Success story – 25 years of digitalization of higher education institutions in Poland

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Abstract

The year was 1999. Polish higher education institutions – HEIs (14 in number), with several European partner HEIs, started the *Tempus JEP* (*New Educational Tools*) project. The goal was to purchase or develop a student information system (SIS). At this time, only one Polish university had a system of this type with a central database, but it was not suitable for deployment in other HEIs. Other institutions either had separate systems in each dean's office, without a common database, or they had nothing and used Excel on an ad hoc basis. The conclusions from market recognition were not optimistic – there was no central system that could be purchased for everyone with the money available in the project. What to do?

The year is 2024. Polish HEIs (96 in number) are gathered in the *University Centre for Informatization* (MUCI) consortium[†] and develop a student information system *University Study Oriented System* (USOS)[‡] for their use. This is a non-profit venture. The USOS system supports all study-related processes, is integrated with other domain systems at the university, and with many central systems in Poland, including systems of the *Ministry of Science and Higher Education* (further referred to as Ministry), as well as with European networks exchanging data on student and staff mobility (EMREX[§], Erasmus Without Paper – EWP[**], eduGAIN[††]).

How did it happen that almost 100 HEIs, differing in profile, scientific category, size and form of ownership, jointly develop a tool necessary in everyday operation? This endeavor covers approximately 50% of public HEIs and 23% of all HEIs in Poland, about 67% of students of public HEIs and 47,35% of students of all HEIs in Poland (data is from December 2022, the numbers are higher in 2024), including majority of the top twenty most prestigious Polish HEIs.

The purpose of this article is to present the USOS system and the MUCI consortium, as well as the path that MUCI and USOS have taken between 1999 and 2024. I hope that readers will find inspiration in this story, both at the organizational and technical level. The history of USOS and MUCI shows that taking challenges pays off.

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[†] https://muci.edu.pl
[‡] https://usos.edu.pl
[§] https://emrex.eu/
[**] https://erasmus-plus.ec.europa.eu/european-student-card-initiative
[††] https://edugain.org/

1 Introduction

Developing software for 25 years for a growing number of institutions is a big challenge. What determines the success of the project? After all, it is not only about the skills of programmers and developers – there is no shortage of such in commercial companies. The price? To some extent yes, but it is not the decisive ingredient. No one will buy a car, even the cheapest one, if there is a hint of risk that the car will stop working right after the warranty period ends. The quality of the software, its stability, the guarantee of development and long-term support are important factors. What else? Let's try to find the answer to this question by following 25 years of development of the USOS system within the MUCI consortium.

2 Milestones and key functionalities

2.1 Milestones in the development of USOS and MUCI

The Tempus NET project was run in 1999-2001. When it became clear that it would not be possible to purchase a ready-made student information system with a central database for all participating HEIs, the decision was made to create such a system ourselves. The University of Warsaw (UW)[‡‡], the coordinator of the Tempus JEP project, undertook to organize the IT team, and the University of Łódź (UŁ)[§§] offered to participate in the development work. Soon, the first forms created in Oracle Forms technology and reports created in Oracle Reports, running on the Oracle database, were developed. Oracle database licenses were purchased for partner universities. At the end of the project, the system – called USOS for *University Study Oriented System* – was operating on a pilot basis in one dean's office of UW and one dean's office of UŁ. After 25 years, we already know that the choice of the Oracle database was the right one (although if the choice were made now, we would choose PostgreSQL). The choice of Oracle Forms and Oracle Reports – technologies from the Rapid Application Development group – was the right one in 2000 and worked well in the early stages of USOS development (later years showed that due to the end of support for this technology, it was necessary to look for another solution).

When funding from the Tempus JEP project ended, the *Conference of Rectors of Polish Universities* (KRUP)[***] established the *Inter-University Center for Informatization* (MUCI) to supervise further development of USOS, financed by university fees. The MUCI secretariat is located at the Adam Mickiewicz University in Poznań (UAM)[†††], the director of MUCI is prof. Marek Kręglewski[‡‡‡] (former UAM vice-rector), the IT team for the development of USOS was established at UW, and its leadership was taken over by dr Janina Mincer-Daszkiewicz[§§§], at that time the deputy dean of the Faculty of Mathematics, Computer Science and Mechanics UW (MIMUW)[****]. In 2021, MUCI celebrated its 20th anniversary (presentations and videos from the birthday conference are available online[††††]).

Various USOS subsystems were successively created. The history of the system can be traced by the EUNIS congresses[‡‡‡‡] at which USOS was presented every year (some articles are omitted):

[‡‡] https://www.uw.edu.pl
[§§] https://www.uni.lodz.pl
[***] https://www.krup.edu.pl
[†††] https://amu.edu.pl
[‡‡‡] https://pl.wikipedia.org/wiki/Marek_Kr%C4%99glewski
[§§§] https://pl.wikipedia.org/wiki/Janina_Mincer-Daszkiewicz
[****] https://www.mimuw.edu.pl
[††††] https://urodzinymuci.usos.edu.pl
[‡‡‡‡] https://eunis.org/events/eunis-congress

1. 2002 (Porto), *Student Management Information System for Polish Universities*.
2. 2003 (Amsterdam), *Deploying University Study-Oriented System at Polish Universities*.
3. 2004 (Bled), *Student Admission System for Warsaw University*.
4. 2005 (Manchester), *Computer system support for the Bologna process at Warsaw University*.
5. 2006 (Tartu), *Central Registry for Results of Maturity Examinations for Student Admission Systems in Poland*.
6. 2007 (Grenoble), *Electronic Student Identity Cards at the University of Warsaw*. MUCI is awarded the EUNIS Elite Award for USOS[§§§§].
7. 2008 (Aarhus), *International Cooperation and Mobility in Higher Education from IT Perspective*.
8. 2009 (Santiago de Compostela), *Web-services for Exchange of Data on Cooperation and Mobility between Higher Education Institutions*.
9. 2010 (Warszawa), *The Mobility Project – Building Network of Web-servers for Exchange of Data on Student Mobility*.
10. 2011 (Dublin), *How to Fight for the ECTS Label*.
11. 2012 (Vila Real), *USOS API – how to open universities to Web 2.0 community by data sharing*.
12. 2013 (Riga), *Framework for rapid in-house development of web applications for higher education institutions in Poland*.
13. 2014 (Umea), *We Publish, You Subscribe – Hubbub as a Natural Habitat for Students and Academic Teachers*.
14. 2015 (Dundee), *Responsive, resilient, elastic and message driven system solving scalability problems of course registrations*.
15. 2016 (Thessaloniki), *EMREX in Poland supporting internal mobility*.
16. 2017 (Munster), *EMREX and EWP Offering Complementary Digital Services in the Higher Education Area*.
17. 2018 (Paris), *Mobility scenarios supported by the Erasmus Without Paper Network*.
18. 2019 (Trondheim), *Erasmus Without Paper Network – from development to production*.
19. 2020 (Helsinki), *How can I get my mobile student ID card?*
20. 2021 (Athenes), *Interoperability across EU*.
21. 2022 (Göttingen), *Signing made easy – hiding complexity of eSignature solutions in a black box*.
22. 2023 (Vigo), *Erasmus Without Paper in numbers*.

2.2 Key applications from the USOS family

Some of the new subsystems of USOS represented a big step forward in the digitalization of student services in Poland. Often, the solutions developed for USOS were avant-garde on a national scale.

In 2004, a system for recruiting candidates for studies was created, the first central system at a university scale. At that time it was a real revolution, earlier recruitment was carried out at each faculty separately, and a candidate applying for admission to different fields of study sometimes had to take an exam in the same subject more than once (or could not apply for admission due to

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[§§§§] https://eunis.org/awards/eunis-elite-award/

conflicting dates). The latest generation of the admission system, created in 2017, is used for recruitment to 73 HEIs in Poland and may become a model for the planned central recruitment system in Poland (Ministry has such plans). It supports a completely remote recruitment which starts from submitting the application and ends when a digitally signed admission decision is issued.

In 2006, on the initiative of MUCI, a system was created to collect Matura examination results from all examination boards in Poland and transfer them to admission systems of HEIs for recruitment purposes. Only in 2021 did the Ministry (obliged by law) create its own system with the same functionality preserving the data exchange format. By downloading the Matura exam results from a reliable source, HEIs were able to automatically qualify candidates, because in most fields of study, only the Matura exam results determine admission.

In 2007, a module for issuing, printing and digitally signing a plastic student card with a chip was created. Such student ID cards have been issued to this day, although the situation will change in 2024 due to a change in the law, which allows the electronic mobile student ID card (mLegitymacja) to be issued in place of the plastic card.

In 2008, at a conference in Aarhus, representatives of some European HEIs began to talk about the electronic transfer of data on student and staff mobility between systems. This idea later provided the basis for initiatives such as the EMREX and EWP networks.

In 2012, the USOS API was developed, which over the years has become one of the key tools for integrating external systems with USOS, including the basis for the implementation of the mobile application, Mobile USOS. In 2014, a notification system was developed as part of USOS API, which implements publish-subscribe paradigm, and a notification daemon which plays the role of the hub. A base for a future event-driven mobile application was created.
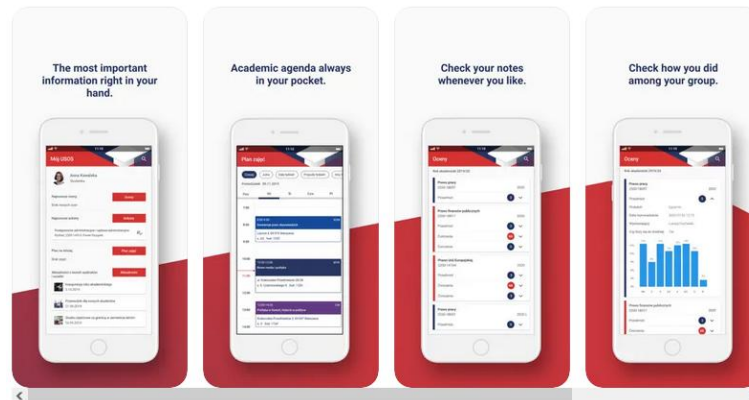

Figure 1 Mobile USOS on the App Store

In the years 2016-2019, Mobile USOS was created, a mobile application for the Android and iOS platforms (see Figure 1), which quickly became a basic tool for students to communicate with the university. The development of the application was financed by the project *e-UW – development of e-services of the University of Warsaw related to education* and it was the first example when one of the MUCI universities participated in a project with external financing, and the generated effects became part of USOS and were distributed to all consortium members. As part of the same project, a new version of the admission system (with support for digitally signed admission decisions) was created, and the USOSweb module (part of USOS for students and academic teachers), under which students were provided with digitally signed scholarship decisions. Soon, a similar project was launched at the Warsaw University of Technology, and thanks to cooperation with the USOS IT team, new USOS modules were created, available to all HEIs, including integration with the Moodle system, a module for registering for classes and a module for surveying classes (the last two within Mobile USOS).

In 2016, as part of the EMREX project, the USOSweb system was enriched with the EMREX Data Access Point and the EMREX Client. A student from any HEI with USOS, in which the module integrating USOS with the EMREX network has been enabled, can download a transcript of records from the institution where they completed part of their studies. The EMREX network currently connects more than 15 hundred institutions from 10 countries.

In 2017, the first EWP project was launched (it was later continued as EWP 2, EDSSI, and currently is implemented under ESCI/EWP+ initiative). The University of Warsaw plays an active role as one of the main technical partners, and the USOS IT team is involved at the executive level. Thanks to this, the team has a real impact on the concept of the network's operation and is one of the first to implement solutions at the technical level, of course as USOS modules. USOS with its mobility module supporting daily operation of the International Relation Office has become a full-fledged node in the EWP network. Statistics for HEIs from MUCI can be found at the Stats Portal[*****] after selecting *Provider* at the top menu (*Aggregation*) and MUCI on the list of providers.

In 2022, thanks to participation in the *eSignForStudy – Highly configurable eSignature solution for Higher Education project*, USOS has been enriched with a configurable tool supporting all types of digital signatures, built on the basis of DSS libraries. This is another example of the development of solutions for all universities in the consortium as part of an external project.

The eSignForStudy module will be an important element of the eDelivery system architecture. In Polish HEIs, the obligation to launch the eDelivery system has been postponed from December 2023 to December 2024. This gives us time to implement the new functionality in the most ergonomic way. The project has already started. The architecture of the solution is shown in Figure 2.
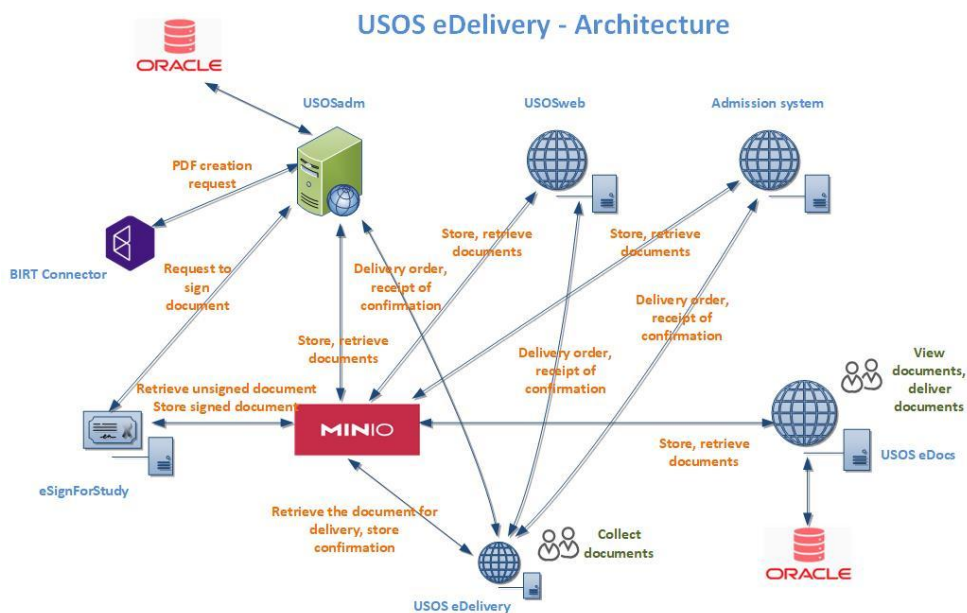

Figure 2: eDelivery in USOS

Let us trace the path of the administrative decision to withdraw a student from studies. An employee of the dean's office generates a decision in the USOSadm system in the form of a PDF file (using the BIRT Connector report engine). The decision is digitally signed with the institutional seal (using eSignForStudy) and saved in the binary object repository (MinIO repository compliant with the S3 standard). USOSadm sends the delivery order to the USOS eDelivery application. After

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completing the operation, USOS eDelivery informs USOSadm where to download the delivery confirmation from. Similarly, delivery orders can be sent from other USOS systems – USOSweb generates scholarship decisions for students, and the admission system generates admission decisions for the candidates. The USOS eDocs system serves as a student's folder with electronic documents, where all documents related to the course of studies are collected. The student can upload an appeal against the decision (and receive confirmation of delivery), which is processed by USOSadm. Everything happens in an environment known to the student and administration staff, without the need to switch to external systems.

A very important aspect of the participation of the University of Warsaw (USOS IT team) in European projects[††††††] should be emphasized. The purpose was to create new USOS functionalities. The University of Warsaw is the official participant, but the generated effects are distributed to all MUCI institutions. Each euro spent in the project is multiplied by the number of HEIs.

USOS development is not limited to new functionalities. The problems the software provider must face also include non-functional requirements, such as personal data protection (can employee X see the data of student Y?), authorization (all systems in the institution should use single-sign on and central authorization system should be attached to eduGAIN), security, scalability (10 thousand students start registration on language courses on a first come first served basis), and many more.

3 Architecture and integration

USOS is not one application, but a whole family of applications. There are several reasons for such architecture. At the very beginning, back in 2000, a decision was made that USOS for administration (USOSadm, initially developed in Oracle Forms, and currently in Java, based on Oracle) was to be separated from USOS for students and academic teachers (USOSweb developed in PHP based on MariaDB synchronized with the central Oracle database), due to security and scalability, as well as licensing issues, which were important at that time. For various reasons (e.g. to switch to new technologies), subsequent subsystems were also created as separate applications – for example, a room reservation system in PHP (with access to the Oracle database), the Archive of Diploma Theses in Python (with access to the Oracle database), USOS API in Python (shares the MariaDB database with USOSweb, synchronized with the Oracle database with the dedicated tool), Mobile USOS in Kotlin with access to USOS via USOS API. Such architecture has both advantages and disadvantages. Some functionalities are necessarily duplicated in various applications (this problem is somewhat alleviated by creating our own framework for applications developed in Python), on the other hand, it is easier to share tasks among team members, and universities can more easily choose applications for deployment. The common graphic design and SSO partially hide this architecture from end users.

A student information system is one of many domain systems at the university. These domain systems are interconnected and must exchange data. The basis of success is the creation of convenient integration tools. USOS integration with domain systems, such as ERP, a library system or even a system controlling access to student dorms, takes place at various levels:

1. Integration at the database level – direct access to a common database (often supported by views that provide read-only access and flatten several tables into one).

2. Integration at the database level by migrating data between databases (original solution called migrator – the application connects to two databases and synchronizes the indicated tables).

3. Integration via USOS API.

No university is an island, it must integrate with other systems that provide external services or expect data to be transferred:

[††††††] https://www.usos.edu.pl/international-cooperation

1. Every university in Poland must submit data to the central systems of the Ministry. These include data on students and researchers (POL-on), diploma theses submitted before their defense to the anti-plagiarism system (JSA), and diploma theses transferred after their defense to the central repository of theses (ORPPD).

2. The previously mentioned system transmits to universities the results of Maturity exams, which are the basis for admission to higher education (SIO-KReM).

3. Mass payment systems offered by banks.

4. Electronic payment systems offered by financial institutions.

5. The gov.pl system maintained by the government offers Polish citizens an electronic ID card (mObywatel) and students an electronic student ID card (mLegitymacja). The student can independently apply for mLegitymacja using Mobile USOS, which connects to USOS to confirm the status of an active student and connects to the mObywatel system to apply for mLegitymacja. Everything is done without the involvement of the university administration.

6. Integration of USOS with the Ministry of Finance gateway, to which PIT (Personal Income Tax) documents issued to students by the university are sent and signed electronically. The need arises because some student scholarships are taxed.

In Chapter 2 integration on a European scale was mentioned:

1. The EMREX network connects systems that provide transcripts of records and diplomas to systems that act as clients – these may be universities where a student wants to continue studies or a job portal where a potential employer verifies the candidate's education.

2. The Erasmus Without Paper (EWP) network, which integrates mobility modules from various universities to transmit nominations, Learning Agreements (LA), transcripts of records, as well as bilateral agreements signed by partners in international projects.

3. The eduGAIN network, which combines university central login systems into a federation and forwards from the university the attributes needed in central European services, e.g. to the EWP Dashboard, where the student fills out the LA, or to the EWP Registration Portal, where an employee manages the university's presence in the EWP network. The USOS application includes a ready-made solution that provides all these functionalities.

4. DS4EU and electronic diplomas on the blockchain – the project has just started, but thanks to the leading role of OPI PIB, the unit offering the IT support for the Ministry, HEIs hope to get a solution that will facilitate electronic processing and transfer of diplomas, which are one of the last documents currently existing only in paper version. The USOS IT team was invited to participate in the pilot.

4   Challenges

Developing software for universities in such an unusual business model is a big challenge. What priorities determine development paths?

University software must offer the desired functionality in line with the business needs of its users. USOS is created at the university and for the university, developers have business experts either directly among them or at their fingertips. There is no need to prepare bulky tender specifications, it is easier to implement projects in the agile style, quickly transmit changes to users and collect feedback. The costs and production time are significantly decreasing. Also, no SLA is in place.

Maintaining one version of the software for such a large number of diverse HEIs is another challenge. There is one law on higher education in Poland, but its implementation is the responsibility of rectors and the university senates. Issues such as the size of the doctoral dissertation committee, the number of people signing recruitment decisions, and the course of the diploma examination vary. USOS is flexible, many of its elements are parameter-controlled. However, you have to draw the line

somewhere, because too far-reaching parameterization makes the software more complex and more difficult to maintain.

The MUCI partners decide on work priorities. This often requires compromise and arrangements between universities. There is a growing awareness that creating separate versions of functionality for each university is expensive and unjustified; over time, universities themselves notice the advantages of unification. It sometimes happens that before a new USOS module is deployed at a HEI, the institution recognizes its capabilities in order to prepare compliant university regulations in advance. Such unification of processes also has advantages for other reasons, e.g. it facilitates correct reporting to the Ministry or the Central Statistical Office.

It happens that a HEI, which has previously used its own SIS, joins MUCI because it realizes that maintaining its own team of programmers is too expensive. Such HEI sometimes continues to use some of their own solutions, e.g. an admission system, for some time but most often after a while they give up on it and start using an analogous system from the USOS family. A rational approach prevails. Sometimes a programmer from such a university adds additional functionalities to USOS – which are then distributed to all partners.

There is also another type of challenge. There are requests, especially from new users of the system, to export data from the system to a CSV file. Such requests raise concern because they indicate that either the system lacks functionalities that allow data to be processed directly within the system and not outside it, or that users have not yet recognized all the system's capabilities. Data processing should take place in the system, and data should be exchanged with other systems via standard APIs. Requesting a CSV file should always result in an honest conversation with end users.

The software must be of good quality, effective and easy to maintain. Academic teachers and researchers in the field of computer science look after programmers, and it is difficult to convince them that *it can't be done better*. Software is not just for today or tomorrow, it must work for years to come. This in particular means that it must be easy to maintain.

Companies come and go. The key is to ensure that the software vendor does not go out of business. In the case of USOS, this is not a threat, programmers from various universities are involved in the development of the code to one extent or another, the know-how is in many places, not only in the USOS IT team and not only at the University of Warsaw.

And what are the challenges related to the age of the application? Unfortunately, technologies are aging and making decisions years in advance is fraught with risk. In the case of USOS, it was necessary to abandon Oracle Forms and Oracle Reports. Choosing a successor was not easy, the team assigned to this task worked for 2 years and made several proofs of concept. Eventually Java was selected. Rewriting the interface from one technology to another continues, especially when refactoring is carried out at the business level at the same time. Unfortunately, technological dependencies are complex. Many HEIS use the free version of Oracle, Oracle Express Edition. The higher version does not work with Oracle Forms, so until we rewrite all forms to Java, we cannot upgrade to the higher Oracle version. This in turn stops the update of other technologies (Python, PHP). Hence the need to hide some applications in containers to isolate them from other systems and their dependencies.

There is a second aspect of using Oracle Express Edition. This version has a limitation on the size of the database. Recently, the number of binary objects in the database has increased (mainly digitally signed PDFs, but also photos, diploma theses, and email attachments). This was one of the reasons why it was decided to introduce a binary object repository, separate from the Oracle database. Initially, this role was performed by the proprietary Blobbox system, supported by USOS API, but in recent years a decision was made to switch to an external, free solution with good support from the community. First of all, it was important to provide a standard interface – S3 was chosen. MinIO was chosen as the reference implementation supported by the USOS IT team, but universities can use any other repository that provides an S3 interface, e.g. Amazon S3.

The decision to support Oracle Express Edition is another manifestation of academic solidarity – those HEIs that have commercial versions of Oracle must delay software updates to allow other HEIs to use the free version.

How has the profile of the USOS IT team changed over time? When the project was launched, it was mainly supported by master students in computer science, many USOS modules were created as master theses. This still happens, but less frequently. It is becoming increasingly difficult to isolate a fragment of the system that meets the requirements of a master thesis and can be completed in the time allocated for it. Developing a module with the hands of one or two programmers is not easy. Backend and frontend specialists, graphic designers and dev-ops are needed. Even if the module is created as a master thesis, it will be with the support of a larger group. Getting involved in a project becomes more challenging as the complexity of the software increases.

Currently, the core of the team consists of full-time employees who have been associated with USOS for many years. The team is stable, there are people who started in the early days of USOS. Thanks to this, there is access to know-how. The arrival of new programmers is very slow, a student after graduation would like to program in Rust, not Java, and ultimately in Python. The team gets support from subcontractors from other universities. It happens that a partner HEI, after finding an error in the system, reports the error and also provides a patch. Often partner HEIs volunteer as beta testers of new functionalities. Partners order for themselves legal expertise or security audits of USOS, and the whole community profits from the results. The approach in which the university delegates a programmer to create a specific functionality (of high importance for this university) and contributes the code to a common repository does happen and is a solution that is beneficial to both parties. On a similar basis, many commercial companies participate in the development of open source systems such as Linux.

The team includes not only programmers. The development infrastructure is complex, hence the need for support at the dev-ops level. Business analysts who do not deliver code and are not IT professionals play an increasingly important role in the team. Similarly, the role of testers is growing. The team composition is changing. An emotional approach to the tasks performed, so common in open-source communities, can also be observed.

5   Conclusions

The decision made 25 years ago was fraught with great risk, but as the results show, the risk paid off. Polish universities have the opportunity to join the consortium and use software whose quality is proven by the high and steadily growing number of participating HEIs. The fee paid by universities is proportional to the number of students (in five ranges), but for even the largest universities it is a small percentage of the cost of systems of a similar scale available on the market, offered by commercial companies (the price list for 2024 is available on the MUCI website[‡‡‡‡‡], fees are usually updated yearly according to the inflation rate). In addition, there is a guarantee of continuity and community of interests – even if HEIs compete for students, they are able to cooperate harmoniously in the field of digitalization.

Software development is financed from university contributions, but also from projects that provide software for all consortium participants. Thanks to the activity of the USOS IT team in the European forum, USOS receives modules and functionalities that will be available in other SIS-type systems in a few years (if at all). This gives us the opportunity to recognize new solutions and technologies and learn from the best. Developers base their solutions on open-source components, which helps minimize costs. A reasonable policy of relying on software that has long-term support also helps minimize the risk of entering a technological dead end.

[‡‡‡‡‡] https://muci.edu.pl/pliki/Informacja%20USOS.docx (in Polish)

In this context, the role of EUNIS as an organization supporting networking and community building around tasks related to the digitization of university systems should be emphasized.

The team focuses on what it does best – analyzing business needs and developing software. Deployment is carried out either by HEIs themselves or by subleased companies. There are many companies interested in offering USOS deployment services.

The team has no plans to take the software beyond Poland (there were such questions and suggestions). The variability of Polish law, including law on higher education, is challenging enough.

USOS is building a community. It may not even be noticed on a daily basis, but each university from the consortium can, through joint discussion fora or thread tracking systems, ask questions about legal interpretation of law on higher education, GDPR issues, security, business and technical aspects of the implementation of processes in USOS – and can count on support from other system users.

The USOS IT team and leaders from partner universities have successfully built awareness of a common goal and a community around tasks related to the digitalization of higher education.

Last but not least somebody could ask why such SIS is not developed – for ALL Polish HEIs – by the Ministry. The effect of scale would be the largest. The answer is not easy. On the one hand one could say that this would be a monopolistic approach, contrary to the principles of free market competition. On the other hand, there are countries in Europe with a longer free market tradition than Poland, where the development of SIS is centrally financed. In Poland, there is already a central anti-plagiarism system, a central repository of diploma theses, and the Ministry is planning a central admission system. So maybe the future will bring a change in approach to SIS.

USOS is not the only student information system available on the Polish education market. There are also some commercial solutions, some HEIs develop and maintain their own system (although the number of such HEIs is decreasing). There are also HEIs which still use simple tools like EXCEL. The deployment of the modern student information system is associated with significant organizational effort, which also requires changes in the way the university operates. However, the need for digitalization is growing, for practical and image reasons. We anticipate that the number of MUCI members will also increase and the USOS IT team will face new challenges.

6 Acknowledgements

Author biographies

Janina Mincer-Daszkiewicz graduated in computer science from the University of Warsaw, Poland, and obtained a Ph.D. degree in math from the same university. She is an associate professor in Computer Science at the Faculty of Mathematics, Informatics and Mechanics at the University of Warsaw. Since 1999, she leads a project for the development of a student management information system USOS, which is used in almost 100 Polish Higher Education Institutions. Janina takes an active part in many nation-wide projects in Poland. She has been involved in EMREX, Erasmus Without Paper, European Digital Student Service Infrastructure and European Student Card Initiative projects.