Ivana Perić[1], Perta Grošelj[2], Andrea Sujová[3], Miljan Kalem[4], Krešimir Greger[1], Jože Kropivšek[2]

Analysis of Implementation of Integrated Information Systems in Croatian Wood Processing Industry

Analiza primjene integriranih informacijskih sustava u hrvatskoj drvoprerađivačkoj industriji

Original scientific paper • Izvorni znanstveni rad
Received – prispjelo: 21. 2. 2019.
Accepted – prihvaćeno: 5. 3. 2019.
*UDK: 630*7*
https://doi.org/10.5552/drvind.2019.1911

ABSTRACT • *It can be said that Integrated Information Systems (IIS) are a fundamental operating tool in modern business systems and form the basis of successful company management. The goal of our research was to determine the IT level of business operations in Croatian wood processing industry and to assess how significant it has been in enhancing its business performance. A survey method was used to collect data, which resulted in gathering predominantly small and medium-sized companies. Our results indicate an average use of IIS modalities among surveyed companies. Using cluster analysis, three types of companies were identified with respect to the degree of system implementation. Analysis of financial benefits of the IIS implementation did not find any statistically significant relationship. However, subjective impressions on non-financial indicators show that companies in all three clusters see the greatest benefit of IIS in the improved inventory efficiency and sales efficiency.*

Keywords: *Integrated Information Sytems (IIS), ERP, Croatian wood processing industry, bussines performance*

SAŽETAK • *Možemo reći da su integrirani informacijski sustavi (IIS) temeljni operativni alat u modernim poslovnim sustavima i čine osnovu uspješnog upravljanja poduzećem. Cilj našeg istraživanja bio je utvrditi razinu informatizacije poslovanja u hrvatskoj drvoprerađivačkoj industriji i ocijeniti koliko je ona važna za poboljšanje poslovnih rezultata poduzeća. Za prikupljanje podataka primijenjena je anketna metoda, koja je rezultirala odzivom pretežito malih i srednjih poduzeća. Naši rezultati upućuju na osrednju upotrebu modaliteta unutar IIS-a u anketiranim poduzećima. Klasterskom su analizom identificirana tri tipa poduzeća s obzirom na stupanj integracije sustava. Analiza financijskih koristi implementacije IIS-a nije se pokazala statistički značajnom. Međutim,*

[1] Authors are postdoctoral researcher and assistant professor at University of Zagreb, Faculty of Forestry, Wood Technology Department, Zagreb, Republic of Croatia. [2]Authors are assistant professors at University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources and Department of Wood Science and Technology, Ljubljana, Republic of Slovenia.[3]Author is associate professor at Technical University in Zvolen, Faculty of Wood Sciences and Technology, Zvolen, Republic of Slovakia and at Mendel University, Faculty of Forestry and Wood Sciences, Brno, Czech Republic. [4]Author is assistant at University of Belgrade, Faculty of Forestry, Department of Technology, Management and Design of Furniture and Wood Products, Belgrade, Republic of Serbia.

[1] Autori su poslijedoktorandica i docent Drvnotehnološkog odsjeka Šumarskog fakulteta, Sveučilište u Zagrebu, Zagreb, Republika Hrvatska. [2]Autori su docenti Biotehničkog fakulteta, Sveučilište u Ljubljani, Ljubljana, Odsjek za šumarstvo i obnovljive šumske resurse i Odsjek za znanost o drvu i drvnu tehnologiju, Republika Slovenija. [3]Autorica je izvanredna profesorica Fakulteta znanosti o drvu i drvne tehnologije, Tehničko sveučilište u Zvolenu, Zvolen, Republika Slovačka i Fakluteta šumarstva i znanosti o drvu, Sveučilište *Mendel*, Brno, Republika Češka. [4]Autor je asistent Odsjeka za tehnologiju, menadžment i projektiranje namještaja i proizvoda od drva Šumarskog fakulteta, Sveučilište u Beogradu, Beograd, Republika Srbija.

subjektivni dojmovi o nefinancijskim pokazateljima govore da poduzeća u sva tri klastera vide najveću korist IIS-a u poboljšanju učinkovitosti upravljanja zalihama i poboljšanju učinkovitosti prodaje.

Ključne riječi: *integrirani informacijski sustavi, ERP, hrvatska drvoprerađivačka industrija, poslovna učinkovitost*

1 INTRODUCTION
1. UVOD

Meeting the demands of today's global market (broad product range, high quality, competitive prices) imposes quick product development and manufacturing. Contrary to the traditional approach of developing new production technologies first, and subsequently creating new products and services, nowadays these phases are carried out simultaneously.

Establishing company-wide high-quality information systems is one of the key prerequisites for preparing companies to enter international markets and play an active role in globalization processes. Besides improving the logistical support for production and services and aiding company management to control and manage company operations better, the information systems should also provide a sufficiently flexible platform for communicating both with clients and suppliers. This holds true especially for small- and medium-sized companies, which operate within the supply chain involving bigger companies (Loch and Koh, 2004).

Considering wood-processing industry as a predominantly production-oriented industry, the requirements on information systems go beyond the increased productivity, achieved through better logistical and IT support (CAD/CAPP systems, NC/CNC machines, flexible production lines, etc.). The needs of companies in this sector extend to facilitated exchange of technical drawings and technological processes, material ordering, product labeling (EAN codes) and dispatching, and finally to carrying out invoicing and payments in line with current standards and protocols in developed countries (Kalem *et al.*, 2018; Majdandžić, 2004). Certainly, Information Technology (IT) is pivotal in managing such companies.

Great logistical advancements have been made towards creating flexible, customer-oriented, flow production (Majdanđić, 2004). In general, production modernization via introducing integrated information systems (IIS) aims at reducing production times and labor costs, while increasing quality and minimizing material waste (Schneider and Andersson, 2016; Venkatraman and Fahd, 2016). In wood-processing industry, the most crucial of the four is minimizing material waste, since the cost of raw material alone can account for 30-80 % of the total production cost (Grladinović *et al.*, 2003). For this reason, in recent years, many companies have embraced a new class of planning and resource management software systems to integrate processes, enforce data integrity, and better manage resources.

0.1 Integrated Information Systems
0.1. Integrirani informacijski sustavi

Today, IIS are a fundamental operating tool in modern business systems and form the basis of successful company management (Bingi *et al.*, 2006; Mabert *et al.*, 2003; Maditinos *et al.*, 2011; Schneider and Andersson, 2016; Shatat, 2015; Zach *et al.*, 2014). Designed as integrated application platforms for company business organization, management and supervision, IIS are commonly referred to as Enterprise Resource Planning systems (ERP), and have evolved from Materials Requirements Planning (MRP) to Manufacturing Resource Planning (MRP II) systems.

Generally speaking, an ERP platform unites information, collected from all departments and functions across a company, into a single system that caters to the unique and varied needs of different departments (human resources, finances, supplies, etc.), while at the same time enabling all departments to access any other relevant business information. This integrated ERP bridge improves the efficiency and effectiveness of all operations. The departments that most benefit from ERP implementation are typically accounting and finance, production operations, sales, product development teams, purchasing and procurement and quality management.

Much progress has been made since Dillard and Yuthas noted in 2006 that most multinational companies were using ERP software packages and even more small and midsize companies were on the route of adopting them. According to industry reports (Market Research Store, 2017), the Global ERP Software Market is expected to grow at a compound annual growth rate of around 7.4 % over the next decade and reach approximately $63.1 billion by 2025. The most noticeable current trends are growing demand for ERP from medium- and small-sized enterprises, and moving to mobile and cloud applications.

ERP solutions can be either generic or industry-specific. Companies usually prefer industry-specific solutions, which contain features addressing their specific challenges. Since creating or adapting an ERP product to a new industry is complicated and expensive, most ERP vendors nowadays choose to specialize in a few specific branches/sectors.

It is imporant to note that ERP systems are very large and complex and require careful planning and execution of their implementation. According to Bingi *et al*. (1999), Nah and Lau (2001), Mabert *et al*. (2003), Maditinos *et al*. (2011) and Shatat (2015), the key factors to consider when implementating such complex systems are:

Implementation stages and costs: Implementing an ERP package sometimes takes several years and needs a lot of capital investment - practice has shown that less than 75 % of the ERP system' effectiveness is utilized, which translates to 25 % of investments not being fully justified;

- Training time: Training and getting used to an ERP system takes a long time and can be costly. Therefore, initially companies tend to assign only a few employ-

ees to the task of setting up the ERP system and later rely on them to train the others;
- Data migration: Migration of historical data to the new information system is often overlooked. However, companies need this data for forecasting purposes and sometimes for compliance or legal reasons;
- Top management support: Implementing an ERP system is not a matter of changing software systems. Rather, it is a matter of repositioning the company and transforming the business practices. Some companies make the grave mistake of handing over the responsibility of ERP implementation to the technology department;
- Consultant support: ERP implementation demands multiple skills, such as functional, technical, and interpersonal. Finding the right people with hands-on experience and keeping them through the implementation is a major challenge.

1.2 Overview of Croatian wood processing industry
1.2. Pregled hrvatske drvoprerađivačke industrije

Historically, the growth of Croatian wood-processing industry, which includes wood-processing and furniture manufacturing companies, was mainly driven by rich natural supplies of high raw material, while its global recognition came from innovations and know-how in manufacturing solid wood furniture and other products. It is worth noting that an important element in the growth of this sector of Croatian economy today is the business collaboration between wood-processing companies and the main supplier of lumber in Croatia, state-owned company *Hrvatske šume* (Croatian Forests), in particular in the area of certified products export (Klarić *et al.*, 2016; Paluš *et al.*, 2018). As a branch of processing industry, wood-processing industry is an essential part of Croatian economy given that it is one of the rare sectors reporting higher export than import. According to Croatian Bureau of Statistics (2019), total export value in this sector in 2018 was 831 million HRK.

Besides its role as an export-oriented sector, wood-processing industry was an instrument in enhancing the development and employment in rural parts of Croatia. However, according to the recent research of Basarac-Sertić *et al.* (2018), a decline in employment has been observed in recent years. This can be attributed to the combined effects of rural flight, migration of workforce from Croatia to developed countries, historically low wages and salaries, and a long-term slow decline in interest for education in the specialized wood-processing trade schools, and even higher education in this field, among the youth (Kropivšek *et al.*, 2011; MINGO, 2014; MPS, 2017). The roots of this problem can be traced to difficulties affecting the whole sector, such as unavailable capital, small local market (the companies must turn to export and compete in bigger markets with much tougher competition), low success rate in obtaining financial support and grants from available sources, low added value in terms of product completion (products sold only go through primary processing), large differences in the economic power of different regions, product standardization issues, etc. (MPS, 2017; MINGO, 2014).

A large proportion of firms within the wood-processing industry in Croatia can be regarded as privately-owned, small- and medium-sized enterprises (SMEs) (this is also true on the state-wide level: the biggest share of Croatian economy is comprised small businesses, namely micro-, small- and medium-sized companies, similar to other European countries). There is a trend for these firms towards penetrating niche markets. Research done by Perić (2015), conducted on a sample of wood-processing companies facing the abovementioned difficulties, has shown that most of these businesses are run by a single manager with only high-school education and average IT skills, while the IT level of the company was rated as below average. However, financial data and other business indicators of companies, which have declared a high IT level and higher average education level of their employees, deviate positively from the statistical mean. This clearly indicates the path to be followed by the whole wood-processing sector in order to successfully compete in national and international markets. Similar conclusions were reached in their research by other EU member states (Sujová *et al.*, 2015; Hitka *et al.*, 2018). They recommend continuous investments in innovations in operational and production processes, new product development and employment of highly trained staff.

1.3 Role of Integrated Information Systems for wood processing industry
1.3. Uloga integriranih informacijskih sustava za drvoprerađivačku industriju

Wood processing industry faces increasing demands on its products and services by the global market, such as high product quality, low production costs and short time to market. These challenging demands are often hard to meet, mainly due to insufficient financial power of wood processing companies for continuous investment into business and production processes (Perić, 2015; MPS, 2017). Consequently, the following issues are common to most companies in this sector: low utilization of raw material, long production planning periods, slow development and introduction of new products to customers, low implementation rate of e-commerce platforms necessary for managing business operations within EU, lack of systematic daily output logging of production lines, individual machines and employees in order to increase efficiency and avoid production stoppages, slow and inefficient archiving of business and technical documentation (a large share of documents still circulate in paper form), insufficient quality control, etc. (Grladinović *et al.*, 2003; Grladinović *et al.*, 2007). One of the ways to combat all these shortcomings, and thereby increase the competitiveness of Croatian wood processing industry in general, could be the implementation of integrated information.

The goal of our research was to determine the IT level of business operations in Croatian wood processing industry and to assess how significant its role has been in enhancing the business performance of compa-

nies in this sector, in particular considering the conditions and circumstances outlined in Croatia. It is worth mentioning that, according to literature review, no similar research has been carried out yet in the wood processing sector in Croatia. Therefore, the preliminary results reported herein present the very first step in a long-needed comprehensive analysis of this topic.

To fulfill the objectives of this investigation, answers to the following questions were sought:

What are the levels of IIS implementation?

What are the criteria for IIS selection?

What are the benefits of IIS implementation?

2 MATERIALS AND METHODS
2. MATERIJALI I METODE

The initial target population for this research was taken from the Register of Business Entities supervised by Croatian Chamber of Commerce (HGK, 2017). The sample included all active companies with more than 5 employees, classified in the Register under "C 16 - Wood Processing" or "C 31 - Furniture Manufacturing" according to their core business activities, the classification based on National Classification of Activities 2007 (NN, 2016). This non-specific population was targeted because there is no record on the implementaion of IIS within the field, which could narrow down the target population. Data on the use of IIS in Croatian wood processing industry was collected via a survey method (Dillman, 2000). The questionnaire consisted of three parts, with a total of twenty-six questions. The first part of the questionnaire contained general questions about the company. The second part addressed specifically the level of implementation measured with seven functional modules and its variables, as follow: *Finance & Accounting (*5 variables), *Human Resource*s (6 variables), *Production Management* (6 variables), *Inventory Management* (5 variables), *Purchase* (3 variables), *Quality Management* (4 variables) and *Sales* (5 variables), and criteria selection of IIS (measured with 7 variables). Finally, the third part examined the benefits of IIS implementation (measured with 5 variables), the motives for IIS implementation (measured with 10 variables) and other questions. Open questions and five-point Likert scale were used for some of the measurements of the analyzed variables (1 = "strongly disagree" through 5 = "strongly agree") or (1 = "very unimportant" through 5 = "very important"). The responses 4 and 5 were considered positive, 1 and 2 were considered negative and 3 was taken as neutral. The neutral responses were not included in the analysis. Data from target population was collected via Survs - online questionnaire. A total of 310 companies were asked to participate in the survey by filling out the questionnaire. 55 companies responded, and after performing all necessary controls, 43 were kept for data analysis (the unusable surveys were the companies that were not interested in survey participation, and/or companies whose main business activities were not in wood processing sector), which corresponds to the response rate of 18.85 %. Financial reports needed for calculating profitability ratios were obtained for the fiscal year 2017 from business information portal Bisonde.hr (2018). The research was conducted during March and July 2017. Data were analyzed using descriptive statistics, Two Step Cluster Analysis, $\chi 2$- test, Levene›s test homogeneity, One-way analysis of variance (ANOVA), Shapiro-Wilk normality tests, Cronbach´s α measure for internal consistency, Principal Component Analysis and Pearson correlation, with the use of the statistical packages SAS® University Edition.

3 RESULTS AND DISCUSSION
3. REZULTATI I RASPRAVA

3.1 Demographic profile of respondents
3.1 Profil ispitanika

Among the considered population, 55.8 % of the respondents declared themselves as wood processing companies and 44.2 % as furniture manufacturing companies. All companies were privately-owned. Regarding production type, 48.5 % companies claimed to have single production, 39.5 % produce small batches, and 11.6 % focus on large batch production. In relation to company size, most respondents belong to small- and medium-sized companies (62.8 % and 18.6 %, respectively), while only 4 companies have more than 250 employees or less than 10 employees. Figure 1 shows that 80.9 % of the respondents had annual income in 2017 of less than 5 million EUR.

3.2 IIS in wood processing companies
3.2. IIS u drvoprerađivačkim poduzećima

In this research, only wood processing companies that claimed to use IIS solutions were considered. The IIS application was categorized as either for business processes or for production processes or for both of them. As shown in Table 1, most companies declared the use of IIS solutions predominantly for business and production processes (70.0 %). More than half of the surveyed companies (62.8 %) have been using IIS solutions from 1 to 3 years, while only 9.3 % implemented them more than 5 years ago. It is interesting to note that, despite IIS platforms like MAPICS and QAD having evolved directly from MRP II packages, the majority of the surveyed companies opted for IIS systems tailored to their specific needs, with 72.0 % of

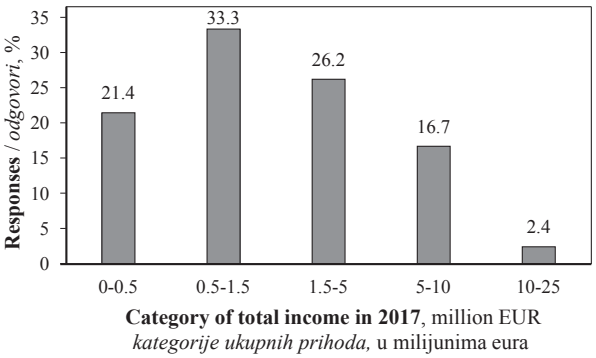

Figure 1 Total income in 2017
Slika 1. Ukupni prihodi u 2017.

Table 1 Industry and IIS
Tablica 1. Industrija i IIS

Characteristics / *Obilježja*	**Description** / *Opis*	%
Classification of IIS use / *klasifikacija primjene IIS-a*	Business processes / *poslovni procesi*	14.0
	Production processes /*proizvodni procesi*	16.0
	Business and production processes / *poslovni i proizvodni procesi*	70.0
IIS vedors / *ponuditelji IIS-a*	Oracle	9.0
	QAD	5.0
	PANTHEON™	5.0
	Microsoft Dynamics NAV	5.0
	MAPICS	2.0
	SAP	2.0
	Custom IIS solutions / *rješenja IIS-a prilagođena naručitelju*	72.0

them declaring to use customized integrated information systems. Major ERP providers like Oracle, QAD, PANTHEON™ and Navision together share only 24.0 % of the IIS market in the analyzed industry.

3.3 IIS application statistics in wood processing industry
3.3. Statistika primjene IIS-a u drvoprerađivačkoj industriji

The main characteristic of ERP systems is their multifunctionality, i.e. they provide modules for managing various business functions ranging from core business management, to resources, human resources and finance management. Our survey results indicate an average use of 64.3 % of the seven groups of modalities queried in the questionnaire (Table 2). The most frequently used module was Finance and Accounting at a rate of 86.0 %, followed by Purchase at 70.0 %. At the other end of the spectrum lie Quality Management and Human Resources modules, with an implementation rate of only 43.0 % and 42.9 %. These results agree well with previous studies reported in the literature (Olhager and Selldin, 2003; Mabert *et al.*, 2003).

Cluster analysis, specifically Two-Step Cluster Method, was conducted to gain a better insight into the differences in IIS use among the surveyed companies. Three clearly distinguishable clusters of companies were identified based on relationship patterns among the clustering variables presented in Table 2.

According to the results obtained, the first cluster groups around the mean of 81 % of IIS modules/functionalities used, and can be designated as companies with a high level of IIS implementation (group A). The second cluster (group B) is made of companies with medium level of IIS implementation, which group around the mean of 65 % of used IIS modules. Finally, the cluster grouping around a value of 45 % was designated as low IIS implementation cluster (group C).

The characteristics distinguishing the three clusters from one another were investigated applying Chi-Square statistic. Test showed that there is a statistically significant difference between clusters mean across almost all modules, with the exception of the module Quality Management ($p > 0.05$), which according to the results obtained has the lowest level of implementation (42.9 % of total).

Differences between Clusters A and B are less immediate. Both use different IIS modules in similar proportions. The most relevant difference between Clusters A and B was detected when using the module Human

Table 2 Profile of company's A, B, C levels of implementation of each module (N=43)
Tablica 2. Profil poduzeća s obzirom na razinu implementacije integriranih informacijskih sustava (N = 43)

Module groups *Grupe modula*	**Two Step Cluster** *Klasterska analiza*			
	A N = 10	**B** N = 7	**C** N = 26	**Average** *Srednja vrijednost*
	% of total implementation *postotak potpune implementacije*	% of total implementation *postotak potpune implementacije*	% of total implementation *postotak potpune implementacije*	% of total implementation *postotak potpune implementacije*
Finance & Accounting / *financije i računovodstvo*	100.0	96.4	61.5	86.0
Human Resources / *ljudski resursi*	68.0	29.0	32.0	43.0
Production Management / *upravljenje proizvodnjom*	92.0	65.7	40.8	66.2
Inventory Management / *upravljanje zalihama*	92.0	65.7	42.3	66.7
Purchase / *nabava*	87.7	81.0	41.0	70.0
Quality Management / *upravljanje kvalitetom*	50.0	37.1	41.5	42.9
Sales / *prodaja*	77.5	78.6	50.8	69.0
Average / *srednja vrijednost*	81.5	65.6	45.8	63.4

Table 3 Classification of cluster companies by number of employees
Tablica 3. Klasifikacija klasterskih poduzeća prema broju zaposlenih

	A	B	C	Total *Ukupno*	Chi-Square Tests		
	N = 10	*N* = 7	*N* = 26	*N* = 43	χ^2	*df*	*p*
Micro companies / *Mikropoduzeća* (Less than 10 / *Do 10)*	0	2	2	4	9.57	6	0.14
Small companies / *Mala poduzeća* (From 11 to 50 / *od 11 do 50)*	7	3	17	27			
Medium-sized companies / *Srednje velika poduzeća* (From 51 to 251 / *od 51 do 251)*	2	0	6	8			
Large companies / *Velika poduzeća* (More than 251 / *više od 251)*	1	2	1	4			

*p** - significant at the 0.05 level / *statistička značajnost na razini od 0,05*

Table 4 Classification of cluster companies by duration of IIS implementation and core activity
Tablica 4. Klasifikacija klasterskih poduzeća prema godini uvođenja IIS-a i temeljnoj djelatnosti

	A	B	C	Total *Ukupno*	Chi-Square Tests		
	N = 10	*N* = 7	*N* = 26	N = 43	χ^2	*df*	*p*
Less than 1 year/ *Manje od jedne godine*	1	4	2	7	11.08	4	0.02*
From 1 to 3 years / *Od 1 do 3 godine*	0	0	0	0			
3 years to 5 years / *Od 3 do 5 godina*	3	0	8	11			
More than 5 years / *Više od 5 godina*	6	3	16	22			
C16 – Wood processing / *Prerada drva*	7	3	14	24	1.33	2	0.51
C31 – Furniture manufacturing / *Proizvodnja namještaja*	3	4	12	19			

*p** - significant at the 0.05 level / *statistička značajnost na razini od 0,05*

Resources ($p = 0.00$). Relating these findings to the demographics (Table 3 and 4) of clusters, it can be noticed that Cluster B predominantly consists of micro and small-sized companies, which have coincidentally declared to have implemented IIS solutions within less than one year (57.1 %). This is in strong contrast to Clusters A and C, where IIS systems have been mostly used for longer than 5 years (60.0 % and 61.5 %, respectively) and where the dominant population consists of micro and small-size companies (70.0 % and 73.1 %, respectively). There are statistically significant differences in the duration of use and level of implementation of all IIS modules in favor of Cluster A ($p < 0.00$). The most indicative, albeit not statistically significant (shown in Table 4, $p > 0.05$), marker distinguishing Clusters A and C is the strong prevalence of wood processing companies (70 % in sector C16) in Cluster A.

3.4 Criteria for selecting Integrated Information System
3.4. Kriteriji pri odabiru integriranoga informacijskog sustava

As mentioned in the Introduction, ERP implementation is expensive and challenging for all businesses, and even more so for small businesses with specific production demands, as is the case of the wood processing sector. To fully exploit the potential of ERP, each organization should choose the right solution or module already in pre-implementation phase because the costs of changing it once deployed become prohibitive. In the survey, we assessed the main criteria for deciding on a particular IIS solution from the company perspective.

To this end, a formative five-point Likert scale was used to measure the perceived value of particular IIS feature, where the responses 4 and 5 were considered positive, 1 and 2 were considered negative and 3 was taken as neutral. Table 5 summarizes the responses related to IIS criteria selection. On top of the scale were *Customizability* and *Upgradeability* (86.0 % and 79.1 %, respectively). This could be in part due to the limited budgets available to small- and mid-size companies operating within the restrictions of a midsize local market. Similar results were obtained in other studies investigating manufacturing companies (Marebet *et al.*, 2003; Van Everdingen *et al*., 2000).

With a fairly small spread between the most and the least important criterion of just above 20 %, no statistically supported conclusions could be drawn as to the relative importance of different criteria. Interestingly, the least important criterion in the survey was Software price, which deviates from the above interpretation of companies working on limited budgets. However, previous study of Mabert *et al*. (2003) conducted on US manufacturers found that ERP implementation costs were associated with company size and were higher for large companies, due to higher consulting and training costs arising from more complex company organization. As our target population is composed of predominantly small- and mid-size companies, the overall reasonably low implementation costs could explain the relative unimportance of IIS price in the selection process when weighted against the potential benefits of its introduction in the business processes.

Table 5 Summary responses for criteria selection of IIS
Tablica 5. Sažetak odgovora o kriterijima odabira implementacije IIS-a

Criteria selection / *Kriteriji odabira*	**A** *N* = 10	**B** *N* = 7	**C** *N* = 26	**Total** *Ukupno N = 43*	***p***
Customizability / *prilagodljivost*	90.0	100.0	80.8	86.0	0.49
IT infrastructure of company / *IT infrastruktura poduzeća*	70.0	100.0	69.2	74.4	0.21
Software price / *cijena softvera*	50.0	100.0	61.5	65.1	0.07
Maintenance costs / *troškovi održavanja*	70.0	100.0	73.1	76.7	0.06
Employees IT competencies / *informatičke vještine zaposlenika*	80.0	71.4	73.1	74.4	0.80
Implementation costs / *troškovi implementacije*	80.0	85.7	61.5	69.8	0.11
Upgradeability / *nadogradivost*	60.0	85.7	84.6	79.1	0.19

*p** - significant at the 0.05 level / *statistička značajnost na razini od 0,05*

An anomaly noticed when performing two-step cluster analysis on this set of questions further supports this hypothesis. While for Clusters A and C, the Software price was ranked lowest among all selection criteria, in Cluster B, it shared the first place with 100 % of companies declaring its importance. Bearing in mind that Cluster B is composed of what we could designate as "late-adopters" (58.0 % of companies acquired their IIS systems within the last year), the high importance assigned to software price in this cluster could be related to the still fresh memory of the investment needed for the implementation.

3.5 Level of IIS implementation and businesses performance
3.5. Razina implementacije i poslovna učinkovitost

Integrated information systems affect all aspects of a business. Their real benefits can be seen outside the IT domain, in the changes in organizational activities that the IT system has enabled (Su & Yang, 2010). As far as financial performance is concerned, previous studies have reported a positive impact of ERP systems on the financial performance and competitive advantage of the adopting organization (Hendricks *et al*., 2007; Marbert *et al.,* 2003). In their work, they examined the most common business performance gains: Return on Sales (ROS), Return on Assets (ROA) and Operational Efficiency (OE).

To explore the benefits of IIS implementation on business performance of Croatian wood-processing industry, a One-way ANOVA test was run. However, this test showed no statistically significant differences between the clusters introduced in previous sections, with *p*-values greater than 0.05. In other words, our results discard the financial performance indicators as useful measures of assessing IIS implementation benefits in Croatian wood-processing industry. A similar phenomenon has already been observed by Elragal and Al-Serafi (2011), who explain that the financial findings can be too aggregate to give an accurate picture of the company.

Without financial indicators, in order to provide insight into the impacts of IIS implementation on company business process performance, non-financial performance indicators such as Sales Efficiency (SE), Inventory Efficiency (IE), Process Efficiency (PE), Organizational Efficiency (OE) and Computer&Communication Skills (CCS) were further examined, using a 5-point Likert scale, where the responses 4 and 5 were considered positive, 1 and 2 were considered negative and 3 was taken as neutral. This approach has already been used by Pertoni (2003), who noted that benefits associated with the implementation of IIS could also be measured in terms of enhanced performance and user satisfaction.

Table 6 summarizes cluster-wise IIS performance measures, validated with One-factor ANOVA test. Overall, the survey results show that the companies in all three clusters see the greatest benefit of IIS in the improved Inventory Efficiency (above 80.0 %) and Sales Efficiency (above 78.0 %). The least improvements were reported in Computer & Communication Skills segment. However, the statistical significance of measured indicators is below the threshold ($p > 0.05$). This absence of strong relationship between IIS implementation and business performance was also found by other studies (Hendricks *et al.*, 2007; Mabert *et al.*, 2003), and can be related to the IT productivity paradox phenomenon (Brynjolfsson, 1993) and the complex nature of IIS platforms, which makes it hard to evaluate their effect with only one (financial) measure. Furthermore, it takes time to achieve the expected benefits when adopting new "business intelligence", and in our case, 41 % of surveyed companies reported to have introduced IIS systems within the last 5 years.

As already mentioned, IIS platforms provide a broad range of solutions covering many aspects of business organization. It is crucial to identify the main objective of implementing IIS. The question is less: "Should we implement ERP?" and more: "What should ERP be implemented for?" The IIS implementation strategy should be derived from analyzing key performance indicators and defining key business objectives, in order to cover both present issues and future projections, thus enabling the company to adapt to the ever-changing business environment.

In order to analyze motives regarding the desired process and business improvements in pre-implementation phase to the actual IIS performance in post-implementation phase, a formative scale was built, presented in Table 7. Our hypothesis is that ERP systems would generate larger benefits when implemented with a clear, unified strategy. For this purpose, a list of 10 variables was offered to respondents to evaluate IIS implementation motives. The variables were partly

adapted to the present investigation from several previous sources (Mabert *et al*. 2003; Petroni, 2002; Soja, 2006). Common variables defining mutually independent strategies were identified using Principal Component Analysis (PCA) with Oblimin rotation, following the rule by Brown (2009).

PCA revealed three dimensions (strategies), which explain over 71.0 % of the variance: *Improving Controlling Efficiency* (ICE), *Improving Production Quality* (IPQ*)* and *Improving Production Efficiency* (IPE). The Kaiser-Meyer-Olkin measure of sampling adequacy was high, suggesting that factor analysis was appropriate for this data set. Bartlett's test of sphericity was large and the associated significance level small ($p < 0.05$). Furthermore, high alpha values (> 0.7) confirm high reliability of detected factors (Brown, 2009).

The difference in strategic orientation of the three clusters is examined in Table 7. It can be seen from mean ratings that no cluster opted for a focused strategic approach, with Cluster A spreading its goals most evenly across all strategies. Companies in Cluster B gave slight preference to ICE strategy, while Cluster C inclined slightly towards IPE strategy.

To explore the link between the identified IIS implementation strategies (Table 8) and perceived performance indicators (Table 6), correlation analysis was done for all three clusters, as shown in Table 9. As a consequence of balanced strategic approach of all three clusters, most statistically significant correlation coefficients were low to moderate ($0.3 < r < 0.6$), leaving the low-level analysis inconclusive. However, observing the link on the macroscopic level with an overall IIS implementation satisfaction grade, calculated as the mean value of ratings given to all five performance indicators defined previously, it can be seen that companies in Cluster B are the most satisfied with IIS implementation outcome (average grade 3.87, compared to 3.58 in Cluster A and 3.48 in Cluster C). This is likely due to their strategic approach addressing their needs best (highest priority given to ICE strategy, which covers sales and inventory efficiency, as well as process efficiency to some extent, which in turn were identified as the most important aspects of IIS within Cluster B (see Table 8). Supporting this hypothesis, the most consistent statistical significance with moderately high positive correlation coefficients was noticed in Cluster B between the corresponding variables (SE, IE, PE) and preferred strategy (ICE).

4 CONCLUSION
4. ZAKLJUČAK

The main purpose of integrated information systems (IIS systems) is to integrate all administrative and manufacturing processes within a company, thus providing timely information to all end-users and increasing efficiency on all levels. Numerous studies (Loch

Table 7 Motives for IIS implementation
Tablica 7. Razlozi implementacije IIS-a

Variables / *Varijable*	**Reliability Statistics** *Inicijalna dimenzionalnost mjerne skale*		**Principal Component Analysis** *Analiza glavnih komponenata*			
	M	Cronbach α *Cronbachov α*	ICE	IPQ	IPE	Cronbach α *Cronbachov α*
Employee management / *koordinacija zaposlenika*	3.72	0.854	**0.925**			0.843
Work procedure standardization / *standardizacija radnih postupaka*	4.00		**0.873**			
Inventory control / *kontrola zaliha*	3.91		**0.729**			
"Real-time" support for customers / *pravodobna potpora kupcima*	3.88		**0.672**		0.293	
Improving product quality / *poboljšanje kvalitete proizvoda*	3.98			**0.902**		0.866
Quality control / *kontrola kvalitete*	3.93		**0.142**	**0.864**		
New production processes / *novi proizvodni procesi*	3.79		**0.420**	**0.566**	0.168	
Delivery management / *kontrola rokova isporuke*	4.30		**0.244**	-0.297	**0.828**	0.821
Reducing manufacturing lead time / *skraćivanje vremena proizvodnog procesa*	3.84		**-0.126**	0.394	**0.673**	
Cost management / *kontrola troškova*	3.84			0.366	**0.553**	

*Bold values indicate significant factors; Extraction method: PCA; Rotation method; Oblimin with Kaiser Normalization / *Zadebljane vrijednosti označavaju značajne čestice; metoda ekstrakcije: PCA; metoda rotacije; oblimin s Kaiser normalizacijom; M-Mean / aritmetička sredina*

Table 8 Strategic priorities of IIS implementation according to Cluster A, B and C
Tablica 8. Strateški prioriteti implementacije IIS-a u klasterima A, B i C

Strategic orientation / *Strateška usmjerenost*	**A**	**B**	**C**
	M	**M**	**M**
Improving controlling efficiency / *poboljšanje kontrolinga*	4.00	4.25	3.73
Improving production quality / *poboljšanje kvalitete proizvodnje*	4.10	3.90	3.82
Improving production efficiency / *poboljšanje proizvodne učinkovitosti*	4.00	3.95	4.15

*M-Mean */ aritmetička sredina*

Table 9 Correlation matrix for Clusters A, B and C
Tablica 9. Matrica korelacija za klastere A, B i C

Cluster mark *Oznaka klastera*			ICE	IPQ	IPE	SE	IE	PI	OE	CCS
			r	***r***	***r***	***r***	***r***	***r***	***r***	***r***
A	**ICE**	*r*	1	0.496	0.236	0.426*	0.547*	0.306	0.404*	-0.074
	IPQ	*r*		1	0.395	0.267	-0.096	-0.206	0.508*	0.386
	IPE	*r*			1	-0.238	0.086	-0.250	0.429*	0.180
	SE	*r*				1	0.486*	0.656*	0.173	-0.106
	IE	*r*					1	0.858**	0.415	0.196
	PI	*r*						1	0.149	0.149
	OE	*r*							1	0.507
	CCS	*r*								1
B	**ICE**	*r*	1	0.802*	0.733	0.626*	0.460*	0.574*	0.264	0.130
	IPQ	*r*		1	0.730	0.573*	0.382	0.508*	0.214	0.317
	IPE	*r*			1	0.388	0.215	0.412*	0.711*	0.331
	SE	*r*				1	0.907**	0.874*	0.253	0.568
	IE	*r*					1	0.910**	0.335	0.742
	PI	*r*						1	0.380	0.636
	OE	*r*							1	0.684
	CCS	*r*								1
C	**ICE**	*r*	1	0.400*	0.415*	0.310	0.328	0.137	0.524**	0.273
	IPQ	*r*		1	0.497**	0.061	0.119	-0.039	0.383	0.289
	IPE	*r*			1	0.418*	0.315	0.382	0.506**	0.534**
	SE	*r*				1	0.820**	0.823**	0.519**	0.273
	IE	*r*					1	0.723**	0.492*	0.251
	PI	*r*						1	0.433*	0.380
	OE	*r*							1	0.789**
	CCS	*r*								1

ICE - improving controlling efficiency / *poboljšanje kontrolinga; IPQ* - improving production quality / *poboljšanje kvalitete proizvodnje: IPE* - improving production efficiency / *poboljšanje proizvodne učinkovitosti;* SE - sales efficiency / *prodajna učinkovitost*; IE - inventory efficiency / *u*činkovitost upravljanja zalihama; PI - process efficiency / *procesna učinkovitost*; OE - organizational efficiency / *organizacijska učinkovitost*; CCS - computer and communication skills / *kompjutorske i komunikacijske vještine; r* - Pearson correlation coefficient / *Pearsonov koeficijent korelacije*
*Correlation is significant at the 0.05 level / *korelacija je značajna na razini 0,05*
**Correlation is significant at the 0.01 level / *korelacija je značajna na razini 0,01*

and Koh, 2004; Mabert *et al.*, 2003; Maditinos *et al.*, 2011; Zach *et al*., 2014) have shown the growing trend in the application of IIS systems in companies – small and large alike – as a lever for increasing business efficiency, productivity and market competitiveness in order to combat growing competition and global market demands. The aim of the present research was to determine to what extent the informatization of business operations has been implemented in Croatian wood processing companies, and whether or not it has resulted in better business performance.

IIS implementation level and demographic profile of respondents were assessed via a questionnaire distributed among Croatian wood processing companies. In the collected population sample, the greatest share was occupied by small- and medium-sized companies. The majority of respondents apply IIS in their businesses, but to a different extent. Most of the implemented IIS systems are tailored to address the particular needs of a company, while the highest level of IIS implementation has been achieved in the administrative aspects of business (finances, accounting, and procurement).

Using cluster analysis, three types of companies with respect to the degree of system implementation have been identified: high degree (cluster A), medium degree (cluster B) and moderate degree (cluster C) of IIS implementation. Clusters A and C consist mostly of small- and medium-sized wood processing companies (sector C16), which have mostly been using IIS for more than 5 years. Conversely, Cluster B hosts mainly micro and small-sized furniture manufacturing companies (sector C31), which declare using IIS less than one year. Given the limited size of the examined population sample, the differences between Clusters A and B were statistically insignificant, while differences between Clusters A and C were statistically significant in most of the analyzed points. All three clusters have indicated customizability, upgradeability and maintenance costs as the most important factors in selecting IIS, which is not surprising given the average company size in the surveyed sample (the majority were small- and medium-sized companies), whose financial possibilities are modest compared to big companies.

Many studies (Elragal and Al-Serafi, 2011; Hendricks, *et al.*, 2007; Marbert *et al.*, 2003; Venkatraman and Fahd, 2016) indicate the positive effects of IIS implementation on business operations. In this research, IIS implementation level was tested with respect to 7 functional modules that are the building blocks of modern universal ERP solutions, while the success of implementation was measured via financial indicators

and subjective ratings. The analysis of the entire population showed no statistically significant correlation between IIS implementation level and company's profitability indicators. In terms of subjective ratings, measured via Likert's scale on five qualitative indicators (sales efficiency, inventory efficiency, process efficiency, organizational efficiency and computer & communication skills), by implementing IIS, the biggest improvements were observed by surveyed companies in inventory and sales efficiency.

The motives for introducing IIS into business operations were divided in ten elementary reasons in this research. By using the Principal Components Analysis (PCA), the investigated companies could be grouped into three basic implementation strategies, based on their stated priorities: improving control efficiency, improving production quality and improving production efficiency. Correlating the identified clusters with individuated strategies, however, it was shown that no cluster had opted for a focused IIS implementation strategy. Instead, they globally decided on a combined strategic approach, with a slight prevalence of ICE strategy in Cluster B and a slight prevalence of IPE strategy in Cluster C. Due to small differences and limited sample size, no statistically significant results were obtained in this part of our investigation. Still, comparing the mean observed values, one can detect the highest level of satisfaction by the introduction of IIS systems into their business operations among Cluster B. This can be explained by the fact that the preferred basic strategy ICE of Cluster B prioritizes the business operation aspects that have been underlined by all surveyed companies as the most important ones. Bearing that in mind, the ICE strategy could be recommended to other companies aiming to introduce IIS systems.

The uneven distribution of companies among categories, mediocre response rate, as well as some common traits of Croatian wood processing companies, e.g. below-average application of business and manufacturing innovations compared to the industry average, were the constraints due to which this research was not able to fully correlate the use of integrated information systems to the measurable benefits, or confidently identify optimal IIS implementation strategies. However, considering this investigation as a first step in a comprehensive analysis of this topic, we hope that subsequent investigations, focusing more on medium- and large-scale companies with higher business and credit ratings, will explain these relations.

5 REFERENCES
5. LITERATURA

1. Basarac Sertić, M.; Pirc Barčić, A.; Klarić, K., 2018: Economic Determinants and Analysis of the European Union Wood Industry SMEs Employment. BioResources, 13 (1): 522-534.
2. Braglia, M.; Petroni, A., 1999: Shortcomings and Benefits Associated with the Implementation. Logistics Information Management, 12 (6): 428-430.
3. Brown, D. J., 2009: Statistics Corner. Questions and answers about language testing statistics: Choosing the Right Type of Rotation in PCA and EFA. Shiken: JALT Testing & Evaluation SIG Newsletter, 13 (3): 20-25.
4. Bingi, P.; Sharma, M. K.; Godla, J. K., 1999: Critical Issues Affecting an ERP Implementation. Information Systems Management, 16 (13): 7-140. https://doi.org/100.1201/1078/431970.16.30.19990601/313100.20.
5. Brynjolfsson, E., 1993: The productivity paradox of information technology. Communications of the ACM, 36 (12): 66-77. http://dx.doi.org/10.1145/163298.163309.
6. Dillard, J. F.; Yuthas, K., 2006: Enterprise resource planning systems and communicative action. Critical Perspectives on Accounting, 17: 202-220. http://dx.doi.org/10.1016/j.cpa.2005.08.0030.
7. Dillman, D. A., 2000: Mail and Internet Surveys: The Tailored Design Method, second edition. John Wiley & Sons, Inc, New York.
8. Grladinović, T.; Benić, D.; Jelačić, D.; Motik, D., 2003: A Dynamic System of Material Flows in Wood Industry Companies. Strojarstvo, 1-3: 65-73.
9. Grladinović, T.; Oblak, L.; Hitka, M., 2007: Production management information system in wood processing and furniture manufacture. Drvna industrija, 58 (3): 141-146.
10. Hendricks, K. B.; Singhal, V. R.; Stratman, J. K., 2007: The impact of enterprise systems on corporate performance: A study of ERP, SCM, and CRM system implementations. Journal of Operations Management, 25: 65-82. http://dx.doi.org/10.1016/j.jom.2006.02.002.
11. Hitka, M.; Lorincova, S.; Bartakova, G. P.; Lizbetinova, L.; Starchon, P.; Li, C.; Zaborova, E.; Markova, T.; Schmidtova, J., 2018: Strategic tool of human resource management for operation of SMEs in the wood-processing industry. BioResources, 13 (2): 2759-2774. http://dx.doi.org/10.15376/biores.13.2.2759-2774.
12. Kalem, M.; Lečić-Cvetković, D.; Glavonjić, B., 2018: Application of The Bar-Code Technology in a System of Production Management: Caste Study of Serbian Producer of Wood Based Panel Furniture. Increasing the Use of Wood in the Global Bio-Economy University of Belgrade, Faculty of Forestry, WoodEMA, Belgrade, 267-275.
13. Klarić, K.; Greger, K.; Klarić, M.; Andrić, T.; Hitka, M.; Kropivšek, J., 2016: An Exploratory Assessment of FSC Chain of Custody Certification Benefits in Croatian Wood Industry. Drvna industrija, 67 (3): 241-248. http://dx.doi.org/10.5552/drind.2016.1540.
14. Kropivšek, J.; Jelačić, D.; Grošelj, P., 2011: Motivating Employees of Slovenian and Croatian Wood-industry Companies in Times of Economic Downturn. Drvna industrija, 62 (2): 97-103, http://dx.doi.org/10.5552/drind.2011.1040.
15. Loch, T. C.; Koh, S. C., 2004: Critical elements for a successful enterprise resource planning implementation in small and medium-sized enterprises. International Journal of Production Research, 42 (17): 3433-3455. http://dx.doi.org/10.1080/00207540410001671679.
16. Mabert, V. A.; Soni, A.; Venkataramanan, M. A., 2003: The impact of organization size on enterprise resource planning (ERP) implementations in the US manufacturing sector. Omega, 31: 235-246. http://dx.doi.org/10.1016/S0305-0483(03)00022-7.
17. Maditinos, D.; Chatzoudes, D.; Tsairidis, C. C., 2011: Factors affecting ERP system implementation effectiveness. Journal of Enterprise Information Management, 25 (1): 60-78. http://dx.doi.org/http://dx.doi.org/10.1108/17410391211192161.
18. Majdanđić, N., 2004: Izgradnja informacijskih sustava proizvodnih poduzeća. Strojarski fakultet Slavonski Brod, Slavonski Brod.

19. Nah, F. H.; Lau, L.-S. J., 2001: Critical factors for successful implementation of enterprise systems. Business Process Management Journal, 7 (3): 285-296.
20. Olhager, J.; Selldin, E., 2003: Enterprise resource planning survey of Swedish manufacturing firms. European Journal of Operational Research, 146: 365-373.
21. Plauš, H.; Parobek, J.; Vlosky, V. R.; Motik, D.; Oblak, L.; Jošt, M.; Glavonjić, B.; Dudík, R.; Wanat, L., 2018: The status of chain-of-custody certification in the countries of Central and South Europe. European Journal of Wood and Wood Products, 76 (2): 699-710. http://dx.doi.org/10.1007/s00107-017-1261-0.
22. Perić, I., 2015: Assessment of Factors of Competitiveness in Furniture Manufacturing Companies, PhD thesis. University of Zagreb, Faculty of Forestry, Zagreb.
23. Petroni, A., 2002: Critical factors of MRP implementation in small and medium-sized firms. International Journal of Operation & Production Management, 22 (3): 329-348. http://dx.doi.org/10.1108/01443570210417623.
24. Schneider, C.; Andersson, O., 2016: Examining Levels of Automation in the Wood Processing Industry – A case study, M. Sc. thesis. Jönköping University, School of Engineering, Jönköping.
25. Shatat, A., 2015: Critical Success Factors in Enterprise Resource Planning (ERP) System Implementation: An Exploratory Study in Oman. The Electronic Journal of Information Systems Evaluation, 18 (1): 36-45.
26. Soja, P., 2006: Success factors in ERP systems implementations: lessons from practice. Journal of Enterprise Information Management, 19 (6): 646-661.
27. Su, Y.; Yang, C., 2010: Why are enterprise resource planning systems indispensable to supply chain management? European Journal of Operational Research, 203: 81-94.
28. Sujová, A.; Hlaváčková, P.; Marcineková, K., 2015: Evaluating the Competitiveness of Wood Processing Industry. Drvna industrija, 66 (4): 281-288. http://dx.doi.org/10.5552/drind.2015.1432.
29. Van Everdingen, Y.; Van Hillegerberg, J.; Waarts, E., 2000: ERP adoption by European midsize companies. Communications of the ACM, 43 (4): 27-31.
30. Venkatraman, S.; Fahd, K., 2016: Article Challenges and Success Factors of ERP Systems in Australian SMEs. Systems, 4 (20): 1-18. doi:10.3390/systems4020020
31. Zach, O.; Munkvold, B. E.; Olsen, D. H., 2014: ERP system implementation in SMEs: exploring the influences of the SME context. Enterprise Information Systems, 8 (2): 309-335. http://dx.doi.org/10.1080/17517575.2012.702358.
32. ***Bisonde, 2018: Boniteti Hrvatska. https://www.bisnode.hr (accessed December 20, 2018).
33. ***CBS, 2019: Foreign Trade in Goods of the Republic of Croatia − Provisional Data January – October 2018 and January – November 2018. Croatian Bureau of Statistics, Zagreb. https://www.dzs.hr (accessed January 10, 2019).
34. ***HGK, 2017: Hrvatska gospodarska komora. https://www.hgk.hr (accessed June 2018).
35. ***Market Research Store, 2017: Global ERP Software Market Analysis & Trends – Industry Forecast to 2025. Research and Markets – The World´s largest Research Store. https://www.researchandmarkets.com (accessed December 10, 2018).
36. ***MINGO, 2014: Ministarstvo gospodarstva. https://www.mingo.hr. pdf (accessed December 10, 2017).
37. ***MPS, 2017: Strategija razvoja prerade drva i proizvodnje namještaja Republike Hrvatske 2017. – 2020. s akcijskim planom provedbe 2017. – 2020. Vlada Republike Hrvatske, Ministry of Agriculture, Zagreb. http://www.mps.hr (accessed June 10, 2017).
38. ***NN, 2016: Narodne novine. Državni zavod za statistiku. https://narodne-novine.nn.hr. (accessed March 10, 2017).
39. ***SAS® University Edition. https://www.sas.com (accessed October, 2018).

Corresponding address:

Assist. prof. KREŠIMIR GREGER, Ph.D.

University of Zagreb, Faculty of Forestry
Wood Technology Department
Svetošimunska 25
10002 Zagreb
REPUBLIC OF CROATIA
e-mail: kgreger@sumfak.hr