more Efficient Business Model In Construction Companies In Underdeveloped Countries And Countries In Transition

Mr. Vuk Vujović, Belgrade, Serbia  
vujovuk@yahoo.com

Mr. Jefto Džino, The Council of Ministers of Bosnia and Herzegovina, Sarajevo  
mail: dzino.jefto@gmail.com,

Prof. dr Mladen Radivojević, LOGOS, Mostar, Bosnia and Herzegovina  
mail: radivojevicmladen60@gmail.com

Abstract:
In this paper we are dealing with improvements in construction companies in underdeveloped countries and countries in transition. The development of new technologies and their large application in all areas of operation led to the need to make them more efficient in construction companies, especially in less developed countries. In this paper we propose the use of appropriate models, tools and concepts that can improve the efficiency of business, and especially cheaper business in construction companies. In addition to the large number, we propose the use of the three most important concepts in civil engineering enterprises in transition countries: 1. Cloud computing - a set of network services designed to provide various services, 2. Building Information Modeling - which serves as the basis for design, simulation and cooperation through all stages of the construction project, 3. Drones - which significantly reduce the time and resources needed for photogrammetry and mapping

Keywords: more efficient work, cloud computing, intelligent data model, drones

1. The impact of digitalisation on the construction sector
The construction industry employs about 7% of the world's working-age population and is one of the largest sectors of the world economy. Regardless of such a large number of employees, the construction industry faces low productivity. Other sectors have transformed and increased productivity. Automation has completely changed the manufacturing and processing industry.

The prevailing opinion is that the construction sector is among the weakest digitized sectors in the world. Global labor productivity in construction has grown by 1% a year over the past twenty years, while productivity of the global economy has grown by an average of 2.8% annually, while productivity increased by as much as 3.6% a year (Bačić, 2018).

It is considered that the inability to control costs is one of the more important causes of this state. In order to be able to control and monitor costs in real time, construction companies must use the latest IT tools. Now new software with appropriate hardware can daily monitor the costs and revenues of a construction company. Whether it wants to do business effectively in the construction sector of underdeveloped countries or countries in transition requires its efficient computerization.

The developments in the construction industry are highly dependent on the demand of the public sector, and especially in civil engineering. In doing so, the market environment is often disturbed by black and corruption. The problem is that the construction sector is crushed, and when contracting jobs often comes to poor risk assessment. The result is poor governance, poor performance, lack of skills, inadequately complicated processes and insufficient investment in education, research and development of this innovation. Innovative construction companies from developed countries show that the improvement (Tatars, Castro-Lacouture 2018) can be achieved:

• better management of supply and service chain,
• More efficient work on the site itself,
• by introducing digital technologies,
• Using new materials and advanced automation,
• developing new skills in the workforce,
• better design of engineering processes,
• changing contractual frameworks ect.
In order for construction companies in underdeveloped countries to change that, they must find money to invest in new machines, devices and digitization. In most construction companies, there is little done about this, but the software solutions that benefit the most, cover control of inputs and outputs of goods, delivery to the site, warehouse control and quantity of goods. Digitalization is used somewhat in the project part, and for the construction process itself, there is not yet some digitized system that can be applied more widely (such as 3D printing).

The lack of quality personnel in the construction industry will force it to think more intensively about new technological solutions that can replace people (robots). In particular, this can be done on building construction where industrial, prefabricated buildings are being used, and most of the elements are mounted on the construction site. Civil engineering is much more oriented to mechanization. One machine for laying asphalt no longer needs much manual work. Therefore, the development of new technologies that will increasingly exclude people from the construction process on the site itself should be monitored.

2. Some experiences of using new technologies in construction companies

In September 2017, Software Connect conducted a survey on the application of information and communication technologies and related software in 158 small and medium-sized construction companies in the United States and Canada (97 percent of enterprises had fewer than 500 employees).

According to this survey, 26% of small and medium-sized construction companies already use or will use drones by 2020, while 81% of respondents plan to significantly increase investments in new technologies in 2018 and 2019. One of the results of the survey showed that the most sought-after software solutions are the ones that enable the monitoring of projects and costs, as well as business planning and assessment. The main requirement of the respondents when buying software is to be easy to use. The ease of use criterion for construction companies is more important than the price and functionality that the software offers.

Companies from the construction sector are more willing to accept cloud software from companies from other sectors. The percentage of cloud-based software acceptance by construction companies is 5% higher than the average for all other sectors.

If we are considering the acceptance of new tools, it can be seen that the drivers are drones, and autonomous machines and equipment. Already, almost every fifth construction company (18%) uses photogrammetric drones and mappings. Research shows that drones significantly reduce the time and resources needed for such tasks. The overview of the site that is carried out in the traditional way of the surveyor takes up to a month, and with the drones, the inspection takes place in a few minutes. This greatly speeds up the procedure and reduces the costs of physical work.

Goldman Sachs estimates that the construction industry will adopt the use of drones faster than all other industries. When looking to the future, 9% of respondents announce the introduction of drones in their business in the next three years.

82% of construction companies involved in research, planning new technologies in the future will invest heavier amounts. 41% of respondents plan to upgrade or purchase new building management software (CMS). Significant new software requirements relate to project monitoring (73%), cost monitoring (72%), and project evaluation (66%). The functionality of the software is only one of the criteria when investing in software, and 37% say that their ease of use is the most important.

A survey conducted by Software Connect shows that construction companies are significantly open to cloud-based software. Compared to other industries, the percentage of companies that are willing to switch business to the cloud is 5% higher. As a reason, field work and the need for mobile technologies. 58% of respondents confirmed that their business relies on at least "sometimes" mobile applications. Mobile applications are commonly used in daily field reports, customer and job information, document management, cost reports, and daily schedules.

Building Information Modeling (BIM) software uses 51% of respondents, but those building companies that use it are not delighted with it (59%). Sometimes dissatisfaction is based on a lack of desire to apply the software to the entire enterprise.
A report presented by McGraw-Hill, which relates to the construction sector, shows that BIM contributes to the return on investment. According to their statistics, only 13% of BIM users show interest in other software.

3. Building Information Modeling

In order to ensure the competitiveness of construction companies, new ways of work, new tools and technologies must be adopted. Complete digitization of the entire process is necessary, from design to construction. In undeveloped countries and countries in transition it has not yet come to life, although there are already methods in the world that integrate these processes through a digitized system. One of them is Building Information Modeling (BIM), representing an intelligent data model that serves as the basis for design, simulation and collaboration across all phases of the construction project. The BIM model allows architects to more effectively inspect the design of the building they design, which provides a better project and more efficient design.

Building information modeling BIM has a multi-dimensional meaning:

- Building Information Model
- Building Information Modeling
- Building Information Management.

All BIM thoughts should refer to the application of three-dimensional models for different purposes. BIM is applied in all phases: planning, design, construction, building management and maintenance. It allows:

- support in project processes,
- spotting potential mistakes in the project,
- detailed analysis,
- quick changes and easier management of changes,
- understanding project goals,
- visualization of project solutions,
- improvements in project design and coordination,
- increasing and ensuring the quality of construction processes and the final product,
- efficiency of the process in the construction phase,
- increasing security,
- support in the life cycle analysis and project costs.

It should be kept in mind that this is a combination of organizational and technological approach and cooperation of all participants using specific tools in order to provide accurate and content information.

In design, BIM technologies are based on the creation of a three-dimensional object model (e.g., buildings). In this case, the model is not only a set of geometric elements and textures but it consists of virtual elements that in reality have specific physical properties. BIM technology allows the design of the building to fully calculate and identify all the processes that occur in it before the start of construction.

Now there are already simple programs for smartphones and tablets. It provides users and developers with a quick and easy access to the BIM model, bringing this technology to an even higher level.

The benefits of using BIM technologies are 3D visualization, and this is the most common way of using this technology.

Its advantage is centralized storage of data in a model that allows efficient and easy change management. When changing the project, it is immediately displayed in all its performances: on layouts, facades or stocks. BIM technology increases the speed of project documentation, and reduces the possibility of error.
4. **Cloud computing**

The development of hardware and software was not even - hardware development has progressed geometrically, (according to Moore's law), and software is barely artificial. Good connoisseurs in informatics can notice that even now large funds are spent on hardware, which is often not used even close to its capabilities. An important part of the business software that is produced, even the one that we say is contemporary, is still relatively closed and often unusable.

Two concepts are now in use: service-oriented architecture and cloud computing. Both of these concepts, although they relate to different domains, have the following essential characteristics: resource utilization, promoting interoperability among systems of different manufacturers, and using standard communication and network technologies.

Cloud computing is a set of network services designed to provide a variety of services (such as digital data storage or the execution of software solutions). It is a means by which appropriate computing resources can be offered to construction companies in the form of a public service.

Here, we are dealing with cloud computing because it can provide cheaper and efficient operation for the construction company and in underdeveloped countries or countries in transition.

Cloud computing is a technology solution proposed in the 1960s, but ten years ago it began to be used more intensively (Cáceres, J; Vaquero, L; Rodero-Merino, L; Polo, A; Hierro, J. 2010.). The road from idea to beginning of use has run in several stages. In each of the phases, some new technological solutions that are the basis of cloud computing or a suitable platform for it have been developed. Development has chartered continuous progress, and the terms that describe it are:

- grid computing,
- parallel computing,
- service-oriented architecture - SOA,
- Application as a Service - AaaS,
- Software as a Service - SaaS,
- Infrastructure as a Service - IaaS,
- Platform as a Service - PaaS,
- Hardware as a Service - HaaS.

Cloud computing and service-oriented architecture (SOA) are technologically complementary concepts where computing in the cloud is an efficient and usable platform for the launch and execution of SOA services.

A small number of research related to service-oriented architecture in cloud computing. The most significant work of this kind was published by de Leusse et al. (2010). They discuss the technical aspects of the entire service-oriented software solution in the cloud.
Slika 1. Computing services in the cloud
Jennings (2009.) also lists other services such as:

- Storage as a Service,
- Database as a Service,
- Information as a Service,
- Process as a Service,
- Integration as a Service,
- Security as a Service,
- Management as a Service,
- Testing as a Service.

All these additional services are a specialized service within the aforementioned service types.

A cloud-based view of the cloud services is shown in the picture "Cloud computing services" that shows the mutual technical relations between SaaS, PaaS and IaaS.

Services do not have to be related to cloud computing, but cloud computing is the most effective platform for their application.

Service features are distinguished by the following features:

- It is self-service but also a request - the user can use computer services automatically, without the need for constant contact with the service provider.
- Network access - services are accessed using standard information and communication technologies and network protocols.
- Resource virtualization - resources are deployed in a way that the user does not need to know the exact microlocation of the hired resource.
- Fast elasticity - the range of services and resources can be quickly expanded or narrowed according to the current needs of the user.
- Charging by consumption - the user does not have to pay the rented service and the resources in advance, but the amount that they use in the given unit of account.

The technical advantages of computing in the cloud are computer, computer and communication. Technical advantages make it easier to manage computers and computer networks, improve software development and improve the performance of the information system.
Linthicum, D.S. (2009.) warns of the need for a complete economic approach in calculating the total cost of information technologies, and at the same time the cost of using cloud computing. He suggests that it must be taken into account:

- Integration of existing solutions with new ones.
- Synchronization of software and hardware with internal and international regulations.
- Data transfer in work.
- Save data and secure copies.
- Recovery from errors.
- Loss during the unavailability of the information system.
- Solving business problems.
- Accounting for software subscriptions and licenses.
- Achieve the required security.
- Value of capital investments.

If all of these elements are included in the cost calculation, it can be assessed whether in each individual case the hiring of the necessary resources is a more favorable option than the purchase of one's own resources or vice versa.

5. Drones

Technologies related to drones are already being extensively used for commercial purposes. Their time is still coming and will significantly affect the competitiveness of construction companies that will be used on time and in an adequate way. Now in developed countries they are intensively used in civil engineering enterprises because they are applicable in almost all project phases to develop the appropriate infrastructure - starting from monitoring construction works and investments, through maintenance of the facility, to inventory of property.

It is estimated that the capital investments in tunnel-related technologies will increase by 30% by the year 2030, but the costs of maintaining an increasing number of infrastructural facilities (Parker, 2013.).

New projects related to civil engineering are often very expensive, so monitoring and controlling investments during the implementation are the biggest challenge for every construction company. It is necessary to monitor the return of invested funds and the justification of investors' investments. Advanced 3D modeling software with the appropriate use of drones can be effectively applied at every stage of the design and construction process.

The construction of transport infrastructure is very expensive and requires the engagement of significant financial resources and a large number of workers. A high level of supervision is needed so that the planning and construction project runs according to the plan and within the budget, while the use of drones is of great benefit because of their precision, ease of use and cost-effectiveness. Their most important role is in the process of monitoring how the project progresses, what is the quality of the works, as well as the distribution of materials in relation to the project design and plan.

Other applications of drones relate to the detection and prevention of unauthorized access to the site, to the improvement of security at the site. PwC's research shows that in cases where trenches are used for surveillance, the number of life-threatening injuries on the construction site is even 91% lower.

Monitoring the results of work in the maintenance process is very important, and the drones can improve this process. Constant check with the support of drones provides more accurate information on some problems, mainly thanks to the ease of comparing data over time, measuring depreciation and estimating the future deterioration of the building.

Tracking inventories that require the control of thousands of individual assets, and therefore a lot of time and workforce, can also be far more efficient thanks to drone technology. The list of goods can be performed in parallel with monitoring the results on the maintenance of the facility.
A new technology that allows joint action with drones is an expanded reality, which is already starting to be used to improve access to basic information on construction sites. Visualization of data, such as construction plans on mobile devices or helmets, helps field teams understand how various systems and components fit together during construction. An expanded reality allows the projected model to be placed directly in a real-time view of the site, providing workers with an insight into the exact location, instructions on how to assemble parts, material information, risk warnings and other information relevant to the project's implementation, which makes it all together easier and accelerates the complete construction process.

Bearing in mind only some of these advantages, construction companies that lead in the efficient use of drone technologies can provide a significant advantage over competition. The data provided by the drones change the rules of the game during the entire life cycle of the investment in civil engineering. Providing precise data in real time and comparable 3D modeling data is essential before and during construction, as well as during the operational phases of the investment project. All this information can be provided thanks to intelligent and cost-effective solutions based on drones.

**Conclusion**

In this paper we have followed some improvements to the workflow that can be provided in construction companies. We have suggested the use of appropriate models, tools and concepts based on new technological solutions that can improve work efficiency, and especially cheaper business in construction companies of underdeveloped countries and developing countries. We selected only three technologies that we think are the most important ones: cloud computing as a set of network services, Building Information Modeling as the basis for design, simulation and collaboration across all phases of the construction project, and drones that reduce the time and resources needed for photogrammetry and mapping.

**References**

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