ADVANCED COCKPITS FOR MUNICIPALITIES – FOCUSING ON THE RELEVANCE AND CHALLENGES OF IMPORTING DATA

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The increasing complexity concerning leadership and management of small and medium size municipalities, poses a high demand on executive authorities. Advanced cockpits collect data for the decision-making processes in order to launch and establish a strategy and to enhance information based municipal leadership. Within a Research & Development (R&D)-project we develop cockpits for small municipalities in Switzerland. The cockpits are built on top of a web-based platform to incorporate collaborative functions and data that are analyzed and structured using Business Intelligence methods. Early in the R&D-project the municipalities received a simple cockpit prototype allowing to get a first impression. Complex cockpit functions however require more tailored data that cannot be handled by manual data entry; the second generation of the cockpit, therefore, includes automated data imports. In this paper we focus on the import process from the different sources and on data protection, pointing out critical aspects and further proceedings. While considering both, the business- and IT view of cockpits, this paper primarily focuses on the IT view.

Keywords: communal cockpits, strategic management, data import, data quality, data protection

1. Cockpits and Importing Data: An Introduction

Introducing a management cockpit in a small or medium municipality can increase the municipality's chance of achieving its goals, strengthen its political leadership, and accomplish more transparency towards its local target audience. The cockpit provides decision-makers with structured information, allows to identify dependencies and synergies, and may give an overview of strategic goal conflicts [1]. The R&D-project (2007-2010) develops management cockpits for small- and middle municipalities in Switzerland.

Early in the project the municipalities were provided with a simple cockpit prototype allowing to get a first impression and to begin working with a cockpit as a management instrument. Data for this cockpit version was entered manually and was already highly aggregated in nature [1]. The second version of the cockpit adds additional indicators, allows for a detailed analysis of their underlying contexts, and provides extensive drill-down capability. The

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amount of detailed data needed for these complex functions cannot be handled manually anymore. Automated data imports from different data sources into the cockpit become necessary. The higher level of data and information integration between the cockpit and other systems achieved through the imports furthers the interoperability within the administration [14]. The reached level of integration and interoperability can be viewed as an indicator for a mature e-government environment [13,16].

From the technical point of view, integrating a data source into the cockpit requires considerable efforts. Every source is different and has a distinct set of characteristics and problems that have to be dealt with when importing its data. Interfaces for extracting the data have to be found. Data quality problems have to be addressed before loading the data into the data warehouse in order to guarantee the required quality of the information in the cockpits. Each data type requires different processing steps, data structures, and also an adequate form of presentation in the cockpit. Since there are a great number of possible data sources, it is necessary to concentrate on the most important ones in order to limit the overall effort. The importance of the data sources is determined by the business requirements of the cockpit. The analysis of the municipalities' business processes has shown that operational systems for accounting and resident register are the two most important data sources, which in turn have been integrated into the second version of the cockpits.

In this paper we first provide relevant background information on the R&D-project in order to focus on the new requirements and applications in the second version cockpit, the actual import process, and data protection, pointing out critical aspects and further proceedings. While considering both the business and IT view of cockpits, this paper mainly focuses on the IT view.

2. Management Cockpits for Municipalities: Business versus IT-view

Municipalities are the smallest political entities in Switzerland. They are in charge of diverse matters such as managing the registry of residents, providing social services, local planning or taxes. The increasing number of responsibilities as well as the resulting increase in complexity and interdependency in the public sector require the municipalities to think in an integrated manner and to gain an overview of different portfolios in various political domains. In this situation a management cockpit aimed at supporting back office and decision making processes can lessen the municipalities' administrative burdens and give them a better chance to achieve their goals. To adopt a cockpit as a management instrument, municipalities however need to develop and implement a strategy, which formulates goals with measurable indicators. IT-based cockpits building on Business Intelligence (BI) is suited to support strategic management [12]. This however, necessitates an alignment between the (local) business and the IT-view in order to reach integration between the cockpit and the municipality's processes [2]. The implementation of the strategy and the integration of the cockpit will require adjustments to the business and decision making processes. However, in the end the properly aligned and integrated cockpit will positively impact decision making processes on the municipalities' operational, management and political levels [10].

Within a R&D-project[3] that started in 2007 we develop management cockpits for small and middle municipalities in Switzerland. The interdisciplinary project team is working on two

[3] The project is supported by the Innovation Promotion Agency (CTI) of the Federal Office for Professional Education and Technology (OPET). As partner the project includes three academic institutions, and seven pilot

research perspectives: a management- and a technical perspective. The researchers dealing with the first perspective work closely with the municipalities. They pursue the aim of raising their awareness for strategic leadership, understanding their policy making and administrative processes, and need to identify as well as support the development of strategy based indicators. The more technical oriented part of the team develops and implements the cockpits for the municipalities adapting BI methods and technologies. It has to ensure the import, storage and processing of data and its presentation in the cockpits [1].

3. Requirements and Applications for Imported Data

The introduction of detailed data into the cockpit is mainly prompted by the need for advanced applications requiring such data. This step is also connected to a new set of business- and technical requirements. The technical requirements are defined by the new data types and the additional business requirements which have to be individually determined for every municipality during requirement analysis [7].

3.1 Requirements for Importing Data

It is important to know the individual requirements of a municipality in order to build a cockpit that generates additional value. These requirements are mainly influenced by the municipality's business and decision-making processes. Understanding these processes also helps to show how the cockpit can be integrated. Qualitative interviews with the political stakeholders of the seven pilot municipalities were conducted in order to model the key processes concerning the annual municipal planning. To receive additional input and feedback based on the findings and the use of the cockpit prototype, workshops with different stakeholders from all municipalities were held. Different requirements on the political and the operational level could be identified: a controlling instrument, information based support for certain lines of argumentation, and a central collaboration platform with document and project management capabilities are needed. The requirements analysis and the feedback on the first cockpit prototypes have further shown that manual data input cannot satisfy all those needs. Especially applications on the operational level but also in some situations on the political level require more detailed data. Most of these affordances can be met by importing detailed data from the operational systems into the cockpit.

Adding detailed data to the cockpits also poses new challenges to their implementation. Suitable interfaces for import and export of the data have to be found. On the organizational side a sustainable process for the data import between the municipalities and the cockpit service providers has to be established. The import itself has to deal with data quality issues such as errors, artifacts, and missing values in order to guarantee the necessary level of quality of the information in the cockpit. The cockpit's data warehouse and the underlying systems have to be adapted to deal with the higher data volumes. The OnLine Analytic Processing (OLAP) Cubes need to be modified in order to cope with the new data structures and the requirements for the analysis of the detailed data. Furthermore, in the cockpit the detailed data has to be presented in a simple and easily understandable manner which poses new challenges on the presentation layer. Last but not least, part of the detailed data is subject

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municipalities from the cantons Berne and Wallis. To ensure a sustainable utilization the project team also works with strong industry partners, the Bern Cantonal Office for Municipal Affairs and Land Use Regulation as well as the Swiss Municipal Association

to strict data protection regulations posing new requirements to the security of the cockpit systems.

3.2 Application Scenarios for Imported Data

The manually entered data in the first version of the cockpit was highly aggregated. Such data is sufficient for high level indicators and simple overview graphics, yet does not provide any drill-down possibility or a sufficient basis for detailed analysis. Automatically importing detailed data from the operational systems opens up new possibilities for the cockpit. Several of the data series, previously entered manually, can be derived automatically from the imported data, e.g. all relevant financial indicators can be derived from the imported financial data. This in turn leads to a reduction of the cockpit related workload in the municipalities.

The detailed data allows the cockpit to fully use the analytic capabilities and drill-down functions of the OLAP Cubes. They can help to analyze causes of critical indicators or explain the change in indicator values, e.g. a drill-down can show the cause of atypically high expenses. The imported data is not just useful on the strategic level, it can also help to provide new functionalities on the operational level. Interviews and workshops with the municipalities have shown that on this level there are a number of reports and statistics which have to be assembled manually as a result of lacking functionality in the operational systems. Such reports can be automatically generated from the data warehouse and made available through the cockpit. Especially the lack of historical data within operational systems is a problem, since it prevents them from showing changes over time, e.g. a change in the demography of the population. The cockpit can fill this gap using its data warehouse which inherently stores historical data [6,11]. Overall autonomously pulling detailed information from the cockpit can further lessen the gap between the information levels of different administrative units and levels in a municipality [12].

The detailed data poses new challenges to the data preparation and presentation. To gain an overview, the data has to be presented in a simple and concise manner that uses a high aggregation level. Drill-down, analysis functions and more detailed reports should only be displayed when needed. Data protection regulations also lead to strict security requirements with the effect that some of the levels of detailed data are only accessible to certain authorized users. Specific training of the users becomes critical for establishing the cockpit in the municipalities and ensuring its correct use. Otherwise the complexity of the new functions and the underlying data model might be used and interpreted incorrectly.

4 Data Import

Data import is a crucial step for integrating detailed data from different sources into the cockpit [6]. The import itself basically constitutes an IT assisted business process with the technical import process as its central step. This process is governed by business as well as technical requirements and involves the municipalities as well as the cockpit service providers on the organizational side and the operative and cockpit systems on the technical side.

4.1 Import Process

The actual data import is not an isolated activity but is embedded in an entire process with surrounding activities. This process is not primarily of technical but organizational nature. It is designed as a partially automated workflow that integrates with everyday business. Figure 1 shows the basic flow of the import process.

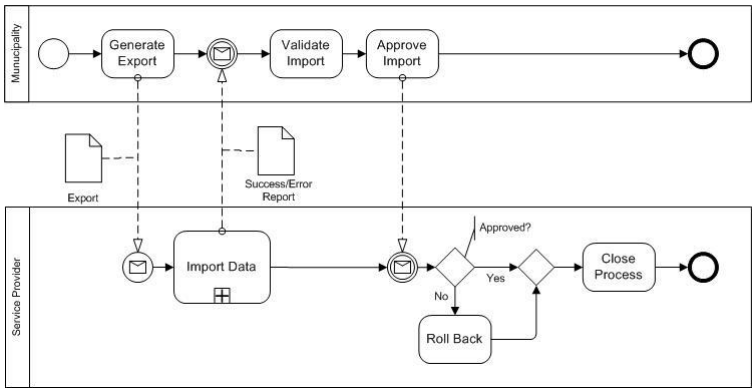

Figure 1 Basic data import process

The cockpits are designed to be hosted by a service provider with a strict separation from the operational systems. The import process is designed accordingly and involves the municipality and the service provider as separate actors. On the side of the municipality processes, such as the annual planning or budgeting as well as their reporting afford govern the periodicity of the data import process. The results of the import process may directly have consequences on operational processes, if there are errors to be corrected, and indirectly influence the decision-making processes through the cockpit.

Since the service provider has no direct access to the operational systems, the data import is decoupled using an interface that produces an export file from the operational systems. The process is started by the municipality generating the export, which is then sent to the service provider. There the data import as the technical core of the process is executed. Depending on the outcome of the import, either a success or an error report is sent as feedback to the municipality. Based on the report and a manual plausibility check of the imported data the municipality can choose whether or not to approve the import. Disapproval triggers a rollback. In case of an error or a disapproved import corrective measures on the side of the provider and/or the municipality are needed before the import can be initiated again.

The Data Import sub-process shown in Figure 2 is the technical core of the import process. It is implemented in a modular way in the form of different import modules. Within the import process the interface for the export and the import module for the data import sub-process are changed depending on the type of data to be imported. The modules implement a so called ETL process (Extract Transform Load) whose basic steps are shown in figure 2 [5].

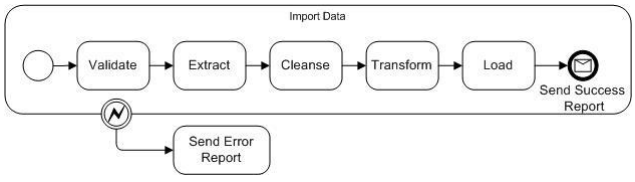

Figure 2: Sub-process Importd Data

First the structure of the export file is validated before the data is extracted. The cleansing step deals with data quality problems and the transform step brings the extracted data into a format suited for loading into to the data warehouse in the last step. The actual operations and implementation within the single steps are specific to the respective interfaces and data types. Also for efficiency reasons some operations may be performed together in one step, e.g. simple transformations are performed together with the loading step.

4.2 Data Types

In first version of the cockpit had no restriction concerning data source e since the data was entered manually. Rather the cockpit was designed to handle a wide variety of data types. Due to the connected complexity, the automated data import had to be restricted to the data types most important to the political decision-making process. Interviews with the municipalities were performed to determine these data types. Almost unanimously financial and resident control data, along with data from geo information systems (GIS), were named as the most important ones. Additional suggestions included tax information, social welfare data, and data about elections. Based on the municipalities' priorities financial and resident control data were chosen as first subjects for the automatic import. Both data types make parts of the manual data entry obsolete because they provide the same information with a finer granularity.

Resident control data comes from the municipal resident register and is used to derive information about the population for the cockpit. This includes basic figures like the number of inhabitants but also more complex information about the demography of the population which may influence many political decisions such as whether to build a new school building or take measures to attract new residents of a certain demographic group. Basic information of that kind was already present in the first version of the cockpit but the automatic import now allows detailed analysis down to the single resident. Using the historical data in the data warehouse also facilitates detailed analysis of the demographic changes in the municipality.

The financial data comes from the municipal accounting systems. It includes actual data on account level and additional budget and planning data. The cockpit uses the data mainly to calculate the financial indicators defined by the cantons and municipalities, which until now have been entered manually. In addition the cockpit now allows detailed financial analysis and drill-down on the indicators. Furthermore, it enables comparisons of the actual data with budget data and/or multiple series of planning data that stems from the rolling planning process.

4.3 Interfaces

To support as many possible applications as data source in an economic manner it is necessary to use a common interface. This requires a certain level of standardization. While a custom interface could be defined, it is difficult to establish such an interface as a standard and to gain the necessary support of the software vendors. Providing that they meet the given needs, R&D-projects like ours can benefit a great deal from existing interfaces resulting from the increasing level of horizontal and vertical integration in a maturing e-government environment [13,16]. Within the Federal organization of Switzerland, especially the vertical data integration between the municipal, cantonal, and federal level (be it for administrative or statistical purposes), lead to the establishment of a number of well standardized and well supported interfaces. One however also has to consider that using existing interfaces introduces a dependency that may necessitate changes in the import process in case the interface is modified.

For the citizen control data we profited from the fact that a nationwide harmonization of the registers of residents is underway. For that purpose the Federal Statistical Office (FSO), in cooperation with the standardization organization eCH, defined an XML based interface standard called eCH-0099 [3] for the necessary data exchange between the institutions involved in the register harmonization. The interface was implemented by all major software vendors including those of the software used by the project’s pilot municipalities. The

standard includes more data than actually needed for the cockpit and is therefore suited for our purposes. The only drawback is that many aspects of the XML structures are optional leading to a higher complexity in the import process.

For the finance data a suitable interface was still in development when we started the project. The FSO in cooperation with the Federal Finance Administration defined the data exchange interface ED-ÖFIN (Elektronische Datenerhebung für die öffentlichen Finanzen: literally Electronic data acquisition for the public finances) [4]. The XML based interface is used to collect finance data from municipalities and cantons for statistical- and other purposes. The exports created with that interface contain partially preprocessed (mainly aggregated) accounting data slightly more detailed than the content of the statements of account published by the municipalities. The level of detail suffices for the cockpit, and the preprocessing even simplifies the import process, which is why the interface is suited for our project. We had to implement a second import process for a proprietary interface, because only one of the two accounting applications used by the pilot municipalities already supported the interface. This import is however more complex and incompatible with the ED-ÖFIN import and will only be used until both systems support the new interface.

4.4 Data Quality

The information in a cockpit needs to be of a certain level of quality in order to assist decision-makers correctly. The quality of the information is influenced by the data processing and analysis methods used but mainly depends on the quality and correctness of the data in the underlying data warehouse. Within the import process it is important to only load data into the warehouse that meets the quality requirements. The data quality requirements have to be defined clearly for every data type since there are usually differences between the types. Different source applications may also have varying levels of data quality. Clearly defined minimal requirements are therefore important to ensure the interoperability and integration between different applications [15]. Data quality problems like invalid or missing values and artifacts however still have to be addressed during the cleansing step of the import [5,8]. Relatively simple measures like domain and range checks, plausibility checks, and defined default values can address most of the problems. It is also important to establish a feedback process with the data supplier, since most data quality problems stem from problems and errors in the source system. Giving feedback on the errors detected during cleansing and correcting them in the source system improves both the data quality in the cockpit and the operational systems.

The requirements for the data quality of the resident control data are mainly defined by the official catalog of attributes for resident registers that defines mandatory and optional attributes. The cockpit expects the mandatory attributes of the official attribute catalog to be present and correct. Simple range (e.g. whether the specified age is positive) and domain checks (e.g. whether the specified place of birth is an existing municipality) are performed to test correctness of the attributes. A flexible data model using explicit "Unknown" markers and default values defined in the attribute catalog are used to deal with missing values. Simple plausibility tests basing on the descriptions in the catalog are performed for some attributes. Detected errors are automatically included in the feedback report, so they can be corrected in the source system. The project also profited from a general increase in data quality of the resident control data that result from the register harmonization. The municipalities have to increase the quality in their registers to a certain level before they can be synchronized with the registers on federal or cantonal levels. For that purpose the FSO and some cantons offer validation services for testing the municipalities' data who return error reports that can be

used to correct errors. These services perform more complex checks and also detect errors and inconsistencies across multiple registers that are impossible to find by simpler checks.

For the financial data the quality requirements are defined by general accounting principles and by the harmonized accounting model (HRM: Harmonisiertes Rechnungs Modell), which serves as a basis for the regulations of municipal accounting in Bern, Wallis, and most other cantons. The cockpit project orients itself directly on the HRM and common accounting principles as a common denominator because the cantonal implementations of HRM and also the municipal concretion may differ slightly. The data quality checks consist mainly of range checks and the automated comparison of aggregated transactions with account balances. Additionally, manual plausibility checks are performed periodically by comparing aggregated values in the cockpit with corresponding values in reports generated by the operational systems. The automatic error feedback through the reports about the imports has shown that most of the errors were systematic in nature. They either originated from the way a municipality booked certain cases, or they were caused by peculiarities in the export of the software. Quality problems introduced by the export differed between the two interfaces used to import the financial data. The ED-ÖFIN interface with the partially preprocessed data generally had less quality problems. This shows that concerning data quality one also has to pay attention to the interface used for data exchange.

4.5 Data Import: Lessons Learned

From the business perspective, especially the establishment of the organizational process around the technical import and the selection of the data types to be imported are important. Limiting the number of data types keeps the necessary effort at a manageable level. Reusing existing interfaces matching the requirements of a project also reduces the necessary development time and effort. Data quality requirements have to be clearly defined and enforced during import in order to maintain the data quality in the data warehouse and consequently the information quality in the cockpit.

5 Data Protection

Like other IT applications, management cockpits have to follow regulations concerning data privacy and protection. The highly aggregated data used in the first version of the cockpit did not fall under any special regulations. By importing detailed data from an operational system, the cockpit however becomes subject to the same strict regulations as the source system. This is especially the case for the personal data in the resident registers. Adding such data to a cockpit system increases the organizational and technical requirements considerably. Guides and best practices offered by official institutions like the Federal Data Protection Commissioner can give a first introduction into the matter [9]. They can give an idea where and with what measures to begin when defining a data protection concept. Due to the complexity of the laws and regulations it is however advisable – like in the case of the R&D-project – to involve a lawyer or professional knowledgeable in the matter. The data protection concept for systems like the cockpits should be set in writing and be made contractually binding for all involved parties. Generally such a concept encompasses organizational (e.g. processes, responsibilities, physical security measures), technical (e.g. encryption, authorization and user concepts), legal (e.g. liability), and other aspects. It may also be necessary to adapt organization specific data protection regulations of the parties involved in the project to include or allow new applications like the cockpit. This was the case for the pilot municipalities who had to make some adjustment to their data protection regulations. With respect to a future certification concerning the data protection, it is advisable to involve

the relevant authority early on and obtain their feedback. On the technical side the main consequences are stricter requirements for the physical data security (e.g. access to systems and backups), data exchange (e.g. secured using SSL), and data access (what data may be accessed by which user). Especially the last point has lead to a fine grained user and authorization concept for the cockpit. Normal users are basically shown only aggregated data, while detailed data is only accessible to users that also have access to the corresponding data in the operational systems. All in all it can be said that a pro active approach to the subject of data protection early on in a project is advisable.

6 Findings and Further Activities

Early prototyping has proven to be a valid approach for developing management cockpits for municipalities. The early contact of the end users with the prototypes increases their understanding of the subject and generates more valuable feedback during the interviews and workshops conducted in the phase of requirement analysis. This feedback helps the research team to better understand the municipalities' business requirements and in turn also helps to align the IT perspective of the cockpits. The requirements analysis has shown that importing detailed data into the cockpit is necessary to fulfill all of the municipalities' needs. Based on the business requirements the necessary data types have to be identified and an import process has to be established. According interfaces for the data types have to be found before they are integrated with the cockpit where special attention to the data quality and data protection regulations have to be paid.

Importing GIS information as the third most important data type into the cockpit and integrating the tools for planning and managing projects and measures are the main technical challenges left for the remainder of the R&D-project. Data Protection constantly remains an important issue and will most probably be a subject of future activities and research beyond the project. Planning and implementing user training will also be a major activity in addition to the ongoing requirement analysis. To actually succeed in all the technical activities and challenges in the project, we further need to successfully establish the management side of the cockpit in the municipalities by establishing a strategy, implementing strategic management, and integrating the cockpit with the municipalities' processes. This part may even be the biggest challenge of the project. Last but not least, ensuring the long term operation of the cockpits for the pilot municipalities through the industry partners of the project, and setting up possibilities for further observation of the development and application of the cockpits as well as future collaborations are also of our concern.

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