile software development: the business of innovation. *Computer*, Vol. 34, No. 9, 120-127.

4. Frank, J. *DevOps Engineer - CI, CD - SF - Travel & Tourism - $150k+,* available on: https://www.jeffersonfrank.com/14534/devops-engineer-ci-cd-sf-travel-tourism-150k.

5. Hoda, R., Noble, J.W. (2017). Becoming Agile: A Grounded Theory of Agile Transitions in Practice, *ICSE '17 Proceedings of the 39th International Conference on Software Engineering*, 141-151.

6. Hofmeister, C., Kruchten, P., Nord, R., Obbink H., Ran, A., America, P. (2005). *Generalizing a Model of Software Architecture Design from Five Industrial Approaches*. Proceedings of the 5th Working IEEE/IFIP Conference on Software Architecture (WICSA5). Pittsburgh, PA, available on: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.85.2043&rep=rep1&type=pdf.

7. Jacobson, I., Wei Ng, P., Spence, I. (2006). The essential unified process. Dr.Dobb's. The World of Software Development.

8. Kazman, R., Kruchten, P., Nord, R., Tomayko, J. (2004). Integrating Software-Architecture-Centric Methods into the Rational Unified Process. Software Engineering Institute.

9. Kontio, M. (2005). *Architectural manifesto: Designing software architectures, Part 5, Introducing the 4+1 view model*, available on: http://www.ibm.com/developerworks/wireless/library/wi-arch11/.

10. Kruchten, P. (1995). *Architectural Blueprints — The "4+1" View Model of Software Architecture.* IEEE Software Vol. 12, No. 6, 42-50.

11. Langovic, Z., Pazun, B. (2016). *Virtualization of Information Resources in Tourism Organizations*, 1th International Scientific Conference, Tourism in Function of Development of the Republic of Serbia, Spa Tourism in Serbia and Experiences of Other Countries, 2-4 June, 2016 Vrnjačka Banja, Serbia, Thematic Proceedings - II, University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, pg.536-552 [ISBN 978-86-89949-09-4; ISBN 978-86-89949-10-0]

12. Kuzmanovic, M., Langovic, Z. (2018). *Factors Affecting Online Booking Intention and Behavior: the Case of AIRBNB*, III International Scientific Conference, Tourism in Function of Development of the Republic of Serbia, Tourism in the Era Digital Transformation, 1-3 June, 2018 Vrnjačka Banja, Serbia, Thematic Proceedings - II, University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, pg. 132-151 [ISBN 978-86-89949-29-2; ISBN 978-86-89949-31-5

13. Langovic, Z., Pazun, B., Tomasevic, V. (2014). *Impact of IS network virtualisation (SDN) on business improvement*, International Conference, SMEs development and Innovation: Building competitive future of South-Eastern Europe, Ohrid, Macedonia, October 3-4, 2014, pg. 463-468, ISBN 978-9989-695-56-8, COBISS.MK-ID 97368586.

14. Nuseibeh, B. (2001). *Weaving the Software Development Process Between Requirements and Architecture.* Proc. Of ICSE 2001 Workshop STRAW-01. Toronto.

15. Pazun, B. (2018). *Cloud computing influence on modern business*. Serbian Journal of Engineering Management, ISSN 2466-4693, Vol. 3, No. 2, 60-66, [COBISS.SR-ID 2048966792].

16. Pazun, B., Langovic, Z., Langovic Milicevic, A. (2015a). *Integration of technologies opendaylight, openstack, NFV/SDN in business environment*, 9th International Quality Conference, 5th June 2015, Center for Quality, Faculty of Engineering, University of Kragujevac, 617-620

[ISBN: 978-86-6335-015–1] COBISS.SR - ID 215331852 CIP - 005.6(082).

17. Pazun, B., Grujcic, Z., Langovic, Z., Ralic, Z. (2015b): *Implementacija tehnologija NV, NFV i SDN u poslovnom okruženju*, međunarodna naučno-stručna konferencija Primenjeni menadžment u funkciji napretka nerazvijenih područja Vojvodine, Beograd, jun 2015.; Fakultet za primenjeni menadžment, ekonomiju i finansije MEF (Beograd) i International centre for knowledge and technology transfer, partnership and innovation (Novi Sad); [ISBN 978-86-84531-21-8], 71-75, COBISS.SR-ID 215974924.

18. PMI (Institute for Project Management). (2018). *Success in Disruptive Times*, available on: https://www.pmi.org/-/media/pmi/documents/public/ pdf/learning/thought-leadership/pulse/pulse-of-the-profession-2018.pdf (accessed 19.3.2019.)

19. Reifer, D., Hastie, S. (2017). *Quantitative Analysis of Agile Methods Study (2017): Twelve Major Findings*, available on: https:// www.infoq.com/articles/reifer-agile-study-2017 (accessed 10.3.2019.)

20. Sato, D., Bassi, D., Goldman, A. (2007). *Extending extreme programming with practices from other agile methodologies*, Workshop de Desenvolvimento Rápido de Aplicaçoes (WDRA 2007) 33 (34), 104.

21. Shuja, A., Krebs, J. (2008). IBM Rational Unified Process Reference and Certification Guide: Solution Designer (RUP). IBM Press.

22. Stallings, W. (2016). Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud. Addison-Wesley.

23. Stal, M. (2016). Twin-Peaks-Modell in der Softwareenticklung. (in English: Twin Peak Model in software development), available on: https://www.heise.de/developer/artikel/Twin-Peaks-Modell-in-der-Soft wareentwicklung-3133582.html. (accessed 5.3.2019.)

24. Republički zavod za statistiku Republike Srbije. (2019). *Turistički promet u Republici Srbiji, februar 2019. (UT10)*, available on: http://webrzs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=180. (accessed 19.3.2019.)

25. Womack, J., Jones, D. (2003). Lean Thinking: Banish Waste and Create Wealth in Your Corporation, New York, NY: Free Press, Simon & Schuster, Inc., 1996, Second Edition

26. WTTC (World Travel & Tourism Council). (2019). *The Economic Impact of Travel & Tourism 2019*, available on: https://www.wttc.org/ (accessed 20.3.2019.)

27. Airbnb: https://www.airbnb.com/ (accessed 20.3.2019.)

28. Amadeus: https://amadeus.com/en (accessed 20.3.2019.)

29. Australian Tourism Data Warehouse (ATDW): https://atdw.com.au/ (accessed 22.3.2019.)

30. Docker: https://www.docker.com/ (accessed 22.3.2019.)

31. KPMG: https://home.kpmg/uk/en/home.html (accessed 20.3.2019.)

32. SapientNitro: https://www.publicissapient.com/ (accessed 15.3.2019.)

33. SignalFx: https://www.signalfx.com/kubernetes-monitoring (accessed 2.3.2019.)

34. Vagrant: https://www.vagrantup.com/ (accessed 18.3.2019.)

35. Vsphere: https://www.vmware.com/products/vsphere.html (accessed 3.3.2019.)