ERP Systems in Public Sector

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Abstract - ERP systems are tended to be implemented in the public sector. In this paper the "industries" of public sector are identified which are suitable for ERP implementation. The systematic review method is used to give an overview of state of the art ERP system implementation in the public sector worldwide in the last five years as well as possible directions of future research. Finally, the critical review is given regarding potential of ERP system implementation in the public sector.

I. INTRODUCTION

The vast majority of ERP system implementation in production systems has been completed and consequently the needs of that market have been satisfied. Some other potential areas of ERP systems implementation were in focus of ERP systems manufacturers. One of the emerging markets is the public sector. Implementation of ERP systems in the public sector has already began regardless of some well-known ERP implementation problems such as enormous investment and risk of failure in implementation itself. Numerous published scientific papers deal with various aspects of ERP systems, but the number of papers regarding ERP systems implementation in the public sector is relatively small. That particular area of the public sector is becoming increasingly interesting for ERP systems manufacturers, and researchers are interested in the areas of public services where the ERP systems have already been implemented.

Vrček and Brumec [6] define ERP system as "set of logically connected programs which support organization's business processes and use central and unique database, … it is not developed for any particular organization, regarding its functions it is general but simultaneously adoptable for specific needs of majority of organizations dealing with similar activities".

International Data Corporation (IDC) [7] defines that Enterprise Application Suite must fulfill the following criteria:

1. Minimal Functionality – not less than four basic functionalities:

    a. financial accounting modules,

    b. procurement modules,

    c. order management modules,

    d. inventory management modules.

2. Integrity – design based on simple rules and use of metadata, provides users access to all functional modules using one interface, it can store and retrieve data in one common database.

3. Relatively high price per user which differentiate s it from low-end book accounting software.

4. Multiuser platform – application (program) is designed for server/host and client/server environment.

According to Tomičić-Pupek [8] the general ERP system classification has not yet been accepted, but some criteria for ERP system classification are defined:

1. According to organization's line of business (a so called industry),

2. According to the set of business activities in one industrial area (vertical industry),

3. According to the business area (e.g. Accounting, Finances, Human Resources, Sales, Procurement, etc.),

4. According to the method of implementation,

5. Accordingto the ERP system adjustment approach to the organizational needs.

Jakupović, Pavlić and Fertalj [9] recommend ERP systems classification according to 70 business operations sorted into the three basic categories (Finances and public services, Production and Services). That approach is based on analyses of commercial ERP system manufacturers' classifications compliant with Global Industry Classification Standard (GICS) and EUROSTAT classification. The authors use the IDC definition of ERP systems, explained earlier.

Classification according the business functions - "industries" is commonly used in ERP system manufacturers' offers and it is concurred with noneconomic service of public interest definition.

The second area of interest in this paper is the public sector. It is important to define which services are offered by public sector and what in fact is the public sector.

Đulabić defines public sector services [1] as activities used to satisfy public needs, whereby the fundamental values of modern democratic societies are achieved. The concepts of "Public Service" and "services of public interest" describes the principle of same activity [1]. The concept of "Public Service" is more often used in continental European countries and the same concept but under the different name as "municipal services" or "public interest" can be found elsewhere [2]. The European Parliament defines public service [2] as permanent

economic activity which is in the public interest, and which is created and controlled by some public institution and at the same time it is under certain degree of legal protection beyond the regular legislative regardless the private or public authority which provides that service.

Public services are based on following principles [2]: equality, continuity, adaptability. Privilege of founding some public service agency (founding, setup and control) are given to [2]: central government (national public services), federal states and local authorities (regions, province, municipalities).

The new standards for public services general interest are established by the new European legislative regulation. The European Union differs economic public services (e.g. network industries) and non-economic public services like social security and healthcare [3]. The economic public services are big industries and network industries like telecoms, post offices, gas distribution, electrical energy distribution, water distribution, etc [4]. The non-economic public services are: education, culture, healthcare, social services, etc, everything which is not commercially based [3].

Koprić [4] indicates that term "services of general interest" isn't used in EC Agreements, and the use of that term spread in the late 1990ties. After intensive and long public discussion, the wider and narrower terms have been defined in a series of public documents. The wider term is defined as "public services of general interest" and the narrower term is defined as "economic public services of general interest". In addition, the specificities of certain categories of public services are recognized, so the terms like "social services of general interest" or "healthcare services of general interest" are also used [4]. According to Koprić [4] the intention of European Union is to harmonize the public services using policies and legislative (White Book, Bolkestein Directive).

Based on the above facts, this research aims at non-economic public services focused on the areas shown in Table I.

In this research it is not important at which level of the government these services are provided, since the research takes into consideration all levels of government.

The research question is defined as follows:

In which direction the ERP systems in non-economic public services have been developing over the last five years.

Research method: A method of systematic literature review as described by B. Kitchenham [5].

TABLE I.   NON-ECONOMIC PUBLIC SERVICES

Code	Non-economic public service
PS1	Education
PS2	Culture
PS3	Health Care
PS4	Social Services
PS5	Law Enforcement
PS6	Military – defense
PS7	Public library
PS8	Public Security
PS9	Physical Planning / Town Planning
PS10	Public sector

II.   SYSTEMATIC LITERATURE REVIEW

A systematic literature review is a means of evaluating and interpreting all available research relevant to a particular research question, topic or phenomenon of interest [5].

A.   Planning

The scientific databases with full text paper, and the other available scientific articles in the field of social sciences were used in the research: Academic Search Complete, Business Source Complete, Directory of Open Access Journals – DOAJ, Regional Business News, Science Direct. Springer Link, IEEE Xplore, Google schoolar, HRČAK – portal znanstvenih časopisa, http://elf.foi.hr/.

All scientific and other papers and works written in the time span from 2008 to March 2013 were taken into account in the results selection.

Based on the analysis of services of general public interest which is described in the introduction to this paper, following keywords will be used to query the database: ERP system, government, public sector, public services, public utilities, public interest, service of general economic interest, education, culture, healthcare, social services, law enforcement, military, defense, public security, physical planning and public administration.

Using the above keywords the queries in Table II. are defined.

The article selection was performed in three stages (according to Jurišić [21]):

1. selection based on the analysis of titles and keywords,

2. selection based on the analysis of the abstracts,

3. selection based on the analysis of the full text.

At all stages of the selection articles related to the areas shown in Table I were considered.

TABLE II.   RESEARCH QUERIES

Code	Query
Q1	'ERP system' AND 'government'
Q2	'ERP system' AND 'public sector'
Q3	'ERP system' AND 'public services'
Q4	'ERP system' AND 'public utilities'
Q5	'ERP system' AND 'public interest'
Q6	'ERP system' AND 'service of general economic interest'
Q7	'ERP system' AND 'education'
Q8	'ERP system' AND 'culture'
Q9	'ERP system' AND 'healthcare'
Q10	'ERP system' AND 'social services'
Q11	'ERP system' AND 'law enforcement'
Q12	'ERP system' AND 'military'
Q13	'ERP system' AND 'defense'
Q14	'ERP system' AND 'public libraries'
Q15	'ERP system' AND 'public security'
Q16	'ERP system' AND 'physical planning'
Q17	'ERP system' AND 'public administration'

At each stage of selection articles that are too general or those who are not focused on the research areas listed in Table 1 were rejected.

Identical articles were identified and duplicates were discarded at each stage of selection.

B. Conduction

After rising queries with keywords in databases and other available sources, according to the strategy specified in the research plan, 1046 articles have been discovered.

Having conducted the first phase - selection based on analysis of titles and keywords from the results of the previous stage - 170 articles have been extracted.

In Phase 2, 170 abstracts of articles resulting from phase 1were analyzed and 67 articles was allocated.

In the third stage of selection, after detailed reading, 67 articles were analyzed. 36 articles of these were eliminated after the content analysis, because they were not related to the topic of research. Some of the reasons were:

- Articles describing the upgrading of the existing ERP system with some new module or a separate decision,

- Articles describing systems that have already been analyzed,

- Articles not dealing exactly with the description of ERP systems, they were related to management, organizational culture, the reasons of successful or unsuccessful implementation, evaluation of investment ...

Full text analysis resulted with a set of 31 articles, 4 of them describing research conducted over more respondents from the public sector [30], [33], [8] [42], while the other 27 refer to one specific ERP system which has been applied to an institution of the public sector. 7 articles do not relate directly to the purpose of the research but generally describe some aspects of the ERP system in the non-economic public services.

C. Results and analysis

Analysis of 31 article shows that the largest number of articles related to the introduction of ERP systems in the field of education (11), then the area of functioning of the public sector (cities, states, regions, agencies) (10), the area of defense (5) area of healthcare (3), and (2) articles describe the introduction of ERP systems in several institutions.

Analyzing separate articles regarding the country of implementation, it was found that the largest number of articles describing the implementation of ERP systems refers the U.S. - 17, an unexpectedly large number of articles describing the implementation of ERP in Croatia - four, while the ERP implementation in Italy, Egypt, Hungary, Portugal, Saudi Arabia, the Netherlands, Denmark and Finland are described with one article each.

Two articles describe ERP implementation in several countries.

Regarding the ERP system manufacturer, most articles - 11 describe SAP, 6 articles describes multiple ERP systems at once, 2 articles describe Oracle, 2 articles describe Microsoft Dynamics AX, 1 article describes each of the following manufacturers: Infor, BAAN, CGI AMS, Datatel Colleague, People Soft, MADAR, MUNIS, "Ericsson Nikola Tesla alliance", Custom solution, while in one article the manufacturer is not even listed.

1) Education

According to the classification of business operations created by Jakupović Pavlic and Fertalj [9], education as part of the public services is divided into three activities: schools, higher education and research. As a result of this research related to education, there were 11 articles discovered describing the ERP modules implemented in educational organizations and they are presented in Table III. Tomicic-Pupek [8] in doctoral dissertation refers to the research of module types, manufacturers and recent clients of the ERP system implementation in higher education institutions in the U.S. where 23 of 66 higher education institutions have introduced full ERP. In the European higher education institutions such register was never found.

2) Public Sector

In the field of public sector, research has identified 10 articles from the level of the city administration up to regional, state and federal government with ERP modules implemented as shown in Table IV.

3) Defence

German army uses the ERP system called "SAP DFPS" (SAP for Defense Forces and Public Security) [16] with ERP modules stated in Table V. In the same article the Logistic information system - ISL (Information System for Logistics) of the Czech Republic Department of Defense and the Czech Republic Army is described [16] developed by Czech producers AURA with the modules presented in Table V.

U.S. Department of Defense 's (DoD - Department of Defense) uses four primary ERP systems [46] and several smaller specialized ERP systems. The largest four are: Integrated Personnel and Pay System (IPPS-A) it is a system of human resource management, the Global Combat Support System for tactical logistics (GCSS-Army), Logistics Modernization Program (LMP) of the National Logistics, General Funds Enterprise Business System (GFEBS) is a global financial system. Manufacturer of the IPPS-A is a PeopleSoft Company, SAP is a manufacturer of the other three.

In addition to the U.S. military, the ERP system was introduced in Denmark army. Christiansen et al. describes the results of the introduction of the SAP ERP system in a special unit of Danish Navy [19]. The main purpose of the system implemented in Denmark army was to meet accounting standards set by the Danish National Audit Office, and modules are presented in Table V.

Hyovnen et al. [20] describe the case of the Finnish Defense Forces. By the end of 2005, the new ERP system replaced 19 different administrative information systems.

TABLE III.   PS1 - EDUCATION

Ref.	ERP Modules Implemented	ERP Manufact.
[35]	Finacial accounting, HT mgt, Material Mgt, Project Mgt, Record Mgt, Faze II: Payroll, Asset Mgt, Procurement Mgt	SAP
[36]	Financial, Human Capital, Pension, Logistics and Technical	SAP
[37]	full ERP	Datatel® Colleague®
[38]	finance, procurement, human resources, campus solution - student modules	PeopleSoft
[39]	full ERP	MADAR
[40]	human capital management, financial management and payroll processing	Munis
[41]	full ERP	Oracle
[8]	different ERP componenets or full ERP implemented in different institutions	multiple manufacturers
[12]	full ERP	proprietary developed ERP "Is_UVN"
[42]	financial system, business processes of budget execution, financial accounting	SAP
[43]	finance, human resources (HR) and student information system software	not specified

SAP R/3 system was introduced with modules specified in Table V, and it was the first major implementation of SAP R/3 system in the Finland public sector [20]. Modules project management, maintenance and human resources are planned for later introduction, the time of implementation has not been determined.

4) Healthcare

Boonstra and Govers [15] in their paper have described the implementation of SAP ERP system in the medium - sized general hospital in the western part of the Netherlands. The hospital consists of six main units: 1 clinical part, 2. outpatient, 3. medical part, 4. facilities, 5. staff, 6. IT and finance. ERP system has been implemented over 5 years and the following modules were introduced: patient management, finance, material management, human resources, laboratory system, management support system, presented in Table VI.

The management has concluded that after three years of implementation, the expected improvements in the business haven't been achieved and that the ERP system is poorly implemented. Implementers wanted, due to fixed implementation costs, to implement the system quickly and therefore they had underestimated the role and the importance of medical practice that is required to get the system set up in accordance with the existing processes of medical practice. Implementer has tried to adapt processes found in hospital system to the ERP system, instead of adapting the ERP system processes to the hospital. Due to poor implementation, the hospital has lost at least 10% of annual revenue and was very close to bankruptcy [15].

The literature review has discovered a practical example of the introduction of an integrated hospital information system (IBIS) at University Hospital "Dubrava" in Croatia.

TABLE IV.   PS10 – PUBLIC SECTOR

Ref.	ERP Modules Implemented	ERP Manufact.
[22]	financial management, procurement, supplier order management, contract management and requsitions, human resources, payroll and employee/manager self service	New York-based Infor
[23]	SB (Basic System): Document and work flow management; SCI (Integrated Accounting System): Accounting and controlling ; HR (Human Resources)	SAP
[24]	HR	SAP
[25]	Accounting, Budgeting, Payroll, Human Resources, and Procurement	SAP R/3
[26]	Full ERP, The ERP system integrates all of the city's business functions, including procurement, payroll, finance, inventory and human resources	Oracle
[27]	financial, procurement, personnel, budget, inventory control, grants and project management wifh fully integrated document management and workflow	SAP
[29]	finance, sales	BAAN
[31]	financials, controlling, human resources, logistics. The software is to assist companies by providing support for sales, customer relationships, inventory, operations, financials and human resources.	Microsoft Dynamics Ax
[32]	budgeting solution	CGI - AMS Advantage ERP Suite
[34]	General Ledger, Purchasing and Workflow. These were complemented with Tyler's Payroll and Cashiering applications	Microsoft Dynamics AX 2012 core ERP

This example is described in two articles [44] and [14] stating that all modules are planned in an integrated hospital information system "Ericsson Nikola Tesla alliance" (company "Ericsson Nikola Tesla" from Zagreb with partners: "Grad" from Pula and "Adacta", "Samson", "HrPro" and "Vams" from Zagreb). It is expected to improve the overall system in the KBD:

• transparent monitoring of hospital operations,

• Fast and efficient invoicing costs

• Maintaining comprehensive costs under control.

The introduction of the ERP system was started in 2003 and in 2005 all modules were not introduced. Only complete system for administrative monitoring of patients has been implemented [44] presented in Table VI.. The project is currently in the phase of standstill.

Authors of the article Motivations Underlying the Adoption of ERP Systems in Healthcare Organizations: An Analysis from the "Success Stories" in their study identified 180 successfully introduced ERP systems in the field of health care in the world. From the perspective of the software manufacturer in this research, the largest market share has Oracle with 100 references , followed by SAP with 38, 37 references has Cerner, 5 references have all other manufacturers [30].

TABLE V. PS6 – MILITARY – DEFENSE

Ref.	ERP Modules Implemented	ERP Manufact.
[18]	Integrated Personnel and Pay System (IPPS-A),Global Combat Support System for tactical logistics (GCSS-Army), the Logistics Modernization Program (LMP), the General Funds Enterprise Business System (GFEBS).	GFEBS - SAP, GCSS-Army - SAP, LMP - SAP R/3, IPSS-A - PeopleSoft, Navy ERP - SAP R/3, GCSS-MC - Oracle, IPPS-Navy - PeopleSoft, DEAMS - Oracle, ECSS - Oracle, AF-IPPS - PeopleSoft
[17]	GFEBS, GCSS-Army, DEAMS, ECSS	GFEBS - SAP, GCSS-Army - SAP, DEAMS - Oracle, and ECSS - Oracle
[19]	human resources, controlling, logistic	SAP R/3
[20]	material management, procurement, asset management, budget planning, payment, and financial management	SAP R/3
[16]	SAP DFPS human resources, finance, operations and business processes, module for modeling units ISL - procurement, supply, logistics, equipment maintenance and ammunition.	SAP DFPS, AURA -ISL

Successful implementation (180) relates to 31 different countries, 92 were in North America (U.S. 89), 68 in Europe (UK 17, Germany 15, Netherlands 8 - all other 28), 12 implementations in Asia, 5 in Latin America and 3 in Oceania. The study noted that the following functionalities (modules) were implemented: 145 administrative systems, clinical information systems 38, 36 clinical support systems and 22 systems for patient management. Administrative systems have modules: accounting, human resources, payroll costs to diseases, material management.

TABLE VI. PS3 – HEALTH CARE

Ref.	ERP Modules Implemented	ERP Manufact.
[30]	multiple ERP systems	multiple manufact
[15]	patient management (appointments, registration, admission, discharge andtransfer);financial management (accounts payable, accounts receivable, general ledger andfixed assets); materials management (inventory and purchase); human resource (scheduling, training and payroll);•ancillary services (dietary, laboratory and pharmacy); and management information (reporting on and providing statistics on various issues).	SAP
[14]	planned: patient management (appointments, registration, admission, discharge and transfer); ancillary services (dietary, laboratory and pharmacy); Radiolgy IS, operations, intensive care; materials management (inventory and purchase); financial management (accounts payable, accounts receivable, general ledger and fixed assets); management information (reporting on and providing) implemented: patient management	Hospital information system "Ericsson Nikola Tesla alliance"

Clinical information systems have modules like emergency services, surgery, nursing services, etc. The clinical support system has modules like pharmacy, etc. The system for managing patients: patient admission, transfer and discharge of patients [30]. The research described earlier is focused on the motivation for the introduction of ERP systems in health care facilities, so that it was not possible to determine which modules were combined together from that article.

III. CONCLUSION

Based on the analysis of the articles presented, regarding the area of non-economic public services shown in Table I, it can be concluded that ERP systems have been introduced in the areas of education, health care, defense, and municipalities, regions and states to support the public administration activities. There were no articles related to non-economic public services in the field of culture, social services, justice, libraries, public safety and urban planning. With regard to the ERP systems classification prepared by the authors Jakupović Pavlic and Fertalj [9], it is evident that there is a full agreement between classifications and systems implemented in practice, and ERP systems are often introduced in the areas of education, public administration, defense and health. As seen from the analyzed articles, despite the fact that European legal regulations recognize some other non-economic public services [3], the implementation of ERP systems in those hasn't been accomplished yet. In addition, even ERP software manufacturers haven't classified such systems.

Some of the general definitions of ERP systems were described in articles [6], [7] and [8]. The articles [8], [10], [11] and [12] give a set of modules which should include ERP systems in education. Complete ERP systems in the field of health should include modules according to the authors [13], [14], [44] and [15]. ERP systems in the field of defense are described in the articles [16], [17] and [18].

Vrček and Brumec [6] in their paper display modules (functions) of ERP system and group them as business support, networking and value chain.

According to Spathis and Constantinides [51] and Spathis [52] research in organizations that have implemented ERP systems, prevalent modules were: finance and accounting, and management support systems for management and control. The authors conclude that organizations introduce ERP system beginning the modules of finance and accounting, with a desire to integrate the accounting processes.

In the field of public administration, according to the data from the articles [22], [23], [24], [25], [26], [27], [29], [31], [32] and [34] and the results obtained by the Microsoft and GFOA [28] and [33], it can be concluded that ERP systems have been introduced solely to support the business .

In the field of education, according to Tomičić-Pupek [8] 23 of the 66 higher education institutions in the United States introduced a full ERP. As seen from the articles of this research, a full ERP in the field of education is described in the articles [37], [41], [12] and [39]. ERP systems to support business operations are covered in the

articles [35], [36], [40] and [42] and it is shown that the institutions have introduced ERP to support the business. ERP systems with different modules that are in the value chain have established institutions that are described in [38], [43].

In the area of defense a full logistics and financial ERP systems were introduced, as described in the articles [17], [18], [16], [19] and [20].

In the field of healthcare according to a study by Poba-Nzaou et al., Described in the article [30] it is noted that in 180 implementations of ERP systems in 31 different country the following functionalities (modules) have been introduced: 145 administrative systems, 38 clinical information systems, 36 clinical support systems and 22 systems for patient management. The full ERP systems implementations introduced or planned in the area of healthcare were described in the articles [15] and [14].

It can be concluded that existing research shows that ERP systems in non-economic public services are generally introduced in the areas of health, education, defense and public administration.

In the area of Healthcare, the most common ERP modules were introduced to support the business processes, while a lesser extent represents modules of the value chain.

In the field of defense, exclusively full ERP systems have been introduced that cover the entire target area: logistics, human resources and finance.

Vrček and Brumec [6] define ERP system and conclude that ERP system is not intended for the implementation in one business function ("island"), but on the contrary, ERP system connects all business functions involved in performing the key processes. Justification for the introduction of the ERP system in the organization is questionable if this system does not include all the necessary modules for specific area from which the organization derives.

Based on the above, it can be concluded that in the area of non-economic public services like public sector, education, healthcare and defense, there is still some space for exploration, especially with respect to the implementation of ERP modules in the value chain of each area, taking into account the specifics with regard to the objectives of the organization and the level of development of the state.

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