HUMANIDADES E CIÊNCIAS SOCIAIS:

Perspectivas Teóricas, Metodológicas e de Investigação

Luis Fernando González-Beltrán
(organizador)

EDITORA ARTEMIS
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PRÓLOGO

En este tercer volumen de Humanidades y Ciencias Sociales: Perspectiva teóricas, Metodológicas y de Investigación, seguimos en la línea de ofrecer trabajos de diferentes disciplinas que, desde sus propias trincheras, intentan el análisis de diferentes aspectos del ser humano, desde el enfoque en el propio individuo, hasta su contexto tanto inmediato como a gran escala, de la escuela que lo forma hasta la ciudad que lo cobija. Pretendiendo, como ya es usual, que el lector curioso encuentre en un solo lugar, lo que le llevaría una enorme labor en los buscadores de temas científicos. Sin perder el foco sobre lo que es inherente al humano, la variedad de autores, de metodologías, de idiomas, de países representados aquí, le dan un mayor valor a la síntesis que intentamos lograr.

La obra presenta 17 investigaciones agrupadas en 4 secciones: iniciamos con el tema A) Alumnos en su contexto escolar. La escuela tiene una importancia innegable en la socialización de los alumnos, por ello se tratan los distintos Procesos educativos, en sus diferentes entornos, tanto físicos como situacionales, así se analizan los problemas del trabajo infantil, los contextos rurales, la autorregulación en el aprendizaje, las habilidades intrapersonales, las competencias investigativas, el Aprendizaje Basado en Proyectos, el pensamiento crítico y alumnos con discapacidades. Es la sección que agrupa más capítulos, con 7.

Continuando con la escuela, vemos también la otra cara de la moneda, con el tema B) Docentes en formación, con dos estudios. También aquí vemos como los profesores se enfrentan a varios retos, por lo que aquí se trata la Planeación estratégica, la situación de docentes con estrés, su entrenamiento, y su ejecución cuando dedican su trabajo a los adultos, en situaciones de Formación a lo largo de la vida.

La tercera sección C) Empresas: Presente, pasado y futuro, revisa el siguiente contexto al que se enfrentan los estudiantes: el trabajo. Iniciamos con un vistazo al pasado, revisando la política de las empresas en el siglo de oro español; el presente con la internalización de empresas; y el futuro tratando cuestiones como, en primer lugar, los intangibles en la sociedad del conocimiento, y en segundo lugar, el diseño estratégico y la ejecución en manejo de proyectos a nivel empresarial.

Finalizamos con una sección D) Ciudades: Arquitectura, diseño, construcción y política. Un contexto físico macro, pero también un entorno Social y Cultural. Iniciamos con la utopía del momento, cómo diseñar ciudades verdes, la infraestructura para vivir bien. Seguimos con lo más concreto, tanto en términos verbales como en términos literales, cómo reforzar el concreto de los edificios que nos alojan. Le sigue otro tópico de urbanismo: recursos humanos en la construcción. Y para cerrar, un poco de política,

cómo en Europa se está manejando la Migración, la crisis de refugiados, un problema que se está agudizando en todos los continentes.

Intentamos haber representado lo más actual de las Humanidades y las Ciencias Sociales, y esperamos seguirlo haciendo en el futuro inmediato.

¡Les deseamos a todos una agradable lectura!

Luis Fernando González-Beltrán
Universidad Nacional Autónoma de México (UNAM)

SUMÁRIO

ALUMNOS EN SU CONTEXTO ESCOLAR

CAPÍTULO 16

WORK PERFORMANCE AS PART OF A CONSTRUCTION PROJECT - PROVIDING HUMAN RESOURCES AND PRODUCTIVITY MANAGEMENT

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ABSTRACT: The construction projects are unique because they have a special place on earth. Each construction project is determined by the quality of the work, the price and the deadline of the project. Each construction project is a determined system. If one part of the system fails, the investor suffers a loss that affects the other systems (e.g. sales, bank loans, etc.). There are several possibilities between the starting point (entry into the system) and the end point (exit from the system) of the construction project. They are reflected in the economic, technical or human resources. Each reflected factor includes different causes. These factors/causes can transform the determinate system into a stochastic system. We speak here of uncertainties. Uncertainties arise from the unsystematic treatment of the construction project, but must be eliminated so that the project is as determinate as possible. Numerous studies on the impact on the performance of contractors in the realization of construction projects (cited in this paper) highlight in particular the impact of human resources. According to some studies, it is the labor force on the construction site that has the greatest impact, according to others, it is the competences/skills/actions of management (especially the management of the construction site - providing the necessary materials and tools, supervising workers and communicating with them, motivating them, creating safe working conditions, etc.) / Problems with human resources are the likelihood of external (labor shortages) and internal mechanisms (skills, languages, motivation) that change the system and lead to changes in the execution phase and subsequent phases. In this paper, we analyze the factors of human resources and the problems that arise from them in construction projects. We propose a new solution/model for the provision of human resources and productivity management.
KEYWORDS: Determined system. Construction project. Uncertainties. Human resources. Productivity management.

1 INTRODUCTION

The most important distinguishing feature of a project (Lock, 2007) is its uniqueness. It is a step into the unknown,

fraught with risks and uncertainties. No two projects are the same: Even a repetitive project differs from its predecessor in one or more commercial, administrative or physical aspects (Lock, 2007), including different lead times, deadlines and information. According to several authors (Kast & Rosenzweig, 2002; Loncarić, 1995; Project Management Institute Inc., 2007), construction projects can be described as non-routine, one-time ventures, financial and technical implementation projects. They can be considered as a collection of tasks and activities that need to be completed before the end of the project. In other words: We can say: the project is a logical sequence of interrelated activities aimed at achieving specific goals within a set time frame. Each project has its own structure, that divides the project into sub-projects with sub-goals. Following the description in the Construction Extension to the PMBOK Guide (Project Management Institute Inc., 2007), the authors show that construction projects inherently contain a high degree of risk in their cost and time forecasts. Each project has its own challenges in maintaining costs, schedule and control. Construction projects must take into account local geography, site conditions and the project‘s relationship with the environment. The analysis of numerous studies by various authors has shown how difficult it is to find a system and set up a model that describes it. Most construction projects can be divided into four or five phases. These phases (Project Management Institute Inc., 2007) are the concept (1), the planning (and development) or preliminary design phase (2), implementation planning (3), the construction phase (4) and commissioning and turnover (5). The construction phase can be divided into preparatory work and work directly related to the construction of the property itself. The processes overlap during the entire project or the entire project phase. Materials, energy and/or information that pass through the boundaries of a system are inputs, while outputs are materials, energy and/or information that are released from the system into the environment. What enters the system in one form and leaves the system in another form is usually referred to as throughput (Kordeš, 2004). The state of a system is the situation (condition and location) of the system or a system component at a given time with respect to its attributes and relationships. Components and attributes are important, but only if the functional relationships that link them together result in a whole system (Kordeš, 2004; Mulej & Potočan, 2006). The defined relationship between the inputs and outputs of a system is equivalent to describing the processes of the system as they relate to the construction project.

Many authors (Blanchard & Fabrycky, 2011; Dickerman, 1973; Meredith, 1973; Rothenstein, 1969; Žaja, 1988) have described the construction project as a system, but we see that there is no uniform way of describing construction projects and that the

authors who use the word “system” have mostly described individual phases of the project. At the same time, no one has explained the impact of workflow or human resource issues on construction project outcomes. Each construction project is unique within the classical framework of minimum cost with maximum quality (Project Management Institute, 2005). If a project has well-defined goals but problems with the workers, it cannot be considered a determinate system (Dvornik Perhavec et al., 2014). Problems in structuring and executing the requirements engineering (RE) process can lead to the failure of a project (Lopez et al., 2018). A link between human error and the problems that can occur in the RE process is possible. Management errors in human resources could affect the next phases of a construction project, commissioning and turnover.

Uncertainties arise that change the system from deterministic to stochastic. Problems with human resources are likely to be external (workers shortages) and internal, and such uncertainties could change the system. However, this later leads to changes in the execution phase and other subsequent phases.

Automated diagnosis of human resource problems on construction sites is very difficult as they are essentially human and subjective. Companies are experiencing a shortage of skilled labour at all levels of the construction industry. Workers‘ migration of labour to high-income countries (e.g. from Bosnia to Slovenia, from Kosovo to Croatia, from Pakistan and India to the United Emirates, from Slovenia to Austria or Germany, from Croatia to Germany and Ireland, etc.) has increased. Most HR experts have studied the types of human errors in different contexts using questionnaires to capture the knowledge of RE practitioners. Most participants agree that knowledge of error typologies can help to improve their processes and avoid problems (Fapohunda & Omoniyi, 2011).

Uncertainties that increase due to human resources in the execution of construction projects are addressed by many authors (Cardoso Teixeira et al., 2006; Chen & Liew, 2003; del Cano & Pilar de la Cruz, 2002; Donath et al., 2004; Ford et al., 1995; Galway, 2004; Huchzermeier & Loch, 2001; Kendrick, 2003; Kleim & Ludin, 1998; Migilinskas & Ustinovichius, 2004; Migilinskas & Ustinovicius, 2008; Mitkus & Trinkunien, 2006; Tah & Carr, 2001; Zavadskas et al., 2003). They found that the more or less uncertainties in construction projects depends on the design of work processes and communication and misunderstandings between employees, professionals and managers. The causes of uncertainties and their impact on the construction project vary and we have summarised them (including the authors) in Table 1.

Table 1: Causes of uncertainties and their impact on the construction project.

Causes of uncertainties	Effects on the construction project
Inconsistent communication (del Cano & Pilar de la Cruz, 2002; Kendrick, 2003) and undefined "project language" –	The use of inconsistent terms leads to misunderstandings between groups of project participants or even members of the project team; Disordered management of project documents leads to chaos in the documents (unnecessary duplication of documents and management procedures, unclear current or even final project design and document revisions, frequent large differences between technical planning documents and work execution documents); Unstructured sequence of project phases or even project execution without any procedures leads to waste of time (duplication of responsibilities and procedures, uncoordinated work of the team or even the project participants); Different project data formats (drawings, design and document files created with different software in a different "project language") can lead to wasted time, quality and communication problems and ruin the project.
Corporate culture, ethics and morals (mutual relations, incompatibility with company goals, unwillingness to learn, neglect of duties); low qualification and professional training (Cardoso Teixeira et al., 2006) of employees	Unqualified personnel can ruin even a very well prepared and organized project with optimally developed construction plans; Stubbornly conservative instead of open-minded and innovative attitude of employees can lead to waste of time and obstacles to the effectiveness of project implementation; Contractor's lack of experience (no experience with similar construction projects, lack of expertise, inadequate project management) can lead to delays in project execution and higher costs.
Unestimated quantities of work (Ford et al., 1995) in the project estimate and unacceptable planning of the work (Chen & Liew, 2003; Kleim & Ludin, 1998)	Delays due to the "extended" scope of work and lack of resources (unplanned labor, materials and machinery); Low quality level as there is not enough time to carry out the work according to the technical and quality requirements of the project (the work is carried out in a rush); Price increase due to rapid planning and execution of the work and unexpected cost increases on the construction site (due to changes by the customer, delayed problem solving by the planners and delayed implementation on the construction site); Investment returns behind schedule and unforeseen cost increases for the client in accordance with contractual obligations (to the bank and another investment source).

Lack of management tools (Galway, 2004; Huchzermeier & Loch, 2001; Migilinskas & Ustinovichius, 2004; Zavadskas et al., 2003) and ineffective-irrational organization of works on the construction site (Donath et al., 2004; Tah & Carr, 2001)	Ineffective organization of works on the construction site due to lack of work plans or non-existent organizational forces; Irrational execution of different types of work (e.g. superstructure, partition walls, finishing and technical installations); The scope of the work (entire floor, entire building section or entire superstructure) instead of dividing the work area into smaller parts.
Unclear boundaries of responsibility (Tah & Carr, 2001) **and no strict contractual obligations** (Mitkus & Trinkunien, 2006)	Uncertainties, ambiguities or responsibilities may force the investor to pay additional unplanned costs on the contractor and vice versa (the client may force the contractor to carry out all the works even if he has unforeseen tasks due to the contractual boundaries of responsibility); Unclear contractual obligations are often the main cause of disputes between client and designer, between client and contractor or between contractor and subcontractor; The shortage of labor, materials and machinery with increasing demand for construction work leads to a supply deficit in the industry and de facto to a price increase.

In Table 1, some authors describe causes and effects on construction projects that can be traced back to the work process and communication between the project participants.

The management of the construction process is a process that is fraught with uncertainty and the outcome of the construction cannot be accurately predicted. The way in which the project is managed and organized is significantly influenced by technical progress and the experience of the employees. Although construction projects are unique, they can gather very useful data when carrying out similar construction projects.

This research is based on our personal experience with workers on construction sites in the Republic of Croatia and the Republic of Slovenia. In the Republic of Croatia, three different studies on the impact on productivity and the implementation of construction projects were conducted in the last years 2017-2019 (Nahod & Knezović, 2017; Tijanić & Car-Pušić. D., 2019; Vidaković D. & Marenjak S., 2019). This article compares and analyzes their results, which point to similar problems. As one of the authors deals with historic buildings, construction projects and systems, she selected two construction sites where reconstruction projects were carried out. We have analyzed the factors affecting the work process on the construction site and propose a new model, which is another model of KAS (Dvornik Perhavec & Vidaković, 2020). We describe methods

for achieving adequate results while avoiding uncertainties caused by problems with workers and work processes.

2 METHODS

In the articles, we found more than 150 factors that influence the system. We have excluded those that we consider irrelevant (e.g. geopolitical attitudes, labour history, political order, etc.). Table 2 gives an overview of the factors that were among the top five in 15 different countries (41% in the EU and the US).

After the literature review, the author from Croatia decided to review the factors listed in Table 2 and compare them with the situation in Croatia.

First, we divided the countries into three groups:

- EU (Croatia - A (Oštarijaš, 1986), United Kingdom - B (Horner et al., 1989), Czech Republic, rating for medium-sized companies - C (Vavra & Synek, 1994), Spain - H (Robles et al., 2014));
- North and South America (USA – D (Kuykendall, 2007), USA - F (Gundecha, 2013), Chile - E (Rivas et al., 2011);
- Other countries (Lagos, Nigeria – G (Jimoh et al., 2019), Egypt - I (Sherif et al., 2014), Palestine - J (Enshassi, 2014), JAR- K (Abrey & Smallwood, 2014), New Zealand - L (Durdyev, 2014), Pakistan- M (Tahir et al., 2015), India - N (Joseph & Ravi S.S., 2015), Jordan - O (Bekr, 2016), Bhind – India - P (Sandeep & Mukesh, 2017), Vietnam - R (Nguyen, 2015).

We have divided the influencing factors into 3 groups:

1. Human resources and productivity management (skill level and experience of workers, incentive program – motivation, competence and leadership (style, communication, etc.), late payment of workers, supervision – control, safety/ accidents)
2. Technical management and logistical supply (supply of construction materials, availability of tools, availability of equipment and trucks)
3. Project and site management (planning/scheduling and unrealistic deadlines, job changes during execution, clarity of design and technical specifications).

Table 2: The main effects on labor productivity in research published from 1986 to 2018.

	Influential factors	EU				North and South America			Other countries								
		A	B	C	H	D	E	F	G	I	J	K	L	M	N	O	P	R
Human resources and productivity management	Qualification level and experience of workers		x	x	x	x			2x	2x	x			x	2x			x
	Supervision - control		x	x						x	x		x		x		x	
	Incentive program – Motivation		x	x		x			x	x								
	Competence and leadership qualities (style, communication, etc.)					x			x							x	x	x
	Safety / accidents					x		x			x	x						
	Delays in payment by workers									x	x				x		x	
Technical management and logistical supply	Delivery of building materials			x	x		x	x				x	x			x	x	
	Availability of tools			x	x		x	x										
	Availability of equipment and trucks				x		x	x								x		
Project and site management	Planning / scheduling and unrealistic deadlines	x				x						x	x			x		
	Changes to the order during execution	x											x	x				
	Clarity of the design and technical specification	x			x										x			

Within the three groups, we found that some of the effects that are relevant in some countries are not important or not remarkable in other country groups (in Table 2 with different colored edges).

Having recognized the need to improve the contractors‘ business/performance and having developed the idea of achieving this by increasing productivity, the first step is to get acquainted with productivity issues (background). It is necessary to define an appropriate subsystem to monitor productivity inside or outside the company and they should be more important than today (Poirier et al., 2015). It is therefore recommended to introduce a function responsible for improving productivity within the company (Shinde V.J. & Hedaoo M.N., 2017).

To increase productivity in construction, it is necessary to better understand what is hindering productivity growth (Green, 2016). Progress is possible, but the problems that stand in the way of significant productivity improvement in construction and among contractors are deeply rooted and sometimes linked to culture (Horner & Duff, 2001). The specific characteristics of the construction industry are the need for labor, equipment and machinery that frequently change sites during work (no chain production, no sequencing), outdoor work (exposed to weather conditions) and many different types of work with different quantities requiring different professions and unequal loads, as well as numerous suppliers and subcontractors. According to Nahod and Knezović (Nahod & Knezović, 2017), the regularity of salary, the amount of salary and monetary bonuses are among the five most important factors influencing labor productivity and include only factors related to workers‘ motivation.

Barriers to work processes in Croatian construction companies were collected through interviews with workers and site managers on construction sites. In Slovenia, one author constantly visited two construction sites once a week over a period of six months and identified the obstacles himself.

3 EXPERIMENT AND RESEARCH RESULTS

Skills or education and experience are one of the most important factors (mentioned in 59% of the articles analyzed). There are other related factors such as low pay and type of pay, motivation, clear assignment of daily tasks and management skills. The top five factors include grading the supply of construction materials (availability on site) and supervision of workers. This is followed by resource management with management skills and the availability of other materials, tools and equipment.

Several case studies of construction projects carried out / realized in Croatia have shown that 75% of projects exceeded the planned deadline due to deficiencies and changes in project documentation, 58% due to bad weather conditions, 17% due to site management and 17% due to lack of expertise of contractors (Tijanić & Car-Pušić. D., 2019). A survey in Eastern Croatia (2018) refers to the experiences of respondents from all construction sites in their previous practice. In a pilot study, respondents highlighted the clarity of technical and design specifications as one of the biggest negative impacts. Most respondents referred to lack of experience and qualities of workers (including training), poor motivation, poor resource management, etc., lack of materials and late payments from investors.

In a pilot study in Slovenia, the first construction site observed was in the pedestrian zone of Maribor city center. Conversion and renovation work was being carried out there. The construction site was observed daily, as the author lived in an adjacent residential building. Shortly after the construction work began, it was discovered that the work was not continuing and that there were disturbances. The professional challenge for us was to observe the construction site, the disruptions and the obstacles that affected the construction progress and the reconstruction of the facility. Two construction companies were working on the site. The first took over the site in March and stopped work in July of the same year. In October of the same year, another construction company took over the site (Figure 1a-b).

Figure 1a-b: Construction site on Gregorciceva, Maribor (SI), Author: Daniela Dvornik Perhavec.

The second was also in the pedestrian zone of Maribor, where a building was being renovated. The author visited the construction site once a week and recorded all the important uncertainties that changed the determined system. She was in contact with the site manager and other employees on the construction site the whole time. Figure 2 a-b shows part of the construction site in Vetrinjska.

Figure 2a-b: Construction site on Vetrinjska, Maribor (SI), Author: Daniela Dvornik Perhavec.

Each area was analyzed separately. A questionnaire was drawn up in which we entered the results on a weekly basis over a longer period of time. The questionnaire contained descriptions of the causes of the disruption and the impact of the disruption on the project. The risk was classified as low, medium or high. The site manager, the project manager and the workers on the construction site were involved in carrying out the survey.

The causes of disruption that we observed on both construction sites can be summarized in four main groups:

- Workplace of the workers,
- Use of mechanization and work equipment,
- Materials and energy,
- Working methods.

In a pilot study in Slovenia (2012), all interviewees cited clarity of technical and design project specification, lack of material supply and site management, lack of experience and characteristics of workers (including training) and delays in payment as the most negative influences. The specificity of the two construction sites in Slovenia were the construction sites in the city center, and there the poor material supply and the lack of logistics and waste disposal were mentioned as reasons. Lack of suitable (trained) craftsmen is a worldwide problem and has existed for many years. Many countries have recognized this problem. Migration is not a solution to this problem, as only some of them have the appropriate training and skills.

Table 3 lists some other important obstacles to increasing labor productivity identified in foreign research studies and the reasons that stand out in Croatia and Slovenia today (according to the sources mentioned, statistical data in public media and interviews with experienced experts from construction practice).

Table 3: Obstacles to increasing productivity in the construction sector in Croatia and Slovenia.

Obstacles identified in foreign research	Obstacles identified in Croatia	Obstacles identified in Slovenia
Fragmentation and often contradictory, partial interests of the construction project (in relation to these conflicting relationships in contracts) (Attar et al., 2012; Horner & Duff, 2001), Instability due to the uncertainty of contracts (Green, 2016); Labour-intensive industry (Green, 2016); Insufficient focus on the workforce (Attar et al., 2012); Insufficient investment in education/training (Adrian, 2008); Lack of basic productivity data, i.e. lack of comparative references (De Araújo et al., 2013); Inefficient management (Attar et al., 2012); Lack of real commitment to continuous improvement (Attar et al., 2012; Horner & Duff, 2001)	Lack of construction workers on the labor market; Older workers (as well as the entire population); Below average wages in the construction industry; The need for extended working hours during the construction season; The inadequate school system for craft workers; Inadequate training of engineers for non-technical skills (handling human resources, logistics, etc.); Insufficient lifelong training for construction engineers; Few large enterprises - mostly small and medium enterprises with insufficient human resources for improvement; Insufficient research and insufficient cooperation between construction workers and scientists	Poor remuneration of workers; Poor site management (lack of engineers for logistics and waste disposal); The need for longer working hours during the construction season; The inadequate training system for craft workers; Insufficient knowledge of workers, especially foreign workers; Language barrier, especially for migrant workers; Many small companies involved in the work process: Overwork of main engineers; Need to improve human resources and work processes; Insufficient research and cooperation between construction workers and scientists

After analyzing the two results, we can highlight four things:

- Both countries have problems with human resource management and productivity. These include the lack of skilled workers, the recruitment of foreign workers, the language barrier, motivation depending on salary, working conditions, working hours, etc.
- Both countries have problems with the clarity of technical and design project specifications;
- Both countries have problems with construction site management
- Both countries have problems with adequate cooperation between construction workers and scientists.

4 KDIS MODEL FOR ACHIEVING PROGRESS IN PERSONNEL AND PRODUCTIVITY MANAGEMENT

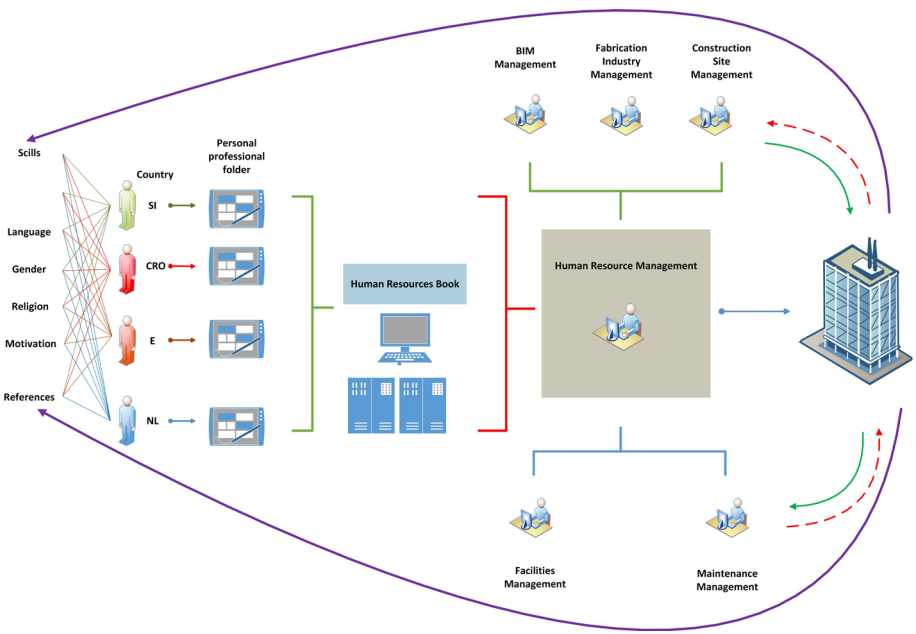
Researching, identifying, and evaluating issues that affect labor productivity are central to project managers (project managers, site managers, construction company

managers, etc.) and their efforts to improve labor productivity (Adrian, 2008). Jamadagni and Birajdar (Jamadagni & Birajdar, 2015) and Gundecha (Gundecha, 2013) emphasize the importance of the actions required to address critical factors in the early stages of construction planning. Our research findings and the highlights from Chapter 3 provide an opportunity to approach a model that can contribute to solving the problem of human resources. According to the Scilcco project (*Www.Skillco.Eu*, n.d.), the knowledge of the labor force is of great importance in the fourth phase of the construction process. The final products of the Scilcco project will give students and construction workers the opportunity to acquire and improve new useful knowledge and skills. The main goal of the Scilcco project is to contribute to a better competitiveness and a better transition of employed construction workers into the common European labor market.

In order to get a complete overview of the acquired and missing skills and competences of individual workers in the construction sector, the solution is a (European or worldwide) Knowledge Database of Individual Skills (KDIS), which helps to find individuals with a high level of knowledge and motivation in the construction sector. In this way, we close the gap in the system that we have pointed out in this article. On the other hand, the same solution leads to a greater and better determination of the construction project.

Fig. 3 shows the KDIS model that represents the solution between the gap and the required skills for some processes in construction systems and (additionally) facilities and maintenance systems.

Fig. 3 Model KDIS (Knowledge Database on Individuals Scills).



The KDIS model is based on digital data on the skills of individual professionals, essentially on the personal professional folder. This folder represents potential construction professionals. Individuals have individual skills acquired through formal or informal education, their own technical or craft skills, references and motivation. Languages, gender and religion are also taken into account. The KDIS model would bring together in one place the personal occupational folders representing personal knowledge, skills and occupation. The responsibility for managing the KDIS model lies with the country participating in the knowledge management process. This is followed by the handover of individuals or groups with the skills and motivation for each phase of work in the construction project to the next construction managers. Upon completion of the work, the individual receives a reference and new skills that are added to their personal professional file. The model is constantly being improved. Educational institutions would use the KDIS model because it makes it clear which skills are lacking in the labor market.

The easiest way to obtain this book is the ontology. We have created a prototype (with fictitious names). The single person with the protocol PERSON gets the position PROFESSION. In this way, recruiters in the construction industry have an easier task to find the right workers in the construction industry.

5 CONCLUSIONS

To successfully control and reduce uncertainty, it is necessary to accurately calculate work quantities before execution and create a 3D model that can be used for simulations of the construction process and during execution to assess the impact of changes to the project and other problems before they actually occur.

Understanding the system and the relationships between the parts of the system, which is emphasized in Chapter 4, is a new challenge to improve the obstacles on the construction site. Automation of a construction project and BIM technology (to improve low-level technical and design project specification) are increasing, but in our opinion, the barriers in workers (to improve low-level training and labor productivity) will remain for a long time. BIM, prefabrication and automation in construction, knowledge management can improve the gap between construction technology and project specification and the knowledge and productivity of workers on site. Considering the observed obstacles and factors that have the greatest impact on the productivity of construction works in Croatia and Slovenia, it is necessary to invest in adequate education/training of workers and management. Eliminating interruptions, obstacles and unnecessary loss of time and increasing productivity will reduce the costs of a construction company, increase

its competitiveness and lead to longer investor satisfaction. Understanding the system and the relationships between the parts of the system is an important challenge in a construction project. Automating a construction project with BIM technology and 3D printers requires specialized knowledge. The process of automating workflows, including the use of 3D printers, requires specialists that are still unknown today. Training at all levels and knowledge management of specialists have great potential for the future. The category of human resources with lack of knowledge, language barriers, etc. (in the BIM system) has not yet been taken into account. Robots and 3D printers for buildings will eliminate the hardest manual labor and replace the shortage of construction workers. However, there will be a growing need for specialists for a different type of work that is still unknown today. Therefore, a formal education system does not guarantee sufficient skills for the new challenges. The construction industry needs new skills and rapid adaptation to manage printers and develop construction technology. The need for new knowledge will increase and human resources in construction will therefore be an even more important category than today.

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