

DIGITISATION AND SYSTEM INTEGRATION IN THE PUBLIC SECTOR – CONSEQUENCES FOR TEACHING¹

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DOI: 10.24989/ocg.v335.15

Abstract

The digitisation of public sector ICT is driven by a number of factors, which are not altogether dissimilar from the private industries: Increased self-service via the Internet, the Internet of Things (IoT), real-time business intelligence and the advent of integrated information systems as the “backbone” of organisational ICT. This fundamentally changes the landscape of public sector ICT. Particularly the smart cities concept has become a main driver of this evolution, whereby the smart cities concept heavily relies on an intelligent infrastructure that is the large-scale application of IoT.

However, how does this translate into public sector-oriented education? This paper presents a university level teaching programme that covers the topics of integrated information systems for the environment described above. The paper deals with the research question how to embed such a programme in a conventional public sector-oriented university course programme. It details the didactic specificities and analyses the feedback from the roll out. It also analyses the prior knowledge required from students and the changes in other elements of a public administration course programme necessitated by a digitisation orientation.

1. Real-World Requirements

ICT in the past two decades generally saw the advent of several technological innovations that have had a considerable impact on business information systems:

- (i) Web-based information systems for customer self-service, whether for ordering, booking services or banking, effectively eliminating whole industries that had acted as intermediaries before (cf. travel agencies);
- (ii) A massive decrease in sensor prices which together with cloud services enabled the digitization of the infrastructure, both in manufacturing and in the city infrastructure (cf. [1]);
- (iii) In the past few years, real-time business intelligence (BI) has become feasible due to in-memory technology [3] that enables to analyse unprecedentedly large data sets in sequential mode without building pre-defined aggregation structures. [4]

¹ This work was supported by the State Ministry of Baden-Württemberg.

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These innovations have also “arrived” in the public sector. Citizen-centric eGovernment enables citizens to quickly and time-independently process their requests and applications, however, it also means that citizens use self-service functions⁵. Sensor networks render a city infrastructure “intelligent” which then leads to the smart city concept, [2] whose data are input for real-time BI solutions. In this regard, public sector ICT has largely mimicked the evolution in the private sector.

However, sensor data, self-service input or the results of BI runs needs to be processed somewhere and linked to existing data. An example: Sensor input indicating that a spare part or component somewhere in the smart city is about to fail, must trigger a service order in the support system, probably procurement processes. The costs of such a service order need to be calculated and there has to be a link to the budgeting system. In the absence of such systems, the sensor input and related information will end up in nowhere. Digitisation hence organically requires system integration. The focus of such integration in manufacturing and logistics has been an Enterprise Resource Planning (ERP) tool (for an introduction cf. [5]). It combines information from accounting, materials management/procurement, manufacturing (where applicable), service management, sales (again, where applicable) and other more specific parts, such as project management. ERP systems also increasingly interact with BI applications both providing input for analyses and receiving analytical results – this works particularly well if BI and ERP system work on the same (in-memory) data basis, such as [6]. ERP systems are being used in public sector ICT, however, it is our observation that such systems are effectively used just for accounting purposes, and even within Accounting mainly for Budget Management and General Ledger (G/L) Accounting. This is of course not the point of an integrated information system. But it appears to be foreseeable that ERP systems already in place will also be used for other purposes, such as materials management and procurement.

These systems require the corresponding skills, most importantly (but not exhaustively)

- (i) Thinking in processes as well as tools and methods for process management;
- (ii) Understanding of process implementation in integrated and customizable information systems (a.k.a. ERP);
- (iii) Fundamental understanding of ICT technologies and their application including ICT risk assessment, such as cyber security;
- (iv) Techniques to structure and analyse large amounts of data including statistical methods.

What does this mean for public administration education, particularly on a university level educating the future leaders in public administration? Can education centred on blackboard and chalk stick prepare these future leaders in the civil service for their job? Even though the answer is obvious, the question remains how to “embed” these skills in a traditional public-sector university education. The remaining paper describes a teaching programme for the public sector application of ERP systems using SAP® ECC, however, it also advances the following refutable hypotheses as research question:

⁵ Useful when formatted data is collected via the web interface, not just free text, eg. via email.

H1: ERP-related subjects serve as a catalyst for curricular change in non-ICT-related areas;

H2: Public sector education while still being distinctly different from a business education approaches the latter in some key aspects.

However, before discussing these hypotheses, let us introduce the teaching programme developed.

2. The Teaching Programme Developed

2.1. The Content

The teaching programme consists of four subjects (two semester hours each), implementing a municipality *Civitas*. Subjects A and B have already been rolled out; the others have to be developed:

- A. Process and data modelling with Business Process Modelling Notation (BPMN) 2.0 [7] and Entity-Relationship Modelling (ERM) [8] followed by public sector budgeting with SAP® ECC, including budget execution and auditing in the municipality.

The prerequisites are knowledge in accounting, public sector budgeting, auditability principles and – like all the other subjects – a basic understanding of computing.

- B. The “service yard” (of *Civitas*) specifically for road cleaning as case study, that covers cost accounting, materials management and procurement as well as service orders (operations management and execution); also this section implemented in ECC.

The prerequisites are knowledge in accounting, materials management and basics of operations management.

- C. Real-time Business Intelligence for formatted data using in-memory computing for flexible analysis; this section will use SAP HANA.

The prerequisites are general knowledge of the public sector and accounting/budgeting.

- D. Real-time Business Intelligence for unformatted data using sound, imagery and video data and linking the data to the formatted data, again implemented in HANA plus tools for tagging analogue data.

The prerequisites are general knowledge of the public sector and data protection rules.

Development of Subjects A and B has been concluded and the subjects rolled out at several institutions in CEE: The National University of Public Service (NKE) and the University of Technology and Economics (BME), both in Budapest, the National Public Administration Academy (AAP) in Chisinau, the University for Public Administration and Finance (HVF) Ludwigsburg, WU Vienna. Except for one, these institutions engage – either exclusively (AAP, NKE, HVF) or at least also (WU) – in public administration education on a university level. Only BME offers a

technically-oriented education and will hence not be considered any further.⁶ Lectures C and D are to be developed in a “second wave” of curricular development.

Considering the programme in its entirety the requirements are (i) accounting/budgeting, (ii) materials management/basics in operations management, (iii) basics in ICT and – if the first course mentioned is not done – also (iv) process and data modelling/management. These elements are arguably not standard elements in public sector education.

The lectures are hands-on and every student implements the respective case study in his/her own virtual municipality. Each subjects are implemented in ICT tools: (i) for process modelling Adonis[®] modeller, (ii) for data modelling Visual Paradigm[®] and for the other elements SAP[®] ECC and HANA. They are accompanied of a host of ICT tools, that is Web trainers for data and process modelling, screen cam shows of decisive or error-prone steps in the process implementation and a text book detailing the implementation steps and which can also serve as a reference later on, when students again encounter such topics. The materials are available in English, German and Romanian.

2.2. Development of the Content

The universities originally participating in the programme development of Lectures A and B agreed on a detailed syllabus and a “storyline” of the case study in each lecture, whereby the storylines of the lectures of course need to be reconciled to enable the creation of big picture of the case. Lectures C and D are to be developed along very much the same lines.

Each lecture was piloted at least once, original language of development and piloting was English (for the very practical reason that English was the only language understood by all partners); the German and Romanian versions were derived thereafter. At the end of each pilot, feedback meetings were held including attendees in the pilot lectures. The feedback was included in the lecture design. This did not only comprise didactic issues but also mistakes in the case or the storyline. Only after stable state for the cases had been achieved, the English-language book was concluded [12] and the other language derivatives written [13, 14].

Technically, the content is implemented in two master clients in SAP ECC, which are copied into the operational client systems, where the lectures are then held.

2.3. Multi-Country Content

The course programme, from its very inception, was designed to be usable throughout the Danube region. The obvious issue in this regard is the language topic. However, other topics at least equally momentous include

- (i) Currencies and national calendars (the latter quite a common entry in logistics as it determines the factory calendar for scheduling): Our solution was to choose EUR, even though two of the original partner countries do not have EUR as currency; the Austrian industrial calendar was chosen as default.

⁶ In some respects, the issue at BME is the exact inverse of the issue discussed in the paper; at least one course that requires strong public sector knowledge (that is Course A) is offered to students who are not trained in this direction.

- (ii) Naming; each case study needs actors in the storyline including actors already created in the system: Our solution was to choose Latin names as this is some kind of common denominator in Europe.
- (iii) VAT treatment of invoices, i.e., whether VAT is deductible or not for public sector entities (key in accounting/budgeting, not so relevant for logistics); also rates vary, of course: Our solution was to show and prepare both variants in the system and let the lecturer choose, the VAT rate chosen was 20% (Austria and Moldova).
- (iv) General legal provisions about how a municipality works, which units it comprises; as an example, municipalities in some countries have police units, others do not, some maintain their own cadastres, etc.; also the fiscal transfer is organised in vastly different ways: Here we ran the very real risk of being confronted with criticism that the case study to be implemented is not “right”. We countered the risk by picking areas as neutral as possible and by pointing this issue out prominently.

Particularly Issues (iii) and (iv) constituted the main topics in this regard.

In ERP-/SAP-based business education, these points are either non-existent or play a much smaller role. For, instance VAT treatment plays a very minor role in courses focusing on cost accounting and logistics (the issue, for instance, never even occurs in Course B). Also (best practice) business processes in logistics/production/project management/etc. are the same everywhere; consumption-based materials management, for instance, is the same whether done in Stuttgart, Vienna, Budapest or Chisinau. Processes in public administration however are determined by national legislation to a much higher extent, which makes design of such case studies a lot more demanding – and sensitive because ultimately students have to accept them as useful for their settings.

2.4. Rollout

A core issue with any curricular development project is sustainability. To achieve this, local teaching personnel must be found and educated that (i) has a long-term perspective in the respective teaching institution, (ii) has the necessary pre-requisites and (iii) is intrinsically motivated to absorb the knowledge necessary to effectively teach the subjects.

The dissemination approach we chose and which proved itself was to hold a first – pilot – lecture with our staff and the prospective lecturer/s attending as students. Lecturers could also go through the subjects and practice by themselves after the lecture familiarising themselves with the content. The second lecture of each type was then held by the local lecturer/s with one of the developing staff in attendance. From the third “run” on, lecturers hold the subjects themselves. They are also free to adapt the transparencies to their specific needs.

Key element in the successful dissemination is a lecturer guidebook. This guide informs lecturers about typical issues during the subjects and how to solve them. This concerns issues behind the scenes of the case study. One example: When a material master in ECC is created using a template material, creation is facilitated to such an extent, where only few entries in the new material master need to be made. The material master has – depending on the material type – about 10 to 20 “views”, i.e. tabs of data. This may lead students to skip most of the tabs and only visit those tabs that need data modifications compared to the template. This procedure however leads to huge gaps in the data created, which in turn may cause errors later on, which may probably not be associated

with missing views in the material master and can cause an awkward standstill in the lecture. In the guidebook, lecturers are alerted to the issue, it is recommended to instruct students accordingly and there is information on how to fix the issue if it occurs. There are a large number of such issues an experienced lecturer has quite naturally come across and has learned to handle, but where a lecturer new to the topic needs guidance.

The guidebook also informs about background information variations to the case study and legal variations in the respective countries (which are included in the guide).

Let us now get back to the hypotheses listed in the first section and see how such a course and an established public sector course programme may interact.

3. A Closer Look at the Prerequisites

3.1. The Process View

In many cases public sector education appears to be legally oriented and focused on structures and cases. A procedural view of the Law in general and of administrative regulations in particular is not standard. However, a legal regulation can always be seen as a process – and it arguably helps to see it as a process (for an example see [9], [10]). For students of Business, process modelling and process management have become a standard feature. At WU Vienna, for instance, every student of whatever course programme has to pass “Business Information Systems I” very early on in the respective course programmes, where event-driven process chains [11] are taught. In public sector-oriented education, a process view on activities is often missing, where the lectures introduce not only a new topic but a radically different view on the entire discipline.

3.2. The ICT View

“eGovernment” has become a buzzword in public administration, however, many pertinent education programmes do little to prepare students in this regard. However, we maintain that a profound ICT education is an *essential and integral* part of any public administration course programme. This not only concerns an introduction to web applications and digital signatures/eID/registers behind the eID, but also to topics, such as data protection, cyber security and intellectual property rights in cyber; the latter three could be considered part of IT management, which of course also encompasses more traditional items, such as life cycle cost assessment for IT projects, IT project management and IT procurement. Also base technologies, such as IoT should be understood. Some methods, such as process modelling, often associated with ICT are in fact general business/organisational methods that can be used completely disassociated from any ICT application, for instance depicting a legal process as such to better analyse it.

Hence, integrated information systems are only one of many topics, but may serve as an introductory initiative, much like a “feeder”, to introduce a broader technology orientation in the curriculum. This leads to an ICT common body of knowledge, which as we believe should be defined for each public sector-oriented course programme ranging from the “basics” of web/IoT technology, registers and eID to IT management in a broader sense.

3.3. Accounting

In our experience, accounting knowledge is quite broadly taught in public sector education course programmes and hence accruals accounting and budgeting can be pre-supposed as common knowledge. This applies less to cost accounting which may be offered in a preparatory course. It should be noted that – completely in line with private sector accounting practices – also the public sector is moving to the triad of cash-based accounting (classical “cameralistics” budgeting) – accruals accounting with periodicity – cost accounting; cf. as an example the Austrian Bundeshaushaltsgesetz BHG 13⁷ which obliges all federal agencies to provide this triad.

3.4. Logistics

Logistics is an area, where organisations may gain or loose substantial amounts of money (cf. [15], Chapter 1.6 and 6.4 with examples). The more ICT-based systems are used to manage logistics the more advanced concepts of materials and operations planning may be implemented, methods which on a paper or near-paper basis (think MS Excel) are not viable, which however become viable in state-of-the-art ICT systems.

We observed that classical public administration course programmes provide little to no introduction to these concepts. Here a lot of future optimisation potential is lost due to the fact that next generation public administration leaders simply are not aware of the potentials to optimally organise and run their logistics and operations.

4. The Hypotheses Revisited – Embedding ERP in a Course Programme

Returning to our hypotheses advanced in the introductory section, we can now clarify them:

H1: In Section 3, we identified at least three areas, where ERP-based teaching content requires or at least promotes non-conventional content for public sector education: process management, ICT common body of knowledge and logistics.

H2: We also hold that these items, which are standard curricular items [16] in business education will also become standard features in public sector education. This will not negate the specificities of public sector education. However, it will tend to bring both strands of administration education – business and public administration – closer together.

It will be an interesting and worthwhile task to test both hypotheses, once a sufficient data set of pertinent course programmes will be available. However, if H2 will turn out to be valid, ERP-based education will have played an important part in this educational transformation and will have made public sector education “fit” for the new century.

⁷ Bundeshaushaltsgesetz 2013, download from <https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20006632>

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