Evaluation of Information Systems Curriculum in Portugal and Russia

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Abstract. The importance of Information Technology (IT) and Information Systems (IS) to organizations and the need for skilled professionals in the field is one of the most important challenges to universities. With the technological and organizational changes, IS education has been under continued adaptation, and higher education institutions have several difficulties in keeping the bachelor degrees curriculum updated. Several international organizations (ACM, AIS, BCS, IFIP, etc.) proposed for the last 40 years several curriculum guidelines, which are important to redesign the curriculum for survival in the current economic environment. The main purpose of this work is to compare Portuguese and Russian bachelor degrees with several standard curriculum on Information Systems proposed by recognized international organizations. The results obtained show the differences that exist between international curriculum guidelines and the bachelor degrees, and give us a perspective of the adequacy of the Portuguese and Russian curricula to the current requirements.

Keywords: Information Technology (IT) · Information Systems (IS)
IS education · IS curriculum

1 Introduction

With the development of information technologies (IT) and the explosive expansion in the use of IT by organizations, Information System (IS) education has been under continued adaption. In a field like IS that is rapidly changing, it is important for institutions offering undergraduate programs in IS to periodically evaluate their curriculum and make necessary modifications to meet the demand and requirements of industry [1, 2].

The importance of the quality of the information system graduates and information systems curriculum is a critical area. Then, the proper education of information systems graduates is becoming more critical and designing a consistent IS curriculum is a challenging yet necessary process for all educational institutions [3].

The work of IS curricula task groups began in the early 1970s and has continued for the past 40 years. The Association for Computing Machinery (ACM) has been a major

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Á. Rocha et al. (Eds.): WorldCIST'18 2018, AISC 745, pp. 498–507, 2018.
https://doi.org/10.1007/978-3-319-77703-0_49

organizer for these task groups including the first efforts in the 1970s. Other organizations, including AIS (Association for Information Systems), AITP (formerly DPMA), BCS (British Computer Society) and IFIP (International Federation for Information Processing), have aided model curriculum development [4–6].

The aim of this paper is to analyze the educational programs of the Portuguese and Russian higher education institutions, and analyze their compliance with current recommendations from educational associations. To study the curriculum of Information Systems, in Portugal and Russia, we used the analysis of the curricula of these higher education institutions and their comparison with recommendations from international associations of Information Systems and Technologies.

2 Importance of the IS

Information systems have become integrated, interactive "smart" tools used in all day-to-day operations and when making decisions in large organizations. From the economic point of view, the technology of information systems can be viewed as a production factor interacting with labor and financial resources, fulfilling their functions. If the cost of information systems falls, this is reflected in labor resources, which have a historical tendency to increase. Hence, using the microeconomic model of the firm, it can be shown that information technology can reduce the number of middle managers and clerks by automating their functions [7]. Information technology, especially when using computer networks, can help firms reduce transaction costs, allowing the use of internal sources, rather than referring to external partners [8].

2.1 IS Professionals

Practically, the activities of all companies require the use of both computer equipment and special programs. Any failure in the program, or even more so the system, can completely stop the work of the whole company, and only the IT specialist can help here to return to its working condition. Clear control of the situation, a quick explanation of the cause of the failure and its elimination, are capable to renew work of the company for a short time [9].

Every organization that uses computers needs the support of an IT specialist. Small companies can call different services when they get into trouble, but medium and large companies usually have their own IT staff to solve their daily problems. IT specialist helps in solving problems related to work, server, site, special programs. In addition, if necessary, he can quickly restore the efficiency of computer technology and other office equipment.

As the world becomes more and more dependent on computers, the demand for IT professionals grows very quickly. Required IT knowledge will increase with time. The importance of this profession is growing every day, and accordingly the number of vacancies increases. Therefore, the quality of education in information systems is so important.

With the constant change in the technology and organizations, the current programs do not deliver graduates with the skills to succeed in the IT industry.

The curriculum is the basis of the learning process. Real changes in education comes with changes in its content that teachers teach and students learn, and in the teaching methods that teachers use. Both curricula and instructions, in turn, form expectations about the types of educational outcomes that students should show up by the time they graduated from the school.

Accordingly, the quality of specialists graduated by a higher educational institution also depends on the content of the educational program. Therefore, it is especially important to keep the state of the educational program in accordance with modern requirements [6].

3 IS Curriculum Guidelines

Efforts to standardize the teaching of computer science deserve the closest attention. The most significant project in this area, of course, is the creation and updating of the document Computing Curricula ("Recommendations for Teaching Informatics in Universities"). The first version of Computing Curricula was developed by the Special Committee for the Education of the Professional Association of Association for Computing Machinery (ACM) and was published in 1968. In the 1970s, another professional society, the IEEE Computer Society, issued a similar document [4–6].

Technological development of the 1950–60's was a prerequisite for the introduction of information technologies in business, as well as the emergence of academic communities engaged in research and training of specialists in this subject area. In Germany and Austria at the same time began to form a community on "economic informatics". Despite the terminological differences, the subject of the study was general - information systems in economics. Understanding the terms "management information systems" and "economic informatics" as synonyms applied to the field of scientific research in question, we will use the name "economic informatics" (EI).

The beginning of the formation of the North American Community for EI was the creation in 1968 of the Research Center Management Information Systems (MISRC) at the School of Management of the University of Minnesota. The center was organized with financial support and direct participation of more than 20 American companies that had international fame and invested in information systems. Four years later, the Association for Computer Science ACM published a curriculum model for the EI specialty at the first stage of higher education, as well as for the same master's and doctoral programs. In 1974, Gordon Davis - the founder of MISRC - published the first and subsequently widely used in the universities textbook "Management Information Systems". To achieve high quality training of EI specialists at universities in the US and Canada, research was organized on the formation of the theoretical foundations of this new subject area and authoritative scientific journals were created to publish the results. The first such magazine, MIS Quarterly, appeared in 1977. To organize cooperation with colleagues from around the world, the North American Community for EI organized the first international conference "International Conference on Information Systems" (ICIS) in 1980 [5].

The German-speaking community for EI, which began to form around the same years as in North America, went through similar stages. In the 1990s, the ICIS International Conference had become a center for cooperation between academic communities on EI from all over the world. In 1994, on the initiative of the conference participants, the International Association for Information Systems (AIS) was established [10].

3.1 Model Curriculum and Guidelines for Degree Programs in IS

We have used as a comparative basis three standard curriculum on Information Systems proposed by international professional organizations. These standards are the latest available plans of recommendations from international organizations involved in the preparation of such plans and developments based on them. In our case, Curricula were used for undergraduate programs in information systems from AIS, ACM, IEEE and the work developed on their backdrop [4, 6].

IS 2010 (and latest version: IS2015)
The Association for Computing Machinery (ACM) and Association for Information Systems (AIS) has proposed a model curriculum and guidelines for undergraduate degree programs in information systems. IS 2010 is the latest in a series of standard curriculum for a bachelor's degree in information systems (at the time of writing, version 2015 was not available for public access). It is based on the foundation formed by this early work, but this is a serious revision of the curriculum and includes several significant new characteristics. IS 2010 is the third joint project of ACM and AIS. Both organizations have a worldwide membership, and therefore IS 2010 includes elements that make it more versatile than its predecessors. IS 2010 is not directly related to the degree structure in any environment, but it contains recommendations on the main content of the curriculum that should be present everywhere, and proposals for possible optional courses and career paths based on them [11].

BISE
This model presents the guidelines for business education and information systems (BISE) in higher education institutions, which were developed by a working group comprising experts in the field, both from academia and from practice. The guidelines contain the results of training in undergraduate and graduate programs the key subject, social and personal skills required by BISE graduates. In addition, the relevant professional profiles, specific skills required, as well as basic and typical training content for BISE training are described. In addition, detailed recommendations are provided for the development of curriculum and by-laws of Bachelor and Master in BISE, business administration and computer science. The presented recommendations serve several purposes. Providing general guidelines for the education of BISE aims to support the personnel responsible for developing the curriculum and assist students in choosing programs and careers [10, 12].

CS2013

ACM and the IEEE-Computer Society have a long history of sponsoring efforts to create international curriculum for undergraduate computation programs for about a decade, beginning with the publication of Curriculum 68 more than 40 years ago. As the field of computation has grown and diversified, it also has recommendations for curricula, and now in addition to computer science there are curricula for computer engineering, information systems, information technology and software development. These volumes are regularly updated to maintain modern and up-to-date computer programs. The "Computer Curriculum 2013" (CS2013) is a comprehensive edition which include an overdetermined amount of knowledge, the result of rethinking the basics required for the curriculum in the field of computer science [6].

The development of curricula for computer science has always been a challenge, given the rapid development and expansion of the field of activity. The growing diversity of topics that may be relevant to education in the field of computer science, and the increasingly integrated integration of computing with other disciplines pose difficulties for these efforts. Particularly difficult is the balancing of actual growth with the need for realistic and realizable recommendations in the context of bachelor's studies. As a result, the CS2013 Steering Committee has made significant efforts to engage the wider informatics community in dialogue to better understand new opportunities and local needs, and to identify successful models of curricula, both established and new [5].

4 Case Study: IPB (Portugal) and KubSAU (Russia)

In the paper, we will perform an analysis between KubSAU (Bachelor in Information Systems and Technologies)/IPB (Bachelor in Management Informatics) and international guidelines. The analysis will be carried out based on the undergraduate curricula of the two universities and the programs of recommendations from international organizations that we considered earlier.

5 Analysis and Results

The main part of the analysis is based on the analysis of the conformity of curricula of higher educational institutions with the recommendations of international organizations. The analysis should be carried out for the correspondence of disciplines and themes that are contained in the disciplines.

Some plans involve sub-themes, which are analyzed in the same way. Upon completion of the analysis, a correspondence table is drawn up, where the percentage indicates how well the program of recommendations has been implemented for each subject. As a result, we will start from these results, drawing conclusions and final recommendations. The analysis is carried out according to the procedure shown in Fig. 1. Next sections shows the results from the analysis.

Disciplin	Topic	Subtopic	Topic	Subtopic	Topic	Subtopic
Algorithms and Complexity	Basic Analysis	Differences among best, expected, and worst case behaviors of an algorithm	x	x	x	x
		Asymptotic analysis of upper and expected complexity bounds		x		
		Big O notation: formal definition		x		x
		Complexity classes, such as constant, logarithmic, linear, quadratic, and				x
		Empirical measurements of performance				x
		Time and space trade-offs in algorithms		x		x
		Big O notation: use				x
		Little o, big omega and big theta notation				
		Recurrence relations				x
		Analysis of iterative and recursive				x
		Some version of a Master Theorem				
	Algorithmic Strategies	Brute-force algorithms				
		Greedy algorithms				

Fig. 1. Start graph of analysis between IPB, KubSAU and CS2013

5.1 IPB/KubSAU vs IS2010

Figure 2 shows the relevance of university curricula to the recommended plan from IS2010. As a result of the analysis between KubSAU, IPB and IS2010, we see that the Polytechnic Institute of Bragança is more in line with the recommendation program. IPB corresponds in general to 50%, KubSAU by 34%.

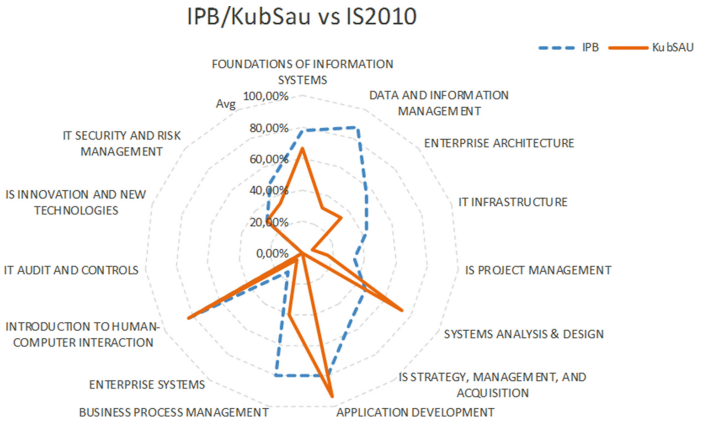

Fig. 2. The result of the analysis between KubSAU, IPB and IS2010

In the results, we see that subjects such as IT audit and controls and IS innovation and new technologies have not been reflected in any of the programs of higher education institutions. Most of the recommended program corresponds to such items as: foundations of information systems, introduction to human-computer interaction. In IPB, the plan for data and information management, business process management is well executed, objects such as enterprise architecture, is strategy, management, and acquisition are well executed.

In higher education institutions, the program of such subjects as: it infrastructure, is project management, enterprise systems, it needs security and risk management. IPB followed to consider the finalization of such items as systems analysis & design. KubSAU followed to consider the finalization of such items as data and information management, enterprise architecture, business process management. It is recommended to introduce missing subjects as separate disciplines.

5.2 IPB/KubSAU vs CS2013

Figure 3 shows how the KubSAU curriculum and IPB curriculum differ against the background of the recommendations for the educational program from CS2013. As a result of the analysis between KubSAU, IPB and CS2013, we see that the Kuban State Agrarian University is more in line with the recommendation program. KubSAU corresponds in general to 51%, IPB by 35%. In the results, we see that subjects such as Systems Fundamentals and Social Issues and Professional Practice have not been reflected in any of the programs of higher education institutions.

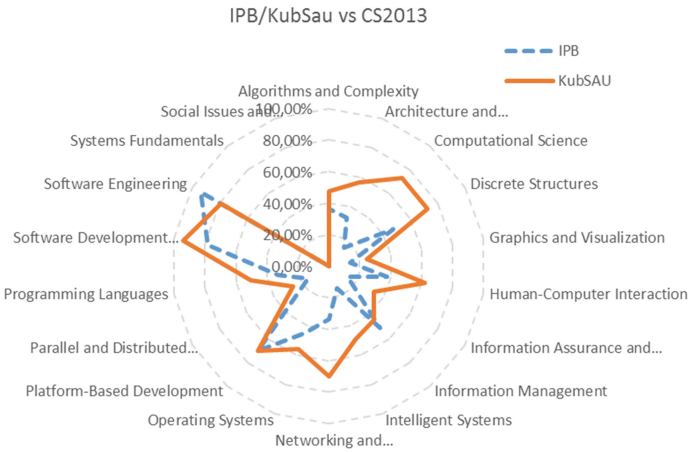

Fig. 3. The result of the analysis between KubSAU, IPB and CS2013

Most of the recommended program corresponds to such items as: Platform-Based Development, Software Development Fundamentals, Software Engineering. In IPB, subjects such as Information Management, Discrete Structures are well executed. In KubSAU the programs on subjects Computational Science, Discrete Structures, Human-Computer Interaction, Networking and Communication were well executed, the plan on Algorithms and Complexity, Architecture and Organization, Operating Systems, Programming Languages, Intelligent Systems was well executed.

In higher education institutions, the programs of such subjects as: Graphics and Visualization, Information Assurance and Security, Parallel and Distributed Computing, need to be improved. IPB followed to consider the finalization of such items as

Algorithms and Complexity, Architecture and Organization, Computational Science, Human-Computer Interaction, Intelligent Systems, Networking and Communication, Operating Systems, Programming Languages. KubSAU followed to consider the finalization of such items as Information Management. It is recommended to introduce missing subjects as separate disciplines.

5.3 IPB/KubSAU vs BISE

The following graph shows the relevance of the IPB curriculum to the recommended educational program plan from BISE. On the last graph, you can see how the KubSAU curriculum and IPB curriculum differ against the background of the recommendations for the educational program from BISE (Fig. 4).

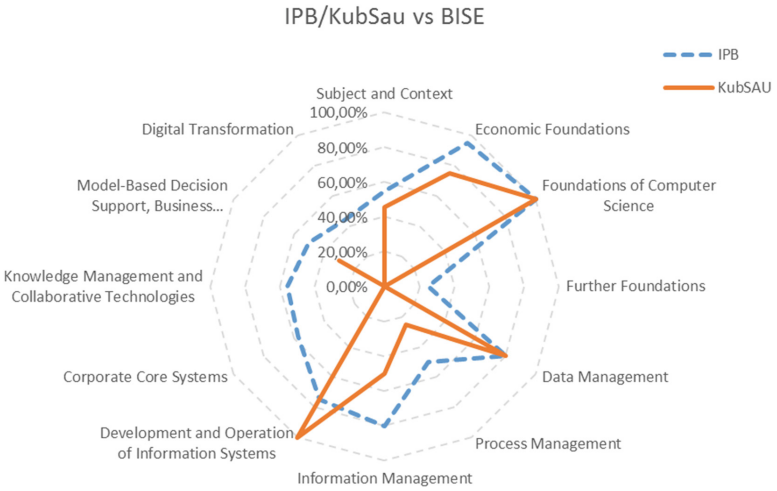

Fig. 4. The result of the analysis between KubSAU, IPB and BISE

As a result of the analysis between KubSAU, IPB and BISE, we see that the Polytechnic Institute of Bragança is more in line with the recommendation program.

IPB corresponds in general to 64%, KubSAU by 42%.

In the results, we see that the discipline Foundations of Computer Science is fully consistent in each of the higher education institutions. Also, the most recommended program corresponds to such subjects as: Economic Foundations, Data Management, Development and Operation of Information Systems. Objects such as Information Management are well executed in IPB, well-built programs of such subjects as Corporate Core Systems, Knowledge Management and Collaborative Technologies, Model-Based Decision Support, Business Intelligence, and Analytics. In KubSAU, the Information Management programs are well executed.

IPB followed to consider the finalization of such items as Further Foundations, Digital Transformation. KubSAU followed to consider the finalization of such items as Subject and Context, Process Management, Model-Based Decision Support, Business

Intelligence, and Analytics. Also, KubSAU is required to enter non-existent items from the recommendation plan, which are missing at the moment: Further Foundations, Corporate Core Systems, Knowledge Management and Collaborative Technologies, Digital Transformation.

5.4 Global Analysis

The results shows that both institutions have several differences with the curricula guidelines proposed by credible professional organizations. Of course, the educational programs for teaching bachelors in the field of information systems of universities are somewhat based on the needs of the local labor market and local trends, but with the increase in labor mobility, the role of international norms in educational programs is growing more and more, and higher education institutions should rely on them.

KubSAU showed its lag in two programs of three (IS2010, BISE). Both these programs are based on the work of the Association for Information Systems. The lag in these programs explains that the educational programs at this university are built according to FGOS standards, which are more focused on the Russian market and have only recently begun integration between domestic norms and European ones. IPB has lagged behind as a result of the analysis of the recommendation program for the formation of information systems CS2013, based on the development of ACM and IEEE computer society.

It cannot be said that the educational program of a university is worse or better. As a result of the research, we see that the IPB and KubSAU educational programs follow slightly different ideas of how an undergraduate education program should be organized in information systems. But basically, they are identical and using the results of research in modernizing educational programs we can supplement existing plans by making trained bachelors readier for changes in information systems and technologies.

6 Conclusions

A comparative analysis has been made between education systems in the information systems of Russia and Portugal, and the recommended plans of educational programs from international associations. The discipline of information systems (IS) is facing greater challenges now than at any time. The university curriculum in information systems is reviewed and frequently modified in higher education institutions to reflect changes in this field. It is important to make the necessary changes to the IS curriculum to make programs challenging and better to prepare graduates for today's labor market.

The study of the curriculum shows the differences in each program. It is also statistically shown that these programs differ depending on the main credit courses and elective courses, regardless of accreditation. The introduction of undemanding elements into curricula will help to improve the quality of education.

This will give students the experience and the possibility of finding employment after the completion of the program. These classes can be an additional course of programming, computer forensics, an extended database, advanced network management or the promotion of a web page.

The result of the study can help programs move to developing a more coherent curriculum. The result of this study is useful for universities when developing or changing an IS program. More detailed studies will be required to better understand the deviation disclosed in this paper. The results can be used to modernize the curricula of Russian and Portuguese universities in the light of expanding international cooperation. However, this analysis should be expanded to other institutions. In the future, the work can be expanded as an analysis of the differences between the educational programs of information systems in Russia (FGOS), Portugal and other countries in Europe, America to identify their strengths and make recommendations for their improvement.

Acknowledgments. UNIAG, R&D unit funded by the FCT – Portuguese Foundation for the Development of Science and Technology, Ministry of Science, Technology and Higher Education. Project no. UID/GES/4752/2016.

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