Digitizing the Austrian Universities' ICR for an Effective Higher Education Governance

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Abstract: The Intellectual Capital Reports (ICR) of the Austrian Universities are a major source of data needed for the evidence-based governance of the higher education sector in Austria. However, the current information gathering processes within the Science Ministry were very time consuming and labor-intensive due to the following reasons: Out of the three sections of the ICR universities could only deliver the indicator section via digital interface. The performance report as well as the performance agreement monitoring chapters, which consist largely of body of texts, had to be processed manually by gathering and compiling data out of separate pdf files for each university. This impedes the effectiveness of the use of the data contained in the ICR for governance purposes. Additionally, creating said elements at the universities largely happens by way of a collaborative effort. At some institutions, however, the processes for an effective collaboration require immense coordination efforts as these processes provide very little digital support. Consequently, the Science Ministry, under involvement of the universities, decided to create a tool, which enables the universities to compile the majority of the ICR in an online database achieving the following effects: The universities compile the ICR in a browser-based application in one of two ways: either they use the application's interface to compile the report elements collaboratively with clear process structures as well as comprehensive tasks and responsibilities. Alternatively, universities may copy texts from MS Word files if they have already established their own processes.The contents of the aforementioned sections are automatically entered into a search database that enables the Science Ministry to browse, compare and compile information either by keyword search or by exporting (sub)chapters. Search results may be grouped by single universities or groups of universities as well as the reporting year. Thus, accessibility of information contained in the ICRs is more easily accessible by providing tools for effective of data mining, thus conserving staff resources and therefore enhance the informed decision-making processes required for effective governance.

Keywords: Intellectual Capital, Higher education governance, digitization, search function

1. Introduction

The State is the major source of finance for the Austrian Public Universities. Accordingly, there is a high level of accountability. In its current role, the Federal Ministry of Education, Science and Research oversees the higher education sector and is responsible for its overall development. As the universities are autonomous entities, the government focuses on steering the sector through governance and policy measures. Effective governance requires not only data and information, but also a systematic approach of acquiring such and easy access to it. In times of tight staffing and an imminent demographic shift, that will drain great amounts of expertise from the administrative system having methods in place that help to affect a better system of information and knowledge management is of vital importance.

In order to increase usability of the Intellectual Capital Reports (ICR), the Science Ministry initiated a project to digitize the ICR and increase the use of the existing data for the purpose of governance.

2. Intellectual Capital Reports of Universities: Origins and Use

2.1 Background

In 2004, by enactment of the universities act, the 22 public universities became autonomous legal entities. This concluded a decades spanning shift in paradigm by applying the new public management principle to a major part of the Austrian higher education sector (Höllinger, 2004).

This new system required a radically different approach: While in the past even minor decision-making processes, which were mostly input- oriented to begin with, had to pass the competent ministry, the new arrangement left the Science Ministry out of the loop and therefore wanting for information. [Note: for political reasons, the competence for higher education switched to different ministries at multiple points in the past. For simplicities sake, the competent ministry of the day will be referred to as 'Science Ministry' to avoid confusion.]

This system change has been described as the most comprehensive, far-reaching higher education reform in Austria since 1849, especially because of the entrepreneurial model at its foundation (Fraenkel-Haeberle, 2014).

Leadership of universities was shared between professional managers and different government boards - University Council and Senate, respectively - and new governance principles and instruments had to be defined (Höllinger, 2004).

To compensate these changes and the loss of most direct oversight and decision-making competencies of the Science Ministry, the legislator decided to establish several new reporting instruments, among them the intellectual capital reports. Relating to this new tool parliament stated the intellectual capital report of the universities (ICR) should serve the universities as an instrument for the holistic presentation, assessment and communication of intangible assets, performance processes and their scope especially considering in regard to the political and the self-defined goals (Austrian Parliament, 2002).

Hence, starting from 2006, the public universities issued individual ICR to the public and the Science Ministry, the latter of which started to use the information from these reports to enhance its own decision making processes as well as using it as a source for several ministerial reporting obligations.

2.2 Periodicity, form and structure of the ICR

The specifics of how ICR has to be generated are defined within the Universities Act and the ICR ordinance (Wissensbilanz-Verordnung 2016) in their current form (BMBWF, 2016). Each public university has to issue an ICR annually, which contains the following sections/parts:

1. Performance Report – structured into ten chapters, this section focusses on a narrative, retrospective description of relevant areas of activity, like teaching, research and responsibilities towards society and the public, amongst others. A full report is required every three years. Universities may opt to restrict themselves to an executive summary in the years between.
2. Indicators – Overall, 24 indicators (plus 4 additional indicators for medical universities) have to be presented in several categories: human capital, relational capital, structural capital, core processes teaching and research, as well as output teaching and research. Indicators include classical higher education indicators like the number of 'exam-active' students as well as indicators concerning social policy like the gender pay gap of the academic staff.
3. Performance Agreement Monitoring – report on the implementation of goals and project over the performance agreement's period. [Note: Performance Agreements are the main governance tool for the public universities, allocating a global budget for a three-year period in return for a description of goals and projects the university pledges to achieve in that time.]

The ICR indicators have to be transmitted to the Ministry electronically for a data clearing process on March 15th every year (April 15th for indicators based on financial data) while the overall report has to be published in the university's gazette and transmitted to the ministry as a PDF file.

2.3 Purpose of ICR reporting and its use

Originally, the ICR was designed as a tool to cope with the changes brought on by implementing a new system of governance. By adapting intellectual capital as pioneered in Germany or at the IST Austria in Klosterneuburg, the legislator sought to create an innovative mechanism within the new public management framework (Habersam et al, 2018). In its current form, the ICR's purpose is a systematic display of the university's intellectual capital as well as the core processes qualitatively and quantitatively in an aggregated form. It serves as one of the bases for the performance agreements and as a standardized reporting tool (BMBWF, 2016).

The Science Ministry uses the contents of the ICR in different ways in order to effect governance decisions:

- • Reporting obligations – The Science Ministry is accountable to Parliament and the Austrian Court of Auditors. Furthermore, Austria has several international reporting obligations and strategies on higher education (i.e. the higher education mobility strategy, reporting obligations in the EU context or the OECD) (BMBWF; 2016). For that purpose, information is drawn from all three parts of ICR, some indicators serve as benchmarks.
- Competitive indicators – Some indicators from the ICR are used as a benchmark to distribute competitive funds alongside the performance agreements. (BMBWF, 2016)
- University report – Every three years the Science Minister must issue a report regarding the public universities to the National Council. The universities' ICR are one of the main sources of information for this report, as it needs to be based on the university's ICR.

- Preparing on-demand reports for the leadership of the Science Ministry – The day-to-day governance of the higher education sector necessitates informed decision-making processes. Requests for information on specific topics from the directors general, the secretary general or the office of the minister are very common. In many cases, information gathered from the ICR is used as a base for these reports.
- Systematic analysis of special areas for policy – governance efforts within the Science Ministry focus on several fields, such as teaching, research, and the vast field of social and general higher education policy. In many cases, the experts within the Science Ministry use the standardized information provided within the ICR to perform systematic analysis, which in turn greatly influences policymaking and governance. Examples include gender equality, intellectual property or development of main research.
- Summary of the Performance Agreement monitoring – each year, the results from Section/Part III of the ICR are summarized in a strategy document that gives an overview of the projects and goals that are being achieved and provides additional comments if the university's goal assessment aligns with the ministry's view. The results of this summary are annually discussed with the universities during the accompanying talks to the performance agreements.

As can be gathered from the points above, the ICR are a major repository of information on the public universities and offer a multitude of applications concerning governance. However, several challenges exist regarding the processing mechanisms of ICR data.

3. Challenges within the existing system

3.1 Setup

At the beginning of the digitization process, the legal framework stipulated a two-tier transmission system to the Science Ministry that involves the university's initiative: Part II, Indicators, is transferred through an online-based application that enables the Science Ministry to perform a data clearing process that consists of a plausibility check. Once the indicators have been cleared, the university rectorates finalize the ICR and pass it on to the university council for authorization. Once this is given the final ICRs are sent to the ministry by e-mail usually as a PDF file (Republik Österreich, 2002) (BMBWF; 2016).

This already highlights the core of the problem: while the indicators are transferred in a way that enables the Science Ministry to directly use and process the provided data, the majority of information contained within the ICR is not. Part I, Performance Report and Part III, Performance Agreement Monitoring, are transmitted as separate files that need to be processed with great effort.

3.2 Challenges

Several factors negatively affect an efficient use of the ICR's data.

Processing the information from Part I and Part III leads to a high workload by being very labor intense. Twenty-two separate documents have to be searched and compared manually to gather the necessary data. This is further hindered by the fact that not all universities provide the information in the same manner, even though the WBV stipulates the structure in detail. As the files are mostly transferred in PDF format this adds an additional layer of complexity.

The manual transference of data increases the chances for transmission errors. The corrections thusly necessitated also bind critical resources.

As there is no formal system for processing data from Part I and III of the ICR currently in place, (re)use of the existing data is being hindered. One could also argue that the ICR contains a 'treasure trove' of unused data. Some experts are even unaware of the existing information since the procurement of the data requires painstaking effort and personnel resources are very scarce.

4. Project Digital ICR

The challenges negatively affect the university governance as resources that could otherwise be devoted to actual analysis of the information and preparing necessary policy actions are used up inefficiently by the current obstacles. Therefore, a project was initiated to analyze possibilities for establishing a more efficient system.

4.1 Beginnings

The project originated in 2017 when ideas were first discussed within the Science Ministry whether or not the very time consuming process of creating the summaries for Part III should be digitalized. These efforts quickly expanded to Part I as well. An in-house project team was established, led by the head of unit responsible for the ICR and including several other departments heavily involved with the subject matter or related topics. Furthermore, staffers from the IT departments were included as consultants and (in the beginning) as possible programmers of the new system.

The first major question to answer was how expansive the digitalization effort should be. In the end, two variants surfaced as possible ways forward:

1. Standardize transmission through predesigned word processing forms that could be included into databases to implement a search engine.
2. Create an online editor to supplant existing ICR systems that the universities had established in the past that would automatically transfer the data to the ministry.

Variant 1 seemed like the safer choice, as the overall system would stay the same while the data could be processed automatically. On the downside, this system would perpetuate the fragmented solution across universities and lead to parallel processes as the universities would keep using their own system and fill in the information in the standardized form.

Variant 2 seemed to address many of these issues yet it would raise some of its own: establishing a single editorial system that would be able to take into account the requirements of all 22 universities would be hard to achieve. For example, some universities have very elaborate work flows and involve many people in the creation of the ICR while others rely on very small teams or even one- person responsible. Catering to all those requirements seemed like a daunting prospect.

These preliminary discussions took place until late 2017 when it was decided to involve the universities in the process early on.

In February 2018, the university ICR officers were invited to a discussion round to enable them to participate in the process on how to proceed.

The digitalization efforts roused the interest of the majority of ICR officers; however, they proposed different ways forward. In the end, the Science Ministry agreed to establish a working group consisting of ministry and university staff nominated by the universities' conference. This working group had an advisory function to discuss the possible implementation of a new system. The final decision rested with the Science Minister.

4.2 Project Goals

One of the first tasks of the working group was to determine and finalize the project goals. These were defined as follows:

- Long-term increase in usability and reduction of the workload for the Science Ministry and the universities
- Minimizing transmission errors
- Increased use of ICR data for governance processes
- Decrease of ad hoc ministry inquiries at universities.
- Enabling to draw a 'basic' ICR from the editor for subsequent use by the universities.

These goals served as a guideline for the remainder of the project along with two non-goals were: long-term increase of workload for the Science Ministry or the universities; creation of a 'surveillance tool' for the Science Ministry.

4.3 Determining the functional requirements

During the starting phase of the working group, the focus mainly lay on the scope of the planned tool and how it should be implemented. By June 2018, several requirements were set forth for the new tool:

- Standardized transmission of the performance report and the performance agreement monitoring.

- Creation of an online editor for the universities with a flexible role system that can be adapted to a university's needs.
- Possibility to export parts or some elements of the ICR as a Word file.
- Implementing a modern and intelligent search tool.
- Creation of an automated report for Part III according to standardized specifications.
- Ensuring the possibility to expand functionalities to other governance instruments like performance agreements.
- Software for consideration needed to be Open Source technology.

The original plan included the implementation of Part I as an APEX based solution. However, after finalizing the technical requirements and desired functionalities it became clear that the programming efforts had to be outsourced.

5. Implementing the Digital ICR

5.1 Search for a technical partner

Consulting the IT department's recommendations the project team scouted for potential IT partners to take over the programming of the new system. Using the Austrian Federal Procurement Agency's database a company was selected. Said business pitched two different approaches by two different sub-contractors to the project team in August 2018.

The first system was a TYPO3 based solution that included intuitive elements and a role based system. However, this concept did not include a search functionality nor did it fulfil the requirement of being an open source technology (Kappe, 2018).

The second system took a more innovative approach by including a more inclusive system based on Node JS and React JS / Create React Application that offered a search engine based on ElasticSearch (Functn/Techtalk 2018).

The project team quickly decided to continue pursuing the second option and expanded the working group by including representatives of the IT Company. From September to December 2018, the technical implementation was discussed in detail by taking the specified requirements, the universities' proposals for functionalities and the Science Ministry's demands to create the technical specifications that serve as the basis for programming work expected from the external IT-partner. Furthermore, a click dummy was created to visualize the functionalities for the decision makers within the Science Ministry.

In January 2019, the Science Minister authorized the project and the funding for it.

5.2 Technical implementation and specification

The actual programming work started by late January 2019 even though the external IT-partner started with some preparatory work before that. Technically, the backend application is based on Node.js 10.x, Postgres 10.x and on ElasticSearch 6.x (Peter et al, 2018)

The Frontend user interface is based on React JS / Create React App and Styled Components. Authentication will be operated through a Shibboleth Proxy layer (Peter et al, 2018).

Browser support will be provided for IE 11 and Evergreen Browser (Chrome, Firefox, and Safari). As it can be expected that work within the system would mostly be done on a desktop PC the system was not be optimized for responsive screens (Peter et al, 2018).

5.3 System Access

One of the first major discussions regarding the actual implementation of a new ICR system was how people working within the editor gain access to it. Discussion had made it clear that easy access through a single-sign-on (SSO) without password input would greatly enhance usability.

As all universities as well as the Science Ministry (at least partly) used authentication systems based on Shibboleth, the choice fell on said system to use it as gatekeeper for the ICR application.

As a first login step, users receive an invitation link by e-mail that leads the user to a landing page where he/she needs to choose his/her institution and will be automatically authenticated. The Shibboleth component processes the information from the identity provider and places http-header to mark the user as authenticated (Peter et al, 2018).

Overall, five different use cases were defined: Login ministry admin, university admin, chapter admin, performance agreement monitoring (PAM) admin and user, as well as maintenance role (Peter et al, 2018).

5.4 Roles

Defining the necessary role was one of the most time consuming aspects of the project. This is not altogether surprising as the question, which roles exist, and what they can and cannot do can make or break the most well designed process.

Roles within ICR system are assigned to the user. Several roles may be given to any specific user.
The Science Ministry roles are (Peter et al, 2018):

- Ministry admin: creates universities in the system, distributes university admins and ministry user roles, sets up chapter-structure and assigns chapters to university types.
- PAM admin: administrates all modules within Part III PAM including establishing periods, performance areas, create adapt, archive, approve and evaluate projects and goals.
- PAM user: sees and evaluates projects and goals and export date for analysis.
- Performance Report user: searches cleared ICR and export data.
- Ministry roles do not have access to the editor or any information in the system during the creation period. University data is only available to the Ministry roles after university clearance.
- University roles encompass (Peter et al, 2018):
- University admin: master admin on the university's side. Manages all users including PAM university admins, sets up additional (sub)chapters, exports the ICR, analyzes data and searches cleared ICR. This admin has all the rights of other university roles. Several university admins may exist, but one admin is compulsory.
- Chapter admin: This role administrates performance report chapters, marks chapters as 'ready for clearance' for the rectorate, creates subchapters as needed and has editorial rights as well as export rights for the chapter.
- Editors: have access to one or more chapters and can create and edit content within these chapters.
- PAM university admin: creates and edits projects and goals as defined in the performance agreements and clears them, exports the PAM, analyzes data and searches the cleared ICR as well as having the editorial rights for PAM.
- PAM editor: evaluates projects including 'traffic light status' enters the current goal value with an explanation and marks the project/goal as ready for clearance.
- Rectorate: has reading rights for editor and PAM. After all chapters in the editor and PAM are complete, the role clears the ICR for approval of the university council. In case of clearance denial, the role may add a comment to suggest changes.
- University council: has reading rights after clearance by the rectorate. Provides final authorization of the ICR after which the data is accessible to the ministry roles. In case of clearance denial, the role may add a comment to suggest changes.
- University read only: Reads all information (whether it is currently cleared or not) and analyzes cleared data.
- The list of roles is very extensive especially for the universities. However, the setup of the system ensures that a single user may perform all steps to create the ICR. This was necessary as some universities have a very minimalistic process structure in that regard.

5.5 Navigation

A central menu overview allows users to navigate the different modules and chapters. As the system is modular, these may be expanded by the ministry admin as necessary (Peter et al, 2018).

The current indicator application was not included for the time being due to time and budgetary constraints, a link to the indicators is provided within the navigation.

5.6 Editor

The editor is at the core of the new ICR system. It allows content to be created and edited by formatting texts, adding pictures and tables as well as creating 'info boxes' and placing footnotes. It also enables the university admin to set a character limit, as an 'internal disciplinary tool' to ensure concise texts (Peter et al, 2018).

In order to avoid loss of data an automated software versioning is in place that can be activated manually as well. Old versions may be restored by the user, which creates a new copy with the old information. For that reason even if the restoration happened by accident, the information would not be lost (Peter et al, 2018).

In order to enable an active process flow users may use the editor's comment function. This system creates a pop-up text field that initiates a comment thread to enable discussions and problem solutions. These threads may be deleted or archived and are inaccessible to the ministry users. (Peter et al, 2018)

Editing functions exist, but on a smaller scale compared to standard text processing applications like Microsoft Word. Similar restrictions apply to the creation of tables that is also limited in choices. This step was taken very consciously since fully re-creating sophisticated applications, as Microsoft Word is not feasible and beyond a reasonable cost-benefit ratio. The existing editing functions, while more minimalistic, serve the required purpose. The contents of all information contained in the performance report and the PAM may be exported, using the export function to ensure further editing.

5.7 PAM

This system allows the administration of all projects and goals contained in Part III of the ICR.

Each PAM period (which aligns with the three-year performance agreement period) needs to be initialized before any data can be provided. After that, projects and goals must be input into the system by the university PAM admin. Predesigned forms for projects and goals exist for that purpose. Once all information has been input the data is locked in and may only be changed by the PAM ministry admin after that (Peter et al, 2018).

The university admin enters the data for the project and goals of the current year and sets the traffic light status as well as gives a written explanation for the projects.

Once the university council clears the ICR, the information contained in the PAM becomes available to the PAM ministry editor. The latter evaluates the traffic light status and the explanations and is able to set their own traffic light status and reasoning. The PAM ministry admin clears, edits or returns single projects and goals to the ministry to clarify questionable content. A comment section enables direct contact with the universities for effective collaborative work (Peter et al, 2018).

A report giving an oversight on projects and goals structured by traffic light status or achieving the goal indicators can be generated from the system and exported as Word file for further processing.

The establishment of this system frees up human resources within the Science Ministry. In the past, just the copy and paste process consumed a lot of time that can be used more productively now.

5.8 Search Function

Making the data contained in the ICR searchable is one of the major goals of the overall project. As stated above, before implementing the new system, 22 separate PDF files had to be searched. A topical search over several years accordingly took up more time. Therefore, great care was taken in establishing the search function.

As the primary database technology used for the application, Postgres, is not the optimal solution for a full text search, the data contained within with the ICR is transferred to an ElasticSearch database. This system allows for different search mechanisms: full text search, filtering of parameters, ranked searches (frequency of word use as well as hierarchical positioning of the keyword) highlighting of keywords (Peter et al, 2018).

The search page includes a search field for specific keywords. Search results may be filtered by universities, groups of universities, reporting year and chapters. Users can apply several filters at once and choose between an exact word search and a fuzzy search. Filter settings can be saved for future use.

Search results contain a preview with highlighted keywords. Each result can be selected and deselected.

Selected results can be exported. The user can choose whether to export the whole chapter or only sections containing search results. Further processing of these texts is achieved by exporting them into a Microsoft Word document.

This feature will immensely reduce time spent on searching for relevant information from the ICR that can be better used for analyzing and preparing policy decisions.

5.9 Changes to the legal framework

Since form and structure of the ICR is defined through ordinance, any changes to the delivery methods must find reflection within the legal framework. Accordingly, a legal update of the ICR ordinance was put into force on November 1st, 2019. The Science Ministry took the opportunity to streamline the performance report (BMBWF, 2016).

6. Project Status and Upcoming Steps

The original project goals have been achieved: The universities deliver the performance report and the PAM via the web application since the reporting year 2020, when its use became compulsory after the test run for the reporting year 2019. The test run of the search function took place in 2021 since productive data was necessary to enable a complete system test.

Currently, the PAM functionalities are being revised to improve on optical aspects as well as the search functionality.

7. Lessons learnt during the project

Implementing a new digital tool is easier said than done. In the beginning, the scope of the project was not fully clear and expanded gradually.

The majority of the project team did not have an IT background, which led to different expectations of what can and cannot be done. The involvement of the IT-department was a critical factor for the success, as the feasibility of the project would have been assessed wrongly several times.

Determining the goals and non-goals of the project and the capabilities of such a system in advance and communicating those to all parties involved was immensely helpful and critical to success.

It cannot be stressed enough how vital the process for creating the requirement specification document was. Particularly challenging was a classical chicken/egg causality: the requirements for the application have to be described very accurately in order to receive the best possible outcome. However, the ignorance of possible tools available might keep IT amateurs from receiving the best technologies for their specific needs. Therefore, trust between any external IT-partners and the client is of critical importance as is an excellent communication basis.

A major obstacle in switching the former analogue reporting system to a digitized one was a certain level of mistrust and reluctance to change the existing processes from some stakeholders. While some university representatives involved in the development process wholeheartedly embraced the possibilities, others saw the project much more critically. A small number of process participants openly opposed the implementation citing the danger of increasing resources required to create the ICR with very little real benefit.

Most of these apprehensions could be alleviated over the course of several meetings. Regardless, any digitalization process should take great care to invest enough time into addressing critical opinions and to onboard dissenters.

8. Outlook

Fully digitalizing the ICR and therefore making essential data necessary for university governance more easily available has the potential of being a major game changer. By freeing up human resources currently bound by

administrative activities or error-prone copy/paste manoeuvres much more time can be invested into analyzing and preparing critical data.

Apart from the direct changes of ICR management, a rippling effect might be created. Especially the custom-made search function could be expanded to other highly relevant strategy documents.

As a next step, the indicators, which are currently administrated through a different platform, will be migrated into the system to streamline the digitalization efforts for the ICR and create a complete export version of the ICR.

In any case, implementing digitalization measures is part of the way to make knowledge management more effective. However, the best digital system does not change anything if people cannot be convinced of its benefit. Therefore, care should be taken to not only implement new systems but also educate the people on how to use them.

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