COCKPITS FOR SWISS MUNICIPALITIES – ADOPTING BUSINESS INTELLIGENCE AND OLAP FOR A STRATEGIC- AND INFORMATION BASED POLITICAL LEADERSHIP

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As a result of the increasing responsibilities and the complexity as well as the interdependence in the public sector, the management of municipalities is becoming increasingly difficult. An information based cockpit can simplify political leadership in municipalities by assisting decision-making and thus, help to achieve strategic goals. For this reason, it is essential to derive measurable goals from strategies. We are developing IT based cockpits for small municipalities in Switzerland within an R&D-project. The cockpits are built on top of a web-based platform to incorporate collaborative functions and data that is analysed and structured using Business Intelligence methods including data warehousing, On Line Analytical Processing (OLAP), data mining, balanced scorecard based performance management, and reporting. Thorough analysis of strategy and decision-making processes is necessary to achieve a tight alignment and integration between the cockpits and the municipality's processes.

1. Cockpits as Management Instruments for Small Municipalities

Municipalities are the smallest political entities in Switzerland. Currently, there are 2636 municipalities, though their number is in decline. Small municipalities tend to merge or to cooperate within an agglomeration in order to carry out their tasks more efficiently. In addition to the tasks that are allocated to them by the Confederation and their canton, such as managing the registry of residents or organising civil defence, the municipalities also have their own responsibilities, including those related to social services, local planning, taxes etc. The municipalities regulate these matters independently to a large extent [1].

Since complexity and interdependence have been rising in the public sector, it is indispensable – especially on a local level – to think in an integrated manner and to gain an overview of different portfolios in various political domains. A cockpit for strategic management in political environments allows to structure basic required and aim-oriented information [2]. That is to say decision-makers need information: a management cockpit permits e.g. the identification of possible deployments, synergies, dependency and goal conflicts between different projects and plans on various levels.

To adopt a cockpit as management instrument, municipalities need to develop a strategy which formulates goals with measurable indicators. This method can facilitate business and

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coordination between different agencies. Furthermore, it permits decision making in goal-conflict-situations by weighing up given preferences. Because of the growth of job complexity and the overstraining of a governmental service-oriented-apparatus, an isolated treatment is no longer adequate. The need for cooperation has been realised on all federal levels and increasingly prioritized, especially on a municipality level. Nowadays it seems inevitable to make decisions on an agglomeration level as well – this poses some challenges, since that level is not politically anchored. In the research project[3], the team will consider these trends and develop cockpits, which have to react to a need, for the participating pilot municipalities. In a further phase, the tools will support the strategic- and information based management on a municipal and agglomeration level.

In this paper we focus on the one hand on the business- and IT-alignment and on the other hand on the state of the project and existing IT solutions, pointing out critical aspects and further proceedings.

2. Strategic and Information Based Management in Policy Making

By introducing a cockpit, municipalities obtain a better chance to achieve their strategic goals, to tighten the political leadership generally and to accomplish more transparency towards the public [3]. This requires that a strategy is given, from which measurable goals can be derived for the definition of cockpit indicators. And of course, it requires the commitment to information-oriented leadership and management.

For the latter, an alignment between the business- and IT-view is essential [4]. In order for the policy making process to rely on an IT-based information system, it must be ensured that the municipal council has access to the required and accurately structured information in the right process phase. More precisely, the available information has to be integrated and condensed, which creates problems with legal interoperability and the political frame of reference. [5, 6]. Thereby, there is a significant risk that developers misshape the architecture because they lack intimate knowledge about political business. To ensure an effective dialogue between end-users and developers on all critical aspects of the project, from the very beginning, the seven pilot municipalities obtained a simple cockpit in a very early phase of the project.

The cockpit should supply the basis for information-based argumentation. Adopting a properly defined cockpit leads to more transparency in the political and operative work of the municipal council. The municipalities participating in the project are eager to adopt it for the strategic management as well as for the operative implementation [7]. According to a survey carried out by the R&D-team, end users are mostly interested in quarter data (e.g.

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[3] The considerations presented in the paper result from a R&D-project started in 2007 and supported by the Innovation Promotion Agency (CTI) of the Federal Office for Professional Education and Technology (OPET) as well as a monitoring project, sponsored by the Bern University of Applied Sciences (BFH). The participating research partners are Division of Computer Science, Bern University of Applied Sciences (CTI-project, Leadership), Institute for Economy and Tourism, University of Applied Sciences Western Switzerland (CTI-project, Co-leader) and the Competence Centre for Public Management and E-Government, Bern University of Applied Sciences (BFH-project, Co-leader): The findings are tested in the following pilot municipalities: Brig-Glis, Brügg, Naters, Roggwil, Stettlen, Visp and Wohlen bei Bern, which are located in then cantons of Berne and Wallis. To ensure a sustainable utilisation the project team works with industry partners (Microsoft Schweiz GmbH, Ruf Informatik AG and Talus Informatik AG), the Bern Cantonal Office for Municipal Affairs and Land Use Regulation as well as the Swiss Municipal Association.

development in different political areas), benchmarks with other municipalities, and functions like extrapolation. Providing an overview for the council and the mayor, efficient document management, and the promotion of collaboration on an agglomeration level are of great relevance [8].

To ensure that the cockpit can be employed in the future as a strategic instrument for information based management, it might be useful that leadership experts examine current decision-making processes within municipalities and make suggestions on the data to be provided, as the municipalities themselves are not yet used to the definition of critical indicators. Therefore, one part of the R&D-team is currently examining decision-making processes in the participating municipalities, such as annual planning, the selection and prioritization of collaborative investments with other municipalities.

3. Designing a Cockpit Solution Architecture

The participants of the project team focusing on the technical view have the task to design an IT centric system architecture for the cockpits being in alignment with the business processes of the municipalities. Further the team takes into consideration the user requirements.

The cockpits contain multiple dashboards providing easily comprehensible overview for distinct subjects or perspectives [15] and thus they can be used to provide properly structured data at the right points of the business processes. Business Intelligence (BI) methods and technologies including reporting, data mining, data analysis and visualization are used to build the dashboards. While cockpits, dashboards, and BI are commonplace in corporate environments, they are equally attractive for the context of public administration where they can be used for information based management and decision support in policy making. This recently led to first efforts to adapt cockpits and BI for public administrations. Practical examples can be found on different levels in the public administration e.g. at the Swiss Federal Office for Sport [16] on a federal level or the research project BASIS in Germany [17] that primarily targets the municipal level.

In order to facilitate accessibility and integration, the cockpit solution is web-based. The municipalities can access their cockpits by means of a secured website which presents dashboards based on the municipality's strategy and views tailored for specific processes and situations. The cockpit sites also serve as a workspace, incorporating collaborative functions. The cockpit solution is designed as a hosted application service offered by service providers. A complete separation between the systems for the cockpit solution and the operational systems of the municipalities is therefore being planned. Figure 1 below shows the general architecture of the cockpit solution. From the technical viewpoint, the system architecture can be divided into data, an analysis, and a presentation layer. From the view of the business architecture the system architecture covers the data and the application layers. The data layer deals with the integration and storage of the data serving as the foundation of the cockpit. Since the cockpit solution is completely separated from the data sources of the cockpit (e.g. accounting applications), the data is imported from intermediate export files and stored in a data warehouse. The analysis layer uses On Line Analytical Processing (OLAP) to analyse the data from the data warehouse. A performance management solution uses the OLAP database as data source. Together with further reports and data analyses the scorecards are combined with specific dashboards. Finally, on the presentation layer the dashboards are made available to the user as part of the cockpit. A security concept which controls the access to the cockpit and the underlying data contains all three layers of the cockpit solution. This is especially necessary because part of the data in the cockpit is, according to law, subject to strict data privacy protection.

The individual cockpits of the municipalities are customized versions of a core cockpit encompassing common features. The customisation mainly concerns the two upper layers of the system architecture since the dashboards and views in the cockpits reflect the strategy of the respective municipality. Further, they are tailored for their individual management processes.

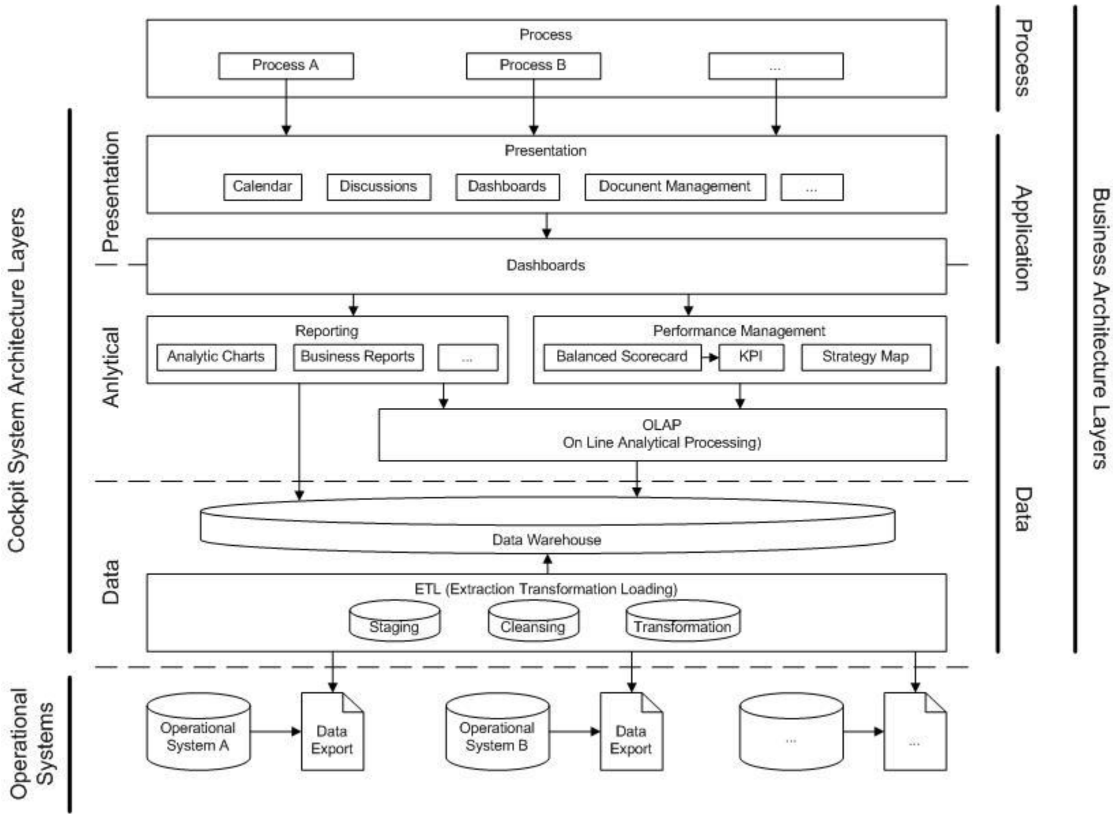

Figure 1:Cockpit solution architecture

3.1 Data Warehousing for Cockpits

Data warehouses can be defined as subject oriented, integrated, non-volatile, time-variant collections of data used as data sources for BI solutions, such as cockpits, in order to support management processes and decisions [9]. The data warehouse of the project's cockpit solution has been designed to support data analysis and aggregation. A multidimensional data model has been chosen for the data warehouse schema in order to enable the use of OLAP cubes. The requirement analysis and additional interviews with the seven pilot municipalities have revealed a significant overlap of about 80% in the data required to calculate the indicators for the cockpits [12]. The same base data can be used to calculate many different financial, demographic, and sustainability indicators (e.g. most financial indicators like revenue or profit may be calculated from the municipalities accounting data, demographic indicators like number of citizens or birth rates may be derived from citizen registration data).

Based on these findings a base version of the data warehouse has been created to cover the common data needs, especially including finance and resident registration data. The individual data warehouses of the municipalities are extended versions of that base data warehouse.

3.2 Data Integration Using a Modular ETL Process

Importing data from different sources and integrating them into the data warehouse is crucial for creating a suitable database for the cockpits. The main data sources are the operational IT systems of the municipalities. The problem here is the number of different software solutions used by the municipalities. Statistics from the KAIO[4] lists 16 different solutions for the Canton of Bern alone [13], however, there are more solutions on the market.

Currently, no standardized interfaces or data-exchange formats for municipal software exist, which would completely match all needs of the project. As the cockpit solution is aimed at a large number of municipalities, the diversity of data sources has to be taken into account by the design of the data integration task by using a modular ETL (Extract Transform Load) process to perform the data integration. The process is divided into four main steps (extract, transform, cleansing, and loading) [14] that are strictly separated and implemented in independent modules. Separate staging, cleansing and transformation databases are used to store intermediate results of the ETL process and thus pass data between the modules.

As shown in figure 1, the data extraction is performed on exported files and not directly on the source systems. Different extraction modules are implemented for different export formats. The main data-quality issues in the extracted data addressed by the cleansing module are inconsistencies between data from different source systems and duplicates. Additional plausibility tests are performed to detect anomalies and incorrect values. The transformation module partially aggregates and reorganises the cleansed data based on the dimensions in order to obtain the required data structure and granularity for the data warehouse. The loading module integrates the transformed data into the data warehouse by updating its dimension and fact tables.

3.3 OLAP Based Data Analysis

The potentially large volumes of data in the data warehouse have to be analysed and prepared for the cockpit in an efficient manner. On Line Analytical Processing (OLAP) systems are optimised in terms of functions and performance for the requirements of data analysis. Compared to a normal On Line Transactional Processing database system, OLAP systems are primarily more efficient in executing the complex queries including complex joins and aggregations that are prevalent in data analysis applications [11]. The cockpit solution uses multidimensional OLAP cubes for analyzing the data in the data warehouse. The cubes are complemented with data mining models for more complex analysis (e.g. trend analysis) and predictive modelling (e.g. demographic developments).

The structure of the cube is driven by the analytic needs of the cockpits. In the current version, the facts mainly consist of financial- and citizen registration data. Additional fact types include project management data, environmental data (e.g. energy and water consumption), and statistical data about the municipality (e.g. traffic statistics, survey results). Figure 2 shows a partial view of the common dimensions and facts. Each fact at least

[4] Kantonales Amt für Informatik und Organisation des Kantons Bern/Office for Informatics and Organisation of the canton Bern http://www.fin.be.ch/site/kaio-index

references the *Time* and *Municipality* dimensions. The latter allows building cockpits for more than one municipality (e.g. a common cockpit for an agglomeration) or for integrating comparative benchmarking data of several municipalities. Further dimensions include the *Accounts* dimension for financial data as well as *Citizen*, *Age Group* and *Income Group* for citizen registration data. Additionally a *Geography* dimension is used for geo-referenced facts.

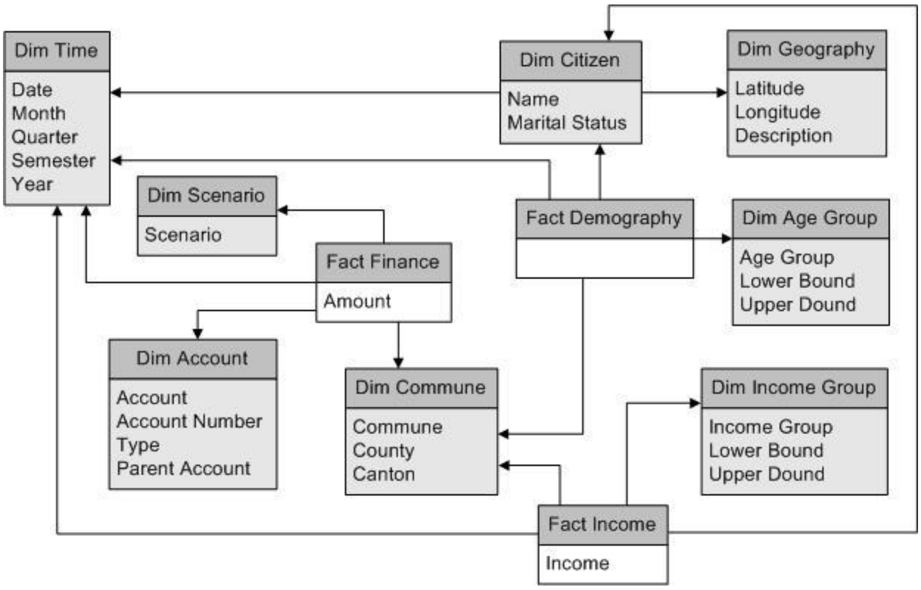

Figure 2:Partial view of the most important dimensions and some examples of facts within the OLAP cube

3.4 Performance Management and Arranging Dashboards

Figure 1 shows that dashboards for the cockpits are built using performance management elements together with additional reports and analyses. The performance management part of the cockpit solutions is based on the balanced scorecards framework [10]. The OLAP cube serves as sole data source for performance management. In accordance with the data source, the Key Performance Indicators (KPI) of the scorecards are designed to be multidimensional. A centrally defined KPI can be examined from different perspectives using the dimensions of the cube. The *Municipality* dimension also allows the definition of KPIs that are based on data from more than one commune (e.g. a KPI for monitoring an inter-municipal project or concerning an agglomeration). The goals for the KPIs can vary at different levels of the hierarchies.

The dashboards combine the scorecards with reports and analyses giving a broader view of the data the KPIs represent in an aggregated form. The reports include classical business-reports using different data sources (e.g. the data warehouse, web services) and mainly interactive charts or data grids with drill-down capabilities based on the OLAP cube. The first versions of the cockpits feature general dashboards, based on aspects of the municipality's strategy (e.g. finance perspective, project perspective). The upcoming challenge will be to translate the results from the analysis of the commune's business processes into dashboards and views tailored for specific process tasks and phases by selecting and combining elements from multiple dashboards. The challenge also extends to the lower layers of the architecture in the sense that the data, needed for the indicators on the dashboards and views, have to be integrated on the data layer and correctly processed as well as prepared on the analytical layer. Additional indicators will also necessitate the integration of new data sources.

3.5 Web-Based Platform for Cockpit Presentation

The presentation layer plays a central role in the cockpit solution since it serves as an interface between the IT systems and the user, as well as a point of integration between the IT solution and business processes. The site is secured and presents to users a customised cockpit based on their role-based access rights. The first versions of the cockpit sites present the strategy based dashboards but no process specific views. The future site is designed as a workspace combining the cockpit elements with collaborative functions such as document management, appointment management and discussions. This allows a direct integration of the cockpit with the workflows and processes of the municipalities.

The web-based nature of the cockpit is also vital for using the cockpit solution in inter-municipal cooperation. The basic design of the cockpit solution explicitly allows building cockpits addressing different needs on a regional- or agglomeration level. A cockpit website can be used as a collaboration platform for various municipalities e.g. when carrying out a common project or working together in the agglomeration.

4. Implementation of the Cockpit Solution

The project team has chosen the Microsoft Business Intelligence platform to implement the cockpit solution described in section 3 above. The platform specifically supports hosted application service solutions like the cockpit. In terms of cost and function the BI platform targets companies of all sizes, including small and middle companies. The platform is also suited for the small and middle-sized municipalities targeted by the project.

The core of the data and analytical layers of the cockpit solution is implemented using the components of the SQL Server Family Release 2008. The SQL Server Integration Services are used for data integration while the SQL Server database engine is used for data warehousing. SQL Server Analysis Services with their OLAP and data mining functions are the core of the analytic layer. The PerformancePoint 2007 Monitoring Server is used for performance management and analysis based on the OLAP cubes and building dashboards. The SQL Reporting Services reports and the ProClarity Analytics Server 6.3 are used for additional reporting and for in depth data analysis based on cubes. The presentation layer and the workspace functions of the cockpit websites are implemented using the Microsoft Office SharePoint 2007 Server. A SWOT analysis has been performed to assess the suitability of the Microsoft BI platform and the cockpit solution.

Strengths	**Opportunities**
• Excellent integration of all BI platform components • Good technical fit with the design goals of the cockpit solution • Intuitive and simple end user tools • Integration with Microsoft Office family tools	• Extensive Microsoft partner and solution network • Sharing of licenses for software used by multiple applications (e.g. SQL Server) • Hosting solutions for the Microsoft software
Weaknesses	**Threats**
• Required platform specific development knowledge • Required knowledge for maintaining and operating the cockpit solution	• High cost for necessary IT infrastructure and software • Lacking acceptance of the cockpit in the communes

Table 1:SWOT analysis of the cockpit system architecture implementation

The integration between software components of the BI stack and the good technical fit with the system architecture simplifies and accelerates implementation. For the project, fast development and implementation allows for an agile reaction to requirement changes and will reduce the overall cost of the solution in the long term.

Providing the cockpit as a hosted solution the cost decreases for the individual municipalities. The hosting provider possesses the necessary knowledge for developing and maintaining the cockpits and is able to share licence- and infrastructure costs between multiple municipalities. The easy usability of the tools in the cockpit and their integration with the wide spread Microsoft Office tools facilitates the cockpit's acceptance in the municipalities and allows for easy integration with existing workflows.

5. Findings, Further Activities and Challenges

The first and probably foremost impact of the introduction of cockpits is the reflection of municipal goals through the definition of measurable indicators. Defining these indicators has turned out a key challenge in our R&D-project for two reasons: (1) Decision-makers in municipalities are not used to measurements in a political context – even if they are well acquainted with such measurements in industry; (2) Linking the perspectives of municipal decision-makers and the perspectives of computer scientists with a background in management is a critical inter-disciplinary challenge. However, there are strong differences in the readiness for measurements in the municipalities involved in the project.

The second could arise from the use of cockpits in everyday political decision-making. This is harder to achieve than the definition of indicators for the cockpit – even if there is a high readiness for measurements among the key persons of a municipality.

So far, we have not yet discussed the particular role of smallness of the municipalities. For us small means less than 20'000 inhabitants. Obviously, there are less stakeholders and less responsibilities. While medium-sized, large, and very large municipalities have public administrations, which resemble medium-sized and large companies, small municipalities are rather different: Their civil servants – if they do exist at all – all have direct contact with their "customers", that is the citizens. In such a situation, strategic thinking is less popular than direct problem solving. Therefore, helping them to establish cockpits requires to understand their local way of political deliberation and deal-making. In particular, it is not yet clear, whether there is a common set of indicators for such small municipalities may be identified, which covers most of their strategic goals.

We shall focus our future research on the process of indicator-definition, on the practical information logistics, and on the stimulation of the actual usage of cockpits in everyday political decision-making in small municipalities. It does not suffice to better understand the management processes and to master technology – although we have not yet achieved the mastering of information logistics anyway – but it is also necessary to adequately educate users. Training is necessary in order to resolve problems in municipality administrations such as differing educational backgrounds and unpaid part-time engagement.

At the end of the project, the cockpit data should provide utility for the strategic management as well as for the daily business. The huge challenge will be to identify incentives to transform the cockpit from a playground into an accepted and frequently used management tool.

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