

# Potential Organizational Absorptive Capacity for Innovation Acceptance

## The example of Building Information Modelling

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**Abstract.** *The purpose of this research is to develop a model for assessing the capacities of an organization to identify, acquire and understand the building information modelling (BIM), as an ICT innovation for an organization in construction sector. The theoretical framework of the research is the absorptive capacity of an organization for the diffusion of innovations. The emphasis is on exploring the potential absorptive capacity (PACap) of organizations, i.e. environmental influences, prior knowledge, perceived innovation properties, and communication channels on the innovativeness of an organization. The research will promote the idea of adopting innovations, while also identifying the key agents of change.*

**Keywords.** BIM, potential absorptive capacity, diffusion of innovations

## 1 Introduction

The development of information and communication technology (ICT) in construction sector resulted with building information modelling (BIM) - the process of creation and usage of the data in designing, building and managing buildings. The result of this process is a building information model - a digital representation of physical and functional characteristics of a facility, forming a reliable basis for decisions during its life-cycle. BIM enhances the construction from automated processes focused on paper to integrated and interoperable workflows joined in one coordinated cooperative process that maximizes the digital possibilities and online communication for aggregation of data in information and knowledge [5].

According to the international research by McGraw-Hill-Construction [1], the majority of construction companies speak positively about the return on investment (ROI) in BIM. The contractors recognized the following benefits of BIM: reduced errors and omissions, collaborating with owners/design firms, enhancing organization's image,

reducing rework, reduced construction cost, etc. On the other hand, the owners see the greatest benefits of using BIM in the fact that BIM visualization enables a better understanding of the proposed design. There are fewer problems during construction related to design errors, coordination issues or construction errors. BIM analyses and simulation capabilities produce a more well-reasoned design. The use of BIM generates a beneficial impact on project schedule and the use of BIM generates a beneficial impact on control of construction costs.

However, despite its recognized advantages, BIM is still not used in the expected scope even in countries which adopted standards for work in BIM, and in which the use of BIM is a strategic orientation, not to mention the countries where neither the public nor the private sector require the realization of their projects in BIM.

The question how to solve the problem of BIM implementation presents itself. According to Murphy [7], this problem can be successfully solved if approached as implementation of innovation.

In the Guidelines for collecting and interpreting innovation data („Oslo Manual“) the following definition of innovation is given [9,46]: „An innovation is the application of a new or significantly improved product (good or service) or process, a new marketing method or a new organizational method in business practices, workplace organization or external relation.“ A widely accepted definition of construction innovation dates as early as 1998, which defines [13] innovation as the actual use of non-trivial change and improvement in the procedure, product or system, which is new for the institution developing this change. Slaughter [13] introduces five kinds of innovations: incremental, modular, architectural, systemic and radical. The main feature of the construction sector is the focus on projects. Each new project gathers new stakeholders with their interests, but also their experiential knowledge, innovative tendencies etc. which can stimulate the creation and acceptance of innovations.

According to the Oslo Manual, BIM is both a product innovation and a process innovation [9]. BIM

is an integrated innovation model in which the data on the product and the data on the process are combined, stored, elaborated and distributed interactively to all relevant participants in construction. BIM is an ICT, systemic innovation, since BIM requires changes in information and communication terms in different organizations, which leads to complex problems of interoperability, depends on the interconnectedness and cooperation of stakeholders, and on cultural changes, all aimed at creating a unique system in order to raise the quality of execution [13].

The subject of this research are the key factors for accepting the ICT innovation on organizational level within construction sector from the theoretical perspective of innovation diffusion and absorption capacities. We seek to contribute to the agile organizational innovation acceptance and to foster networking for research capacity strengthening and for further development of the integration solutions in construction sector.

## 2 Research problem

Within research problems of ICT adoption the following theoretical problems were usually used: TAM (Technology Acceptance Model), TRA (Theory of Reasoned Action), TPB (Theory of Planned Behaviour) and UTAUT (Unified Theory of Acceptance and Use of Technology). However, these models are oriented on individual but not on institutional level of technology adoption. They do not include all impacts of the environment on the technology system acceptance [2].

More comprehensive approach offers the theory Diffusion of Innovations (DOI). According to Rogers [12,5] the diffusion is "the process by which an innovation is communicated through certain channels over time among the members of a social system". The definition itself contains the four basic elements of DOI: (1) innovation, (2) communication channels, (3) time and (4) social system. The innovation is "any idea, practice or object that is perceived as new by an individual or other unit of adoption." [12,12].

Innovation process is one of the fundamental processes in all organizations, wherein the term "organization" for Rogers [12,404] assumes „a stable system of individuals that work together to achieve common goals through the hierarchy of ranks and division of labor“. In a certain organization, the innovation process consists of two main groups of activities: (1) initiation (introduction), starting from the collection of all information, conceptualization and the planning of innovation acceptance until the decision on adoption is made, and (2) implementation, which consists of all events, activities and decisions related to putting the innovation to use. The need but also the knowledge and awareness are the drives of innovation process.

The rate of innovation adoption is influenced by the perceived properties of innovation, type of innovation decision, communication channels, characteristics of the social system and action of the representatives of changes [12]. However, in previous research, DOI were researched partially, mostly the perceived properties of the innovation itself and the time required for an individual to adopt innovation, which is one of the main deficiencies of DOI implementation, [10]. The research of the early recognition of the innovation was described in barely 5% of the published papers and the research of diffusion nets in less than 1% [12].

The ability of the organization to recognize the value of new knowledge or information, assimilate it, and apply it to commercial ends means its absorption capacity (ACap), according to Cohen and Levinthal concept from 1990. Zahra and George redefined ACap as „a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability“[14,186]. ACap consists of the following two elements: „potential ACap“ (PACap) – that includes the acquisition and the assimilation” and „realized ACap“ – the capacities of transformation and exploitation of the new knowledge. Under „acquisition“ the authors understand „the firm's capability to identify and acquire external generated knowledge that is critical to its operations“. „Assimilation“ understands the „firm's routines and processes that allow it to analyse processes, interpret and understand the information obtained from external sources“. „Transformation“ is „firm's capability to develop and refine the routines that facilitate combining the existing knowledge and newly acquired and assimilated knowledge“. The fourth element „exploitation“, means the „organizational capability based on the routines that allow firms to refine, extend and leverage the existing competences or to create new ones by incorporating acquired and transformed knowledge into its operations“.

The ACapa concept is considered as one of the most important concepts in the field of organizational research.

The objective of this research is to develop unique methodological frame to estimate the organizational PACap within construction sector for the acceptance of the ICT innovation (on the example of BIM).

The stated objective includes the following research questions. :

- IP1: How the theories DOI and ACap can be further developed to form unique conceptual model for innovation acceptance?
- IP2: What is the impact of the communication channels within PACap organizations?
- IP3: What are the influence factors for the institutional acceptance of BIM and how is their impact determined?

IP4: How can we estimate own organizational PACap for the acceptance of BIM?

The research hypotheses are:

H1: There is a connection between the organisational environment factor, the existing and new knowledge and the organizational PACap regarding the acceptance of ICT innovations.

H2: Organizational PACap regarding the acceptance of BIM is affirmatively connected with the level of organizational innovativeness.

### 3 Methodology

The research is built on the pragmatic scientific hypothesis, based on the recognized problem of innovation acceptance within construction organizations and supported with theoretical concepts: Diffusion of Innovation (DOI) and Absorption capacities (ACap). In literature such research is known as transformative combined research [3]. The theory is integrated in all phases of the research process, qualitative and quantitative research methods that are mutually supplemented and combined.

First, it is important to develop the measurement instrument to evaluate the impact of the organizational environment on its PACap regarding the innovation acceptance. That will be conducted according to the research steps in social sciences [4], in line with the examples of the research instrument development within information sciences.

The existing ACap models recognized past similar knowledge being the important impact factor for the innovation acceptance. Within the potential capacities for BIM absorption the level of knowledge and the experience in using CAD program is considered as well as the objective of the usage of CAD model. BIM includes the cooperation of different professions and organizations and therefore the know-how in project management and the experiences in team coordination are the important prerequisites for more successful BIM absorption.

The research instrument for the past similar knowledge will be in-lined with the NBS questionnaire instrument [8].

According to DOI, the innovation absorption dynamics is influenced by the perceived properties of innovation that can be organised in five main groups: relative advantage, compatibility, complexity, testing possibility and visibility [12]. Since we research ICT innovation, the perceived innovation properties defined above will be amended in line with the measurement instrument of the perceived properties of the IT innovation [6] with the additional property – Voluntariness. This instrument will be developed in accordance with the instrument for perceived properties of BIM used in British research [8].

The organizational innovativeness is defined as the degree to which an organization is relatively faster

in adopting new ideas than other members of a system. The organisational innovativeness includes 5 levels of adopters: (1) innovators, (2) early adopters, (3) early majority, (4) late majority and (5) laggards. It will be measured by the estimation of the time necessary for an organisation to be ready for innovation acceptance. This is followed by further deduction of research, definition and development of variables in unique conceptual model.

The validation of the conceptual model will be conducted within the research of the BIM acceptance in Croatian construction sector. The data will be collected quantitatively (questionnaire) and qualitatively (literature research, expert panels, semi-structured interviews). The sample of the quantitative part of research will be based on the e-mail lists comprising of members of the professional chambers and associations of engineers and architects, thus representing all categories of examinees. The number of examinees will be connected to the number of questions in the questionnaires and analysis methods.

The questionnaire will be structured within four thematic set of questions: (1) examinee's general data, (2) set of questions related to the final assessment of the validity and reliability of the measurement instruments for organizational variables (for H1), (3) questions regarding concrete innovation, BIM (for H1, H2), (4) set of questions regarding the recognition of the communication source and channel for the innovation absorption.

The data collected by questionnaires will be analysed by descriptive statistics but the ANOVA test will be used to determine whether the differences in opinions within different groups are statistically significant, Factor analysis will be used for data variables reduction and for the reveal of the connection structure between variables. Statistical testing of the hypothesis will be used to check the hypothesis H1 and H2 (the application of the test will depend on the size of sample and scale type).

The results of the survey will be qualitatively analysed by the comparison of the similar research. The semi-structured interview will be custom-designed and conducted according to the main types of the examinees in order to use the smaller sample for the additional check of survey results.

Due to the impact research of the communication formal and non-formal networks in recognition and adoption of new knowledge as well as its understanding and acceptance by the organizations in certain social context, the model will be established to join the analysis method of the social networks with the ACap concept for the initial phase of the innovation diffusion in an organization. The model will be validated on the example of the communicative networks of Croatian constructors. SNA is a recognised method that enables the nature of the relationship or connections between participants

both graphically and mathematically, and that can be also applied within the construction sector [11].

All impact factors that will result from the analysis of the gathered data are not of the same importance for PACap organizations for innovation acceptance. The application of the analytical hierarchical process (AHP) will enable the prioritization of the diffusion variables regarding the PACap organization in construction. The gathered information and research results via modelling method and synthesis will be consolidated in the methodological model for self-assessment of the potential ACap of the organization for BIM acceptance. The developed research instrument for self-assessment will be delivered in excel format to be easily accessible for Croatian construction organizations.

## 4 Expected contributions

As opposed to the existing research, this research will give the complete image of the impact factors regarding the process of the innovation absorption, mainly in the initiation phase, on the organizational level. The expected research contribution regards primarily the synergy connection of the two theories - ACap concept and DOI theory – that will be the basis for the development of the unique absorption model on the organizational level enabling the management of the initial phase of the innovation process for the purpose of decision making on innovation absorption. Furthermore, such approach to problem resolving will be applicable within other research areas, eg. strategic decision-making in higher education [15].

Furthermore, the integration of the methods from different fields will enable the analysis model of social networks for the impact research of the communication channels to the innovation absorption. Finally, the instrument for the evaluation of the PACap institution regarding BIM absorption will be developed that is the basis for the capacity development for innovation acceptance.

The social contribution to BIM dissemination within Croatian construction sector includes the awareness raising about the strengthening needs for organizational ACap regarding BIM absorption.

## 5 Acknowledgments

This work has been supported by the Croatian Science Foundation under the project IP-2014-09-7854.

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