Building an Information System for
a Higher Education Register in Croatia

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Abstract

Higher education in Croatia has a long tradition; there are many strong HEIs with a large student population, and higher education is recognised as essential for the country's development. Public HEIs are developed based on program financing and contracting between HEIs and the Ministry of Science and Education to support economic needs by educating needed professionals. However, reporting and measuring key performance indicators and, finally, recognition or lack of concrete results are missing in this process. One of the primary reasons for that is a lack of a register of students, teachers and diplomas that would enable accurate and easy reporting, data analysis and tracking of developments and trends. The register should also enable other informed decision-making and the creation of policies and measures based on the evidence.

Building an Information System for Higher Education Register in Croatia started in the middle of 2022 and should last for three and a half years. In this paper, we describe the objectives that drive the project, list major information systems recognised as the primary data sources for the Register, and provide basic concepts covered during the system design. Also, we present, in short, a development approach that will drive the project of building the information system for the HE Register. Current status and plans are provided briefly in conclusion.

1 Introduction

Higher education in Croatia supports university and professional study programs (binary system) at different qualification levels (5, 6, 7, and 8) that correspond to the European Qualifications Framework. University studies cover all three cycles, and professional studies cover only the first two. (AZVO - Study programmes in Croatia, 2023)

In total, Croatia has 133 higher education institutions located in all parts of the country. Its largest university is the University of Zagreb, with over 75,000 enrolled students - making it the largest university in South-Eastern Europe. Founded in 1669, the University of Zagreb is also the oldest in the region. (Study in Croatia at Glance, 2023)

From the point of financing, there are all types of public, government-financed and private higher education institutions. For the students that study at public institutions, additional student benefits are provided to more than 140.000 active students per year. Benefits consist of government-financed student restaurants, dormitories and cheaper public transportation. Also, government scholarships based on socioeconomic status and for the deficit professions are given to more than 10.000 students each year. (ISVU - Pregled sustava, 2023)

International students studying in Croatia for a shorter time or the whole study bring additional heterogeneity into the system.

We can say that higher education in Croatia has a long tradition; there are many strong HEIs with a large student population, and higher education is recognised as essential for the country's development. The development of public HEIs is based on program financing and contracting between HEIs and the Ministry of Science and Education to support the economic needs of higher education. However, reporting, measuring of key performance indicators and eventually recognition of concrete results are lacking in this process. One of the primary reasons for that is a lack of a central register of students, teachers and diplomas that would enable accurate and easy reporting, data analysis and tracking of developments and trends. The central register should also enable other informed decision-making and the creation of policies and measures based on evidence.

Having all that in mind, as part of the more extensive digitalisation program in higher education, a project of development and implementation of the Croatian higher education register started in 2022. The project should last for three and a half years. Its goal is to build the central information system for the higher education register in Croatia (ISeVO – *Informacijski sustav evidencija u visokom obrazovanju*). The register should contain data about institutions, study programs, enrolments, students, diplomas and teachers. Once built and in function, it should become a single source of truth for various processes in the higher education system and related areas.

2 The objective of building the Information system for the Higher education register

The objective of building ISeVO - the information system for the higher education register (later in text HE register), is to establish a sole system of accurate, complete and reliable information that will form a foundation for decision-making on all levels of the higher education system. It should also become a basis for tracking, reporting and analysis, as well as planning and predicting in higher education. (Milanović, 2022) The latter will enable systematic monitoring and evaluation as well as goal recognition of the program financing. Systematic monitoring and regular evaluation should increase the efficiency of HEIs and usage of public funds, ensuring prerequisites to accomplish more relevant education of better quality and functional integration of higher education institutions.

In particular, ISeVO will help with the following:
-      strategic planning and argument-based policy governance of higher education based on data and key performance indicators;
-      operational management of the higher education system;
-      better written and digital presentation of country potential, the potential of higher education institutions and related individuals;
-      the process of accreditation and reaccreditation of institutions in research and education;
-      the preparation of documentation needed for elections, re-elections and advancements of the teachers in higher education;
-      cooperation of economy and higher education;
-      the attraction of Croatian or international students;

- the preparation of materials for publishing regular or jubilee publications of individual institutions.

Finally, when we observe and analyse the information landscape of the higher education system in Croatia, the lack of a central information system for higher education is evident. It should be the central reference system that all interested parties can use, and its building should significantly improve data quality in higher education and science in Croatia.

3 Information landscape of higher education in Croatia

To enable a better understanding of the development plan and data flow for the HE Register, we present here the current and most important information systems in higher education in Croatia that will be integrated with ISeVO and will be significant data sources for it. These information systems are presented in Figure 1 concerning their usage and role during studying or on a student roadmap. Specifically, when in the student roadmap, they play a role or collect data about students and related events or entities (enrolments, courses, exams, grades and graduations).
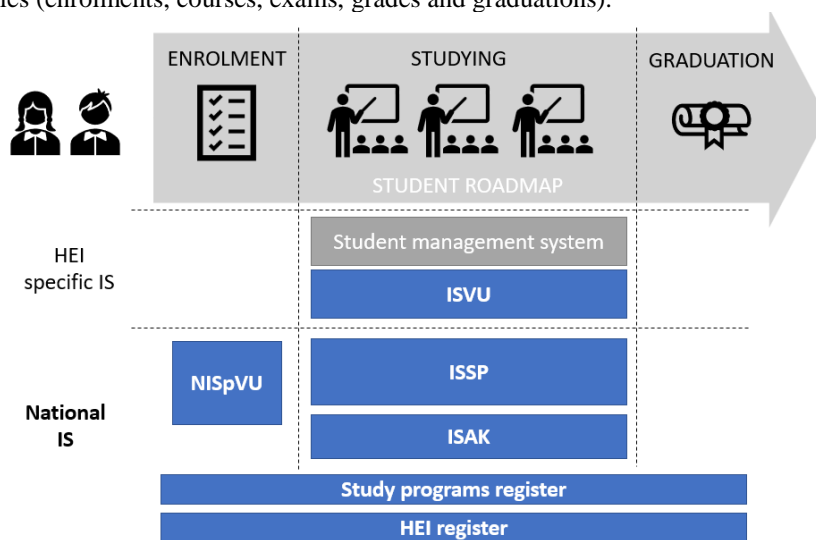

Figure 1 Major current information systems in higher education in Croatia

3.1 ISSP & ISAK – Information System of Student Rights and Information System of Academy Cards

The information system of student rights (ISSP – *Informacijski Sustav Studentskih Prava*) (ISSP & ISAK, 2022) was created 25 years ago, and its original purpose was to enable and monitor the financing of student restaurants. Everything is based on the rules for calculating the amount students can spend in restaurants and tracking and reporting the number of meals sold. This system maintains and executes the rules for calculating student rights daily. The system contains data about all students in Croatia and is currently used as the data source for students and various reports because there is no better data source. It is also a data source for many external systems with REST API as a technology used for integration. It is planned to move the calculation of student rights from ISSP to ISeVO and switch integration with external systems to ISeVO instead of ISSP.

The information system about student cards (ISAK – *Informacijski Sustav Akademskih Kartica*) is closely connected to ISSP and enables issuing and managing student cards as its central function.

3.2 ISVU – Information system for HEIs

The information system for HEIs (ISVU – *Informacijski Sustav Visokih Učilišta*) (ISVU, 2022) is a national student management system. It enables HEI to manage data about students, teachers, courses, programs, plans, enrolments, exams, student mobilities and many others. The system is owned and financed by the Ministry of Science and Education and is used individually by HEIs free of charge. Currently, it is used by more than 110 HEIs in Croatia, and all but one public HEI uses ISVU. It is the major data source for building the HE Register.

3.3 NISpVU – National enrolments information system

National enrolments information system (NISpVU – *Nacionalni informacijski sustav prijave na visoka učilišta*) (NISpVU - Postani student, 2022) supports a process of enrolment for undergraduate and graduate studies in Croatia. It covers steps from the application of students for the state graduation subjects, insight into the results of state graduation, application to particular HE programs, results of the application and final right to enrol to the HEI.

3.4 Higher Education Institutions Register

Higher Education Institutions Register is a software module in the CroRIS – Croatian Research Information System (CroRIS - MZO Upisnik ustanova, 2022). The module supports the registration of higher education and research institutions due to the considerable overlapping of the data set maintained for those entities. The Ministry of Science and Education manages the data, which will be one of the foundation bricks in ISeVO, together with the Study Programs Register.

3.5 Study Programs Register

Study Programs Register is a software module implemented as part of the information system for the Register of Croatian qualification framework (ISRHKO – *Informacijski sustav Hrvatskog kvalifikacijskog okvira*) (Upisnik studijskih programa, 2022). Study Programs Register is also one of the building blocks for ISeVO.

4 System design

The system design was based on the experience of designing and building other information systems and following good practices in software engineering (Pressman, 2001). During that process, various components were considered, like stakeholders and end-users of the system, business processes that need to be supported, and external information systems that will be integrated with the new system. The design also considered the architecture and security requirements, data protection requirements, and many more. All requirements and design decisions were compiled and documented in a design, architecture and implementation document. This document was verified with the representatives of the stakeholders. It will serve as a basis for developing and building this information system.

This chapter presents an overview of major components from the business perspective.

4.1   User groups

Eight different groups of users were recognised based on their usage of the system and access rights, i.e. their business needs. They are the Ministry of Science and Education, government agencies, higher education institutions, and legal entities that work with students, students, enrolment candidates, graduates (ex-students) and the public.

In particular, it is planned that students have access only to their data (read-only rights), HEI's users can view and edit HEI and their students' data, and the Ministry of Science and Education have access to the whole system. The bird-view notion of the data organisation is shown in Figure 2.
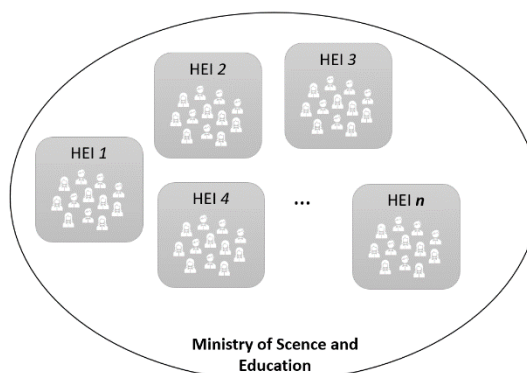

Figure 2 High level idea of the data organization

Legal entities that work with students can access the part of the system related to their services. Also, part of the system will be publicly available to anonymous users, which should cover general reports and information attractive to the public about the higher education system.

4.2   Main processes

The information system for the HE Register will contain data about many entities and procedures in higher education. Processes that will support all that and which should be developed in the system can be organised into three main groups:

- Data collection, delivery and storage

- Calculation of student rights

- Analysis and reporting

Data collection, delivery and storage

HE Register is built by storing data about higher education by collecting it via software application interfaces of other information systems used in higher education, as mentioned earlier in section 3. It is anticipated that processes based on REST API technology will be developed and implemented for these particular systems. These processes will be run automatically and regularly, including data quality checks and validations before storing the data in the system.

There may be cases when data cannot be found in one of those generally used systems, e.g. HEI is using their student management system and not ISVU. Then, the REST API interface for data delivery will be available, and data should be delivered to the system through that interface. The by-law will regulate the frequency of data delivery, and the responsibility to deliver data will lay with the owner of the primary data source (i.e. HEI).

A third way of delivering data to the HE Register is by manual input in web applications that will be part of the system developed for that purpose. This manual data input will happen for particular cases and for a smaller amount of data that needs to be collected. It is also an undesirable way of delivering data to the HE register, but it needs to be available.

Calculation of student rights

Student status is checked daily according to the rules specified in the connected by-law to enable the usage of benefits provided for regular students in Croatia, as mentioned in the Introduction. The result of this process is used in student restaurants, agencies for work, transportation services, libraries, HEIs' information systems and all other stakeholders that need the information.

This process is part of the ISSP (Information system for student rights), initially designed as an information system for student provisions 25 years ago. Having all the data needed for the calculation stored in the HE register, it is logically imposed to implement the process for the calculation in the same information system and to provide only the results to ISSP. Reengineering and modernising the existing system and returning it to its original purpose will be possible after that.

Analysis and Reporting

Processes that support analysis and reporting are a natural part of the system as one of the main objective of the development of the HE Register is building a source of accurate, complete and reliable information.

Here we bring only a couple of the reporting and analysis processes that were recognised during the design of the system, and that must be supported:

- Reporting about students, their studies and diplomas;

- Reporting for reaccreditation of HEIs and control of delivering of study programs;

- Realisation and verification of student rights;

- Reporting on services for student benefits;

- Monitoring the teaching load of teachers in the higher education system;

- Verification of diplomas and acquired academic and professional titles and academic degrees.

4.3   Data model and subject areas

After understanding and analysing the processes that must be implemented in ISeVO, we focused on the principles and fundamental characteristics the data model needs to follow to have a stable and reliable information system for the HE Register. The essential characteristics for building a data model for ISeVO are subject orientation, integration, time variance and nonvolatility.

The subject-oriented data model means that data is organised by main business subjects rather than business processes or functions. (Pressman, 2001) Specifically, the HE register will not contain all available data about some student or event. However, it will contain the most important data organised and grouped by subject areas. These subject areas correspond to the specific registers described in the related by-law and are organised to enable more straightforward data analysis and reporting.

Some entities in different subject areas can be the same in the real world but have different roles in the different subject areas and are described with different data attributes. That means entities in different subject areas must be uniquely identified to enable a consistent view of the HE system. For example, the same person can appear in Enrolments, Students, Diplomas and Employees. This person must have a unique identifier to connect all the dots (data) about her/him. Figure 3 shows subject areas in the ISeVO data model.
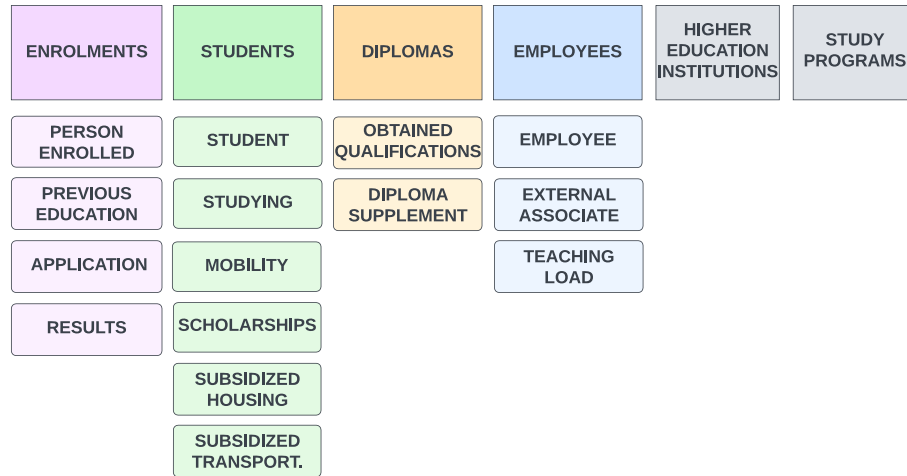
Figure 3 Subject areas in the HE Register data model

The main entities and relations are shown on a separate ER diagram prepared for each subject area. This ER diagram is a starting point for defining a detailed data model for each subject area.

4.4 Modules of the HE Register

The information system for the HE Register will be assembled out of separate software modules. Different software modules will be built for the end-users and system administrators. Other modules will run as regular batch jobs on the server. Concerning the recognised functionalities and user interaction, ISeVO modules are divided to:
-      Web applications for the end-users accessible only through web browsers,
-      Server-side applications for integration with other systems and batch jobs.
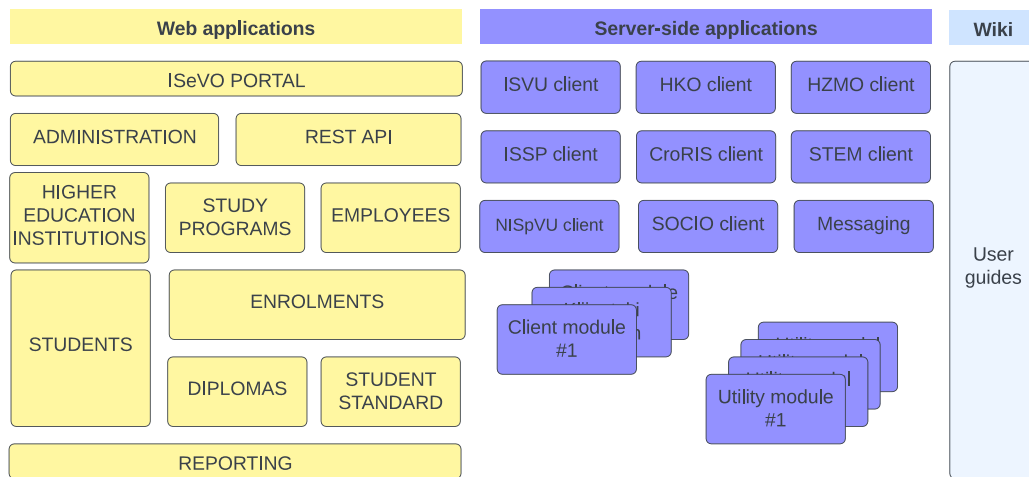Figure 4 gives an overview of software modules organised by functionality and mode of operation.

Figure 4 Overview of ISeVO software modules

ISeVO user interface should act as a portal to the registers in higher education. It will provide access to data logically grouped and based on interconnectivity and related processes. From the end-user

perspective, the only way to access the HE Register will be through a web browser on the unique web address.

The starting point of the user interface is a portal's home page that should be informative, offer direct links to the essential data and processes, and provide attractive summary information from the HE system. It should also retain simplicity and user-friendliness. Each system part (module) should have navigation to the other related parts and a home page. For each module, part of the functionalities will be publicly available (unrestricted access to the data), and authorised functionalities dependent on the user privileges in the system for a particular module.

5   Development Approach, Priority of Deliverables and Risks

5.1   Development Approach

The development and implementation of the information system for the HE register will be done in phases following the agile approach to the software development and the need to provide valuable deliverables to the users in regular time intervals and before the end of the project (Ambler, 2022). The basic idea, while planning the development of the ISeVO, is to enable the quick delivery of valuable parts of the system. That may mean the delivery of modules with limited functionality. Software modules will be upgraded and extended constantly with additional features. Also, we aim to have the end-users and stakeholders involved in the project all the time.

The project's first deliverable was a design document: "Conceptual and Implementation Solution for the Information System for the Higher Education Register "(Milanović, 2022). The document was prepared by the University Computing Centre of the University of Zagreb – SRCE and confirmed by the working group for ISeVO. This document defines the high-level scope of the project and sets some technical and design requirements for the information system that needs to be built. It was also a prerequisite for the public procurement procedure needed to acquire programming services from the external company. We are currently in the public procurement procedure and hope to finish it during the summer and immediately start with the system's building. As part of the preparations, we focus on the requirements analysis and preparation of functional specifications.

Besides building a new information system, the project of building the HE Register also includes modifications and adjustments to the existing information systems mentioned in Chapter 3. The plan is to build software modules one by one, starting with the core module that will contain significant functionalities and serve as a foundation for the whole system and then build on top of that, starting with the following modules: Portal, Higher Education Institutions, Study Programs, and Students.

5.2   Priorities of Deliverables

During the design document preparation and the continuous conversation with the stakeholders (Ministry, Agency and Higher Education Institutions), we have identified priorities to work on first and which should become deliverables as soon as possible.

In order of recognised priority, these are:

-       Connect data about higher education institutions listed in the official register with the data about study programs in the separate register of the study programs

-       Development of a process for the calculation of student rights and migration from ISSP to ISeVO

-       Provide reliable data sources for the analysis of the higher education system, i.e. number of students, number of graduates per various parameters – HEIs, fields, and citizenship.

- Register of diplomas where all new diplomas will be registered to enable central verification of diplomas. The plan is also to create an archive of diplomas for the last 40 years, and the ISeVO should be able to support that.

5.3 Project Challenges and Concerns

As part of the project preparation, we have done a high-level risk analysis, and the following things were recognised as major challenges that we need to be aware of, and that might cause delays:

- Employment of programmers for the core project team,

- Implementation of the public procurement procedure for external programming services,

- Existence of a valid and transparent legal framework that serves as a foundation for the definition of specific requirements to be met,

- Decision-making from the main stakeholders (Ministry) and obtaining the necessary information on time,

- Heterogeneity of the higher education system,

- General software development challenges include time management, communication, scope creep, low-quality code and technology changes.

6 Conclusion

At the time of writing this paper, the public procurement process for external programming services is in progress. Usually, this process lasts for a couple of months, and hopefully, without any complications, it will be finalised during the summer of 2023. Because of that, the majority of software developers and external resources will be able to join the project in the late summer or beginning of autumn.

In the meantime, we are doing the business analysis and gathering user requirements for the system that will be built. Also, functional specifications are written and stored on the collaboration tool (Confluence), which will be used during the project. We anticipate that these preparations will enable a rapid programming start, better utilisation of external resources, and faster delivery of specific project results.

Additionally, we are involved in preparing the related by-laws that should regulate the operation of the HE Register.

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8   Author Biographies

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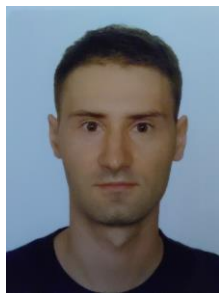
Matija Kranjčina is a software developer and project leader at the Software Infrastructure Department of the University of Zagreb, University Computing Centre. He has over ten years of experience designing and developing higher education applications. Since 2017, he has been working as leader of the Mozvag project - an information system supporting quality assurance procedures implemented by the Croatian Agency for Science and Higher Education.