CHALMERS
UNIVERSITY OF TECHNOLOGY

Dashboard & Operational Report Automation (DORA)

- An operational process performance measurement tool

Master's thesis in Automation and Mechatronics

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DORA – Dashboard and Operational Report Automation
- An operational process performance measurement tool
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Report No. SSYX02-15-39

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Abstract

In a constantly changing and challenging environment, organizations must be competitive and able to adapt quickly, otherwise their sustainability would be gone in an instant. In order to meet these requirements, there is an ongoing trend among big enterprises to organize their non-core operational activities into centralized teams.

This centralization is often done in lower cost countries. Big focus is put on minimizing cultural and linguistic differences that pose a very serious risk of jeopardizing operations. With setting up these teams, companies can decreases the operational costs. Also, the concentrating of knowledge and expertise in centers both increase effectiveness and flexibility.

This report aims at introducing a project in detail that has been focusing on optimizing the performance measurement system of one of these centralized operational teams. The project has been conducted at one of the transactional procurement operations teams at a major player in the fast moving customer goods industry.

The project's purpose has been to standardize and optimize the reporting of the team's performance indicators (PI-s). The plan has been to choose a set of critical business PI-s with the help of the management. Then, a brand new, standardized reporting method had to be built based on available transactional data in the company's enterprise resource planning (ERP) system.

The outcome of the construction had to be an automatic solution that allows the team members and the management to monitor and track these PI-s. The PI-s had to be updated daily to increase immediate control over the business operations. The solution had to be flexible, allowing reporting analysts without programing knowledge to easily perform changes in the existing calculation methods or to extend the scope of extracted data – even to be able to create new PI-s in case the business need alters. Due to time and financial limitations, it has been a clearly set priority of the solution to handle only the most critical team PI-s.

Keywords: Supply Chain, Procurement Operations, Performance Measurement, Automated Performance Reporting

Acknowledgement

This bachelor thesis introduces the reader to an industrial bachelor project that has been done at the department of signals and systems, autumn, 2014. It presents the development of a new performance measurement system for a transactional procurement operations team within the fast moving customer goods industry.

There has to be some special thanks said to

Gergo R, Project Team Member & Reporting Analysts,
Peter V, Project Sponsor & Procurement Centre Director,
Petter Falkman, Supervisor & Head of Programme in Automation and Mechatronics

for the support and working hours they have contributed to the success of this project and bachelor thesis.

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1 Introduction

"The goal is to turn data into information, and information into insight."

- Carly Fiorina, Former CEO of HP

1.1 Background

Big enterprises within the fast moving customer goods industry tend to organize process-based centralized teams for their none-core, administrative activities – for very evident reasons this has become a standard among these companies. The team that is formed after the centralization is often stationed in one of the lower cost countries. There is an effort on minimizing cultural and linguistic differences because they can jeopardize operations – the enterprises prefer countries where the education system focuses on teaching foreign languages. In Europe these tasks are very often transferred to countries like Poland, Czech Republic, Slovakia, Romania, Bulgaria or Hungary, for these are the countries still relatively cheap but also capable of training the kind of workforce the enterprises are looking for. Having a centralized team of professionals in these countries means that the companies increase effectiveness, while at the same time, decrease operational costs.

Since this line of business is heavily dependent on production, the procurement organization's task is not simply the realization of savings, but also the managing of supply and the reducing of risks – production should never stop due to an inventory shortage. Because of this, companies develop a set of performance indicators. These are regularly measured and monitored in order to evaluate team performance and secure that the business needs are constantly met.

The project that is going to be described in detail in this report aims at optimizing such a team performance measurement system.

1.2 Problem description

At the start, the company's team performance measurement reports were calculated and presented only on a monthly basis. The task of gathering the required data, the performing of the necessary calculations, and the updating of the presentation were all done manually. The whole process had a certain kind of fragmentation about it because of the manual data input and time delay. This posed a very formidable business risk. The existing process delayed corrective action in regard to daily operations; simply put, it took too long for the valuable information to arrive to those in need of it.

The management obviously required prompt information in order to take adequate decisions. There was a demand for smaller but more frequent operational control reports in order to increase awareness regarding business procedures – to control team performance, and to reduce risks of a possible supply shortage.

Producing these reports with time consuming manual data input was a very ineffective way of reporting analysis. There was a demand for performing cause and effect, or, opportunity data analysis in hope of slackening the delays in the information flow and turning performance control into something substantially more effective.

1.3 Project Aims

The aim was not only to create an automated procedure that could measure the team performance indicators on a daily basis, and so, to enhance control over daily operational performance. The measured results also had to be presented in an easy to read, dynamic graphic system which is available for team members, management, and reporting specialists. The solution had to achieve the aforementioned objectives without additional effort or cost implications, furthermore, it had to be flexible, so reporting specialists without programming knowledge could create new or change current elements of the measurement methodology with ease.

1.4 Project Scope and Method

In theory, on paper, best practice is most of the times perfectly clear. In reality, though, there are always special factors, particular circumstances that are unique for each and every implementation. It was not different in this project's case, either.

At the beginning, it was not at all straightforward, which were the performance indicators (PI-s) that should have been measured, that should be looked at as the "key" factors evaluating the team's business performance. It was not an obvious choice at all, and as it took time to develop the automated measurement system an agreement was made. The choice over the PI-s was going to be finalized while the implementation of the system took place, instead of choosing them prior the process of developing the new measurement system.

For the team developing the system, to be able to start the work, it was enough to know that the solution had to be built on the data that could be found in the company's enterprise resource planning (ERP) system. As they did not have a sophisticated and separated reporting system, any data from other sources than the ERP were straight away excluded from the scope of the project.

There were some financial limitations as well – it was decided at the beginning that there would be no budget assigned for new tools or for external development. That meant that the PI calculations and the data storage had to be handled with the already available resources and applications. That also meant that the buying of new program licenses or the involvement of a third party would not be at any point possible.

At the very start, these were the most prominent conditions the project had to be shaped according to – in other words these were the defining factors of the project's scope and method.

2 Literature Study

This literature study approaches the topic with a glimpse into the bigger picture. The general study of the theories of Performance Management will help in understanding the basic terminology and background the problem should be discussed in. Then the report will scale down to the subject of performance measurement – it will present an introduction to what is going on in this field and how others have solved performance monitoring issues in the past. As much as possible, the literature study remains generic. Still, there is a focus on the topic of process monitoring – the models and methods described in here will be used later in the actual project that is the main topic of this report.

2.1 Performance Management & Measurement

Performance management is a very wide subject. It also lacks a solid definition, it is difficult to identify the boundaries, difficult to draw the lines regarding what activities and practices are or are not in the scope of the subject. Here are some examples of the existing comprehensive definitions.

HM Treasury (2001) describes performance management very shortly as "managing the performance of an organization or individual". Meanwhile, Bititci, Carrie & McDevitt (1997) defines it "as a process by which the company manages its performance in line with its corporate and functional strategies and objectives."

Since the middle of the 1980's, the interest in performance management has notably increased (Taticchi, 2008). Companies have realized the growing need of controlling their business processes and have understood that in a continuously changing environment it is necessary to monitor and understand performance to remain competitive. Because of this, performance measurement has been recognized as a crucial element to manage and improve business performance effectively (Sharma, Bhagwat & Dangayach 2005). The argument given by Lebas (1995), states this very clearly: *"Performance management precedes and follows performance measurement, in a virtuous spiral and performance management creates the context for measurement, so they are not separable"*. To further emphasize on the quote above, here is another one from Peter Drucker (management consultant, often renowned for being the founder of the philosophy of modern management): *"What gets measured, gets managed."*

Performance measurement is the area within performance management which has been the most extensively and effectively investigated, therefore also has the most academic literature about it. Performance has been defined by Neely, Gregory & Platts (1995) after an extensive review as: *"The level of performance a business attains is a function of the efficiency and effectiveness of the actions it undertakes"*. Effectiveness refers to what extent customer requirements are met, while efficiency is a measure of how economically the resources are utilized when providing a given level of customer satisfaction.

In this study, when performance measurement is mentioned, it is meant as the process of quantifying the efficiency and effectiveness of an action. A performance measure will be a metric used to quantify the efficiency and the effectiveness of an action. And last, a performance measurement system will be a set of metrics used to quantify both the efficiency and the effectiveness of a set of actions.

2.1.1 Performance Measurement Approaches

Traditionally, companies tracked their performance by measuring only a set of indicators based on their accounting. However, in the 1980's this approach received heavy criticism as it was inappropriate when it came to daily business decision making.

The SMART model, developed in 1988, represents an important change in performance measurement. For the first time in the history of performance measurement, it linked strategy to operations, using external and internal measures of performance.

It was followed by the SPA model which introduces two important innovations. First, it presented the concept of balanced measures. Second, it started to use non-financial indicators in the performance measurement calculations. In the 1990's, SPA was developed further into one of the most often used performance measure approaches of nowadays, the Balanced Scorecard model, has been created and successfully applied in several industries for the last twenty years (Taticchi, Tonelli & Cagnazzo, 2010).

The Balanced Scorecard model was first introduced to the wider public in the Harvard Business Review in 1992. It identified financial performance measures as lagging indicators which show the impact of decisions made in the past. It introduced non-financial performance measures as leading indicators. Basically, it says that customer, internal business process and learning and growth perspectives are the real drivers of future financial performance. This integration of non-financial measures into a system of traditional financial measures provided a new perspective over performance – it was a revolution within enterprise performance management and measurement. The Balanced Scorecard approach looks at performance from four interrelated perspectives (Kaplan and Norton 1992):

- Financial perspective - how do we measure financial performance?
(*e.g.* operating profits, return on capital invested, unit costs)
- Customer perspective - how do we measure customer satisfaction?
(*e.g.* customer profitability, customer satisfaction, and market share)
- Internal business-process perspective - what must we excel at?
(*e.g.* time to develop new products, defect rates, and product returns)
- Learning and growth perspective - how can we continue to improve and create value?
(*e.g.* employee satisfaction and employee productivity)

Self-Assessment is another approach to measure business performance. Organizations can undertake a self-assessment and analyze opportunities of improvement. All this has to be based on predetermined criteria and a defined framework developed by various quality management associations. This offers a number of advantages: an objective identification of strengths and weaknesses for example, or an analysis of performance capabilities in a given area that can become a solid basis for continued performance improvement (Hakes 1996).

But there is an important thing to notice. By characteristics, the Balanced Scorecard and the Self-Assessment approach, are focusing on overall strategic measures of corporations rather than measuring the performance of business processes. They only take the performance of business processes into account if they have a great impact on customer satisfaction or the organization's financial objectives (Kueng, 1998). On the other hand, there are also multiple approaches developed on measuring business process performance.

There is, for example the so called process output defect rates method. It measures the ratio of process output that does not meet the predefined set of specifications in the whole process output. It allows the monitoring of process failures and sets targets for reducing it (Neely, Gregory &Platts, 1995).

Statistical process control is “the application of statistical methods to the measurement and analysis of variation in any process". The main objective of this method is to ensure that processes remain stable through measuring and reducing process variance. The statistical approach makes it possible to predict future behavior (Juran&Gryna, 1993).

Workflow-based monitoring is another effective way to measure process performance. A Workflow is a system that supports automatic or semi-automatic execution of process instances, the coordination between activities, and the communication between process participants. As a side-effect, such a system is generating data that can be gathered, evaluated and presented automatically in real-time. That provides plenty of useful information regarding various areas, such as the lead time of process instances, or the workload on process participants, etc. (McLellan, 1996).

Another methodology that is widely used is the introduction of a so called process performance measurement system. It is basically an information system with several specific functions. It gathers the set of data of one or several businesses – the data that is relevant for the process performance indicators. It compares and presents the results as current value, target value, gap and trend for each performance indicator on a regular basis. With this approach, two crucial questions are answered at once. First, is the current performance of the business processes better than it was yesterday? And second, to what degree the target values are fulfilled (Kueng, 2000)? These are the questions all organizations are likely to ask over and over again.

2.1.2 Performance Measurement Metric Design

The performance measures within an organization can be designed on the basis of at least six different approaches (Waggoner, Neely & Kennerley 1999):

- The engineering approach, which measures the input/output ratio of a process;
- The system approach which sets objectives for each work unit and measures the achievement of these objectives;
- The management accounting approach measuring the achievement of financial results;
- The statistical approach which extends the engineering approach by providing empirically tested information about input/output processes;
- The consumer marketing approach which measures consumer satisfaction;
- The so called “conformance to specifications” approach which advocates the use of a checklist of attributes of a product or service and its service delivery system.

Even with having all this said, the question remains, how do we define what we want to measure? Also, the literature seems to present many different procedures and techniques. In another study, Bourne, Neely, Mills & Platts, (2003) manage to consolidate these procedures into three main groups:

- The needs led approach is a top down procedure, where customer, business, and stakeholder needs are identified and used as a basis for the development of performance measures to track the progress towards achievement of these needs;
- The audit led approach is a bottom up procedure, starting with an audit of the existing performance measures and the information collected is then used to challenge and amend these existing performance measures;

- The model led approach which uses a recommended theoretical model as a basis for designing the performance measures that should be deployed within the organization.

Some suggestions have been made for a more generic approach, too (Brooks 2005). First, it is recommended to understand and outline the business objectives. Each market segment or organizational unit should have specific business objectives regardless of the industry. Then, there should be an agreement on which exact processes and activities drive these objectives. And then, obviously, measuring these will give the best possible and most meaningful indicators on performance. Brooks (2005) also emphasizes on the importance of not only focusing on the organization as a whole. He believes that there should be quantifiable and specific measures within the measurement metric that show the performance of a department, a team, or even an individual.

2.1.3 Selecting Data Collection Method

Once the performance measures are clearly defined, it is necessary to identify data sources and design the collection methods needed to accurately track them. The source of the data depends mostly on what and how is measured. It can come from one or multiple internal and external data sources – *e.g.* estimates, manual counts, ERP systems, customer relationship management (CRM) systems, management reports, surveys, interviews, workshops, brainstorming sessions, etc.

How to select the most appropriate method in any given situation should be taken into careful consideration. Phillips & Stawarski (2008) define some key dimensions according which such a consideration can be implemented:

- Type of Data - One of the most important issues to consider when selecting a data collection method is the type of data that will be collected.
- Time Investment - Another important factor is the amount of time participants must spend on collecting and evaluating the data in the systems. Time requirement is better minimized in all cases.
- Collection Cost –This should always be considered when selecting the data collection method. Some data collection methods might be more expensive than others – as it was with time, this is better minimized in all cases.
- Disruption of Normal Work Activities - Perhaps the issue that generates the greatest concern among managers is the degree of work disruption that the data collection will create. Routine work processes should be disrupted only as little as possible.
- Data Accuracy - The accuracy of the technique is another factor to consider when selecting a data collection method. Some data collection methods are more accurate than others – they may also cost more or require more time invested in, and a balance should be found.
- Built-In Design Possibility - Building a data collecting function into evaluation plans is important. How easily the data collecting method can be built into a program is another thing to consider. Best is if it becomes an integral part of the program.
- Utility of an Additional Method - Because there are so many methods of collecting data, using more than one is at least a tempting option. On the downside, synchronizing multiple data collection methods adds time and cost to an evaluation process while the result may be only a minor addition of value.

- Cultural Bias of Data Collection Method - The culture or philosophy of the organization may dictate which data collection methods will be best to use.

2.2 Performance Measurement Systems

Once a company has selected what they would like to measure, identified how it should be measured – once the sources and the collection methods are chosen – it is ready to pick the technology that will enable a regular tracking, and allow each and every relevant member of the ecosystem to easily access the information critical to their performance.

The previous chapter has already mentioned a brief definition of the performance management system as "the set of metrics used to quantify both the efficiency and effectiveness of actions." A more precise definition is that a performance management system is an information system which (Kueng 2000):

- Gathers performance relevant data through a set of indicators,
- Compares the current values against historical or planned values,
- Disseminates the results to the process actors and managers.

The last couple of challenging decades forced the companies to develop and enhance their approach on performance measurement. Likewise, the technologies available for tracking their performance indicators have evolved. In order to proactively respond to the challenges, management requires up-to-date and accurate performance information on its business. This is an ongoing evolution, it started with using paper and pen, then their role was taken over by spreadsheets and databases, the use of those led to develop data warehouses – and lately business intelligence tools with sophisticated built-in analytical functions arrived (Brooks 2005).

2.2.1 Performance Measurement System Architecture

Although, most people will agree that it makes sense to standardize reports, there are still numerous companies unable to cope with complex reporting architectures, and inconsistencies in their reporting remain an issue. One obstruction that stands in the way of an efficient and effective reporting process is an environment of multiple and inconsistent types of reports and charts with a varying level of detail and different definitions of data. To overcome such an obstacle, practical approaches can be taken when designing standard reports and charts which include all the needed dimensions (*e.g.* geographical, organizational, etc.) that are required for the management and the employees to analyze performance and make decisions based on that data (Taylor 2001).

Automation is also possible since mature information technology companies offer solutions – platforms and user interfaces that integrate the performance management functions. Automated systems "decrease workload, ensure widespread access, and provide a standardized format for collecting, storing, and reporting performance data" (Pulakos, 2009).

The success of performance management systems has been and still is driven by new Web-based technologies – particularly by the development of Business Intelligence (BI). BI integrates decision support systems with the Web (*e.g.* a corporate Intranet), providing a single business data-base, a so called "repository". This repository can answer all kinds of questions. The data stored in there can be analyzed in many ways with distinct and precise reasons. A repository creates knowledge for all "knowledge workers" in the company, not just for the management (Tonchia & Tramontano 2004).

BI can be defined as a collection of mathematical models and analytical methods which are used to generate knowledge valuable for the decision-making processes from the available data (Fig.1). To highlight the importance of a BI in companies and organizations, it is important to state that it combines multiple data sources and provides answers to the questions that arise during the study of the collected data. And not only that, it also ensures

efficient distribution of essential data and statistics, enhances the decision-making ability, and enables faster decision making based on facts rather than instincts or loose predictions. In short, it helps to direct the organization towards its main objectives without compromises (Kopčeková, Kopček & Tanuška, 2013).

BUSINESS INTELLIGENCE ARCHITECTURE

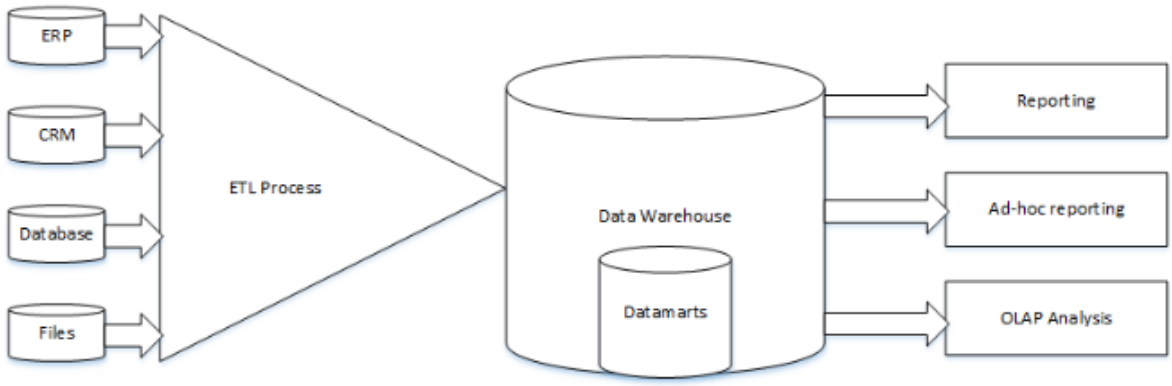

Figure 1. Typical architecture of the Business Intelligence system

The main parts of a typical BI system architecture (shown in Fig. 1) are:

- The Data Sources; that contains the relevant data / information. These sources can be either internal or external.
- The Extract Transform Load (ETL) process; the activity that gathers, organizes and loads the relevant data / information into the data warehouse.
- The Data Warehouse; that stores and aggregates the information gathered by the ETL process;
- The BI Methodologies; the extracted data is then used as inputs of various mathematical models and analytical methods which are used by the end users.

Since around 2005, BI software development has been one of the fastest growing business software technology segment in the world. As more and more users, vendors, and industry analysts focus on BI, a number of interchangeable or overlapping terms have been introduced. A more narrow area of BI is business performance management, which is a framework for organizing, automating, and analyzing business methodologies, metrics, processes and systems that drive business performance (Rasmussen, Chen & Bansal 2009).

Tonchia & Quagini (2010) argues that BI should be at the basis of any advanced performance measurement system as it enables the use of online analytical processing methods which make it possible to run software algorithms that can gather and process data. Therefore producing and presenting results in a form of parameters that represent the status and the trends within the business processes becomes quite easy. It offers a consistent and accurate availability of performance indicators.

However it is not enough only to gather, process, and present the data. It should also be presented in a way that allows managers and employees to monitor and control the performance without getting overloaded with information. The data should be presented in a readable format to give a good overview on status. The so called “Tableau de bord”, used in the management literature for the last 50 years, represents an information presentation model based on the idea of having a “cockpit”. When you drive a car, vital information about speed, oil-pressure, etc. is available in front of you on the dashboard. With gauges and odometers positioned in a way that a quick glance is enough to know if everything is okay (or not),

decisions can be made in real time, according to the situation. Similarly, organizations use operational dashboards with performance indicators captured real-time, daily, or weekly, and displayed through ergonomically designed graphics and charts. They review status and help people to understand the cause-effect relationships between actions taken and the trends they initiate in business performance. In short, a dashboard is an ideal tool to manage performance (Rasmussen, Chen & Bansal 2009; Marchand & Raymond 2008).

Rasmussen, Chen & Bansal (2009) also states that the base functionality of any modern performance measurement system should be to:

- Display data that originally came from many sources;
- Display metrics that are the result of simple or complex calculations;
- Provide new information on the screen quickly, with minimal processing time;
- Offer a chance for drilling down from summary data to detailed transactions.

2.2.2 Performance Measurement System Usage

The provision of performance information on its own is not sufficient to improve business results. The real success lies in when people start using this performance information before making decisions. Many executives and academics believe that the main reason of why performance measurement systems are short-lived at some companies is because people fail at capitalizing on the available new information (Marchand, Davenport & Dickson 2000).

Once the performance measures are implemented through performance information practices, the next step is the exploitation of this new information by the people working for the company.

Performance information behavior is defined as the people's behavior with performance information. It can be a positive behavior, such as pro-active and confident decision-making, continuous improvement, *etc*. It can also be a negative behavior, such as resistance, wrong interpretation of information, and so on. The real success lies in peoples' behavior in using this performance measurement system and the newly implemented performance information practices (Prahalad & Krishnan 2002).

According to Meekings (1995), successful implementation of performance measurement system depends not as much on selecting the right measures as on the way these measures are implemented and used by the people in the business. Making people use measures properly not only delivers performance improvement but also becomes a vehicle for a cultural change, which helps liberating the hidden power within an organization.

Staff must be capable of conducting performance management effectively. Moreover, emphasizing on training shows the importance of the new system. Also, employees and managers are more willing to show acceptance and interest when they see that the commitment to performance management is coming from the top levels of leadership (Packová & Karácsony 2010).

Another pillar of a successful performance management system is an ongoing communication. Communication is important at all stages of the performance management process. The communication process should be set up in a way that it does not put on more workload than necessary. Companies and managers can choose between different types of communication forms, like one-to-one meetings, team meetings, or even written reports, supported by informal communication processes (Packová & Karácsony 2010).

3 Implementation Approach and Solution Design

As it has been mentioned in the introduction, the project's primary aim is to create an automated solution to measure and present team performance indicators on a daily basis and thereby increase the control over the daily business process operations. A business process is defined as: *"A set of linked activities that take an input and transform it to create an output"* (Johansson 1993). The business process in scope for this performance measurement system is the transactional procurement & procure to pay process. This process contains the steps needed for a demand to be transformed into an order, then a delivery, then an invoice, and finally into a payment. (Figure 2).

BUSINESS PROCESS: TRANSACTIONAL PROCUREMENT & PROCURE TO PAY

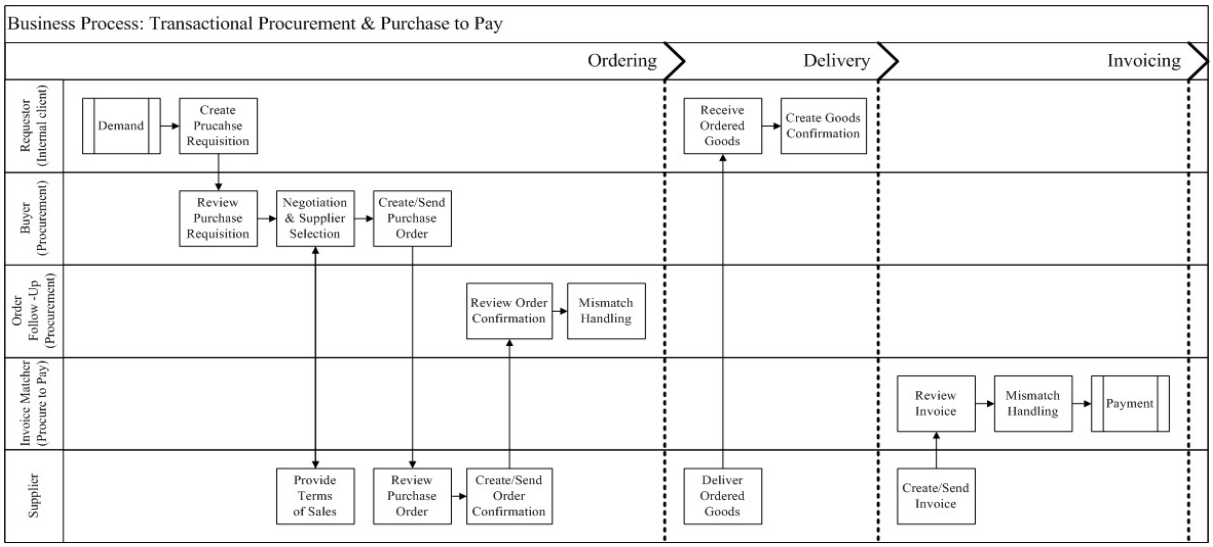

Figure 2. Flow chart of the transactional procurement & procure to pay process

3.1 Define Performance Indicators and Data Gathering Method

The first part of the actual project was to design a measurement matrix. It might sound trivial, but still, the first questions that had to be answered was: what should be measured and how could it be measured? A workshop had to be set up where the department's management participated – after all, the management will be one of the primordial users of the new system. Together, two distinct approaches were developed.

The first was a decision that the current performance measures needed an extensive review. The aim was to understand what is measured exactly. It was not evident whether all of those indicators currently in use were needed. Maybe, some were superfluous. It was also necessary to see how the current calculation methodology can be reformed.

The second approach was more concerned on the department's business goals. It was examined in detail what these goals exactly were. After that, the whole process flow (Figure 2) was studied step by step, and it was considered if there was a need for any new indicators to measure – and if yes, how they could be added to the system and how they should be measured in practice. Important requirements from the management were: the system had to be able not only to measure the efficiency of the internal business processes, but also, it had

to have a perspective focusing on customer satisfaction, and as such, measure process defect rates.

A list was composed from the identified performance indicators – and all indicators were prioritized based on their impact on business objectives. As a guideline, five procurement priorities were used:

1. Service – the goods have to be delivered on time.
2. Quality – the internal quality expectations must be met.
3. Cost – where and how some savings can be made.
4. Cash – the cash generated by prolonged payment terms or reduction in stock levels.
5. Flexibility – changes in demand must be detected and handled.

In agreement with the management, these factors were used to identify the most critical performance indicators – the ones which were going to be in the scope of the new performance measurement system. The agreed indicators were wanted to be calculated and presented on a daily basis for the use of the management.

The second part of the project was to design the calculation methods for the chosen indicators. To do so, first the possible sources of the required data had to be identified. The management emphasized on using already available and accurate data. The actual gathering of the data had to remain as simple as possible – any disruption of the daily activities or the need of additional time investment from the participants of the process had to be avoided. Another important aspect was that the data gathering had to be conducted with the systems and tools already available at the department. As a solution, using the transaction content and processing logs found in the department's ERP system seemed an ideal choice – it contained accurate data and it was relatively easy to extract it and create reports based on it. The decision was made that the design of the calculation method had to be based on the data in the ERP system.

3.2 Design Technical Landscape for Automated Solution

The relevant academic literature suggests that an automated performance measurement system is best based on Business Intelligence (BI) architecture (Tonchia & Quagini 2010). In such architecture, first, the relevant data is extracted from different sources, then it is converted into a preferred format, and finally, it is loaded into a database. There must also be a platform connected to this database, where the users of the system can review the measures current statuses, trends, and they can perform analysis if needed. The decision was made to use such an approach. But as the department lacked a sophisticated BI, and no resources were allocated to buy and implement BI software solutions, the actual design had to be built from scratch, using the available tools and systems (Figure 3).

TECHNICAL LANDSCAPE VISION

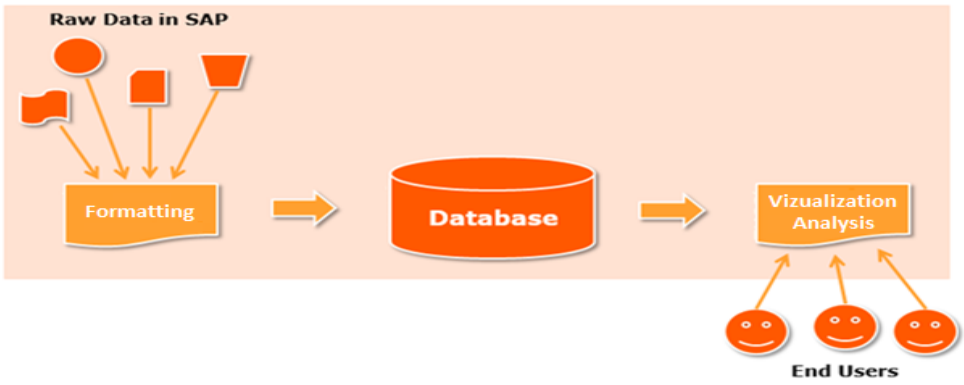

Figure 3. Technical landscape of the designed performance measurement system

3.2.1 Data Gathering Approach

First, the company's ERP system (SAP) had to be understood – the structure of the tables containing the required data needed to be examined – the information required for the PI calculations had to be located. Also, an optimal solution for extracting this data had to be developed.

There are multiple ways to extract data from an SAP system. One of them is to use the system's standard reports. Unfortunately, during the investigation, it turned out that the already existing reports did not contain all the necessary data fields, or, could not be extracted with the desired selection parameters. Another option would have been to extract the data directly from the SAP tables. This way all the necessary data could have been accessed to, but the matching and merging of the information from different tables would have required lots of external processing. Finally, the decision was made to use a specific SAP function that allows building custom reports by joining tables from the table structure together and choosing fields and selection parameters according to specific demands.

This function allowed to build the reports with the fields and selection parameters needed. The other advantage of this data collection method was that these custom reports could be scheduled to run with any preferred frequency. This meant that the reports needed to calculate the performance indicators could be run within the already existing system, on a daily basis, overnight, without the need of any human intervention.

3.2.2 Database Design

The following challenge was to find a solution to store and aggregate these daily data extracts. As it was suggested in the literature, a database had been built to perform these tasks. The design of the database had to be based on the requirements raised by the end-users of the system. In general, the data could have been stored as “raw data” - in the same or at least in a similar format as it was in when it had been extracted from the SAP system. With this approach, the business logic calculations and arrangements had to happen when end-users called the data from the database to review the status of a performance indicator. The other option was to format the extracted data before it arrives to the database – add the required business logic calculations and prearrange the data before loading it into the database. This allowed the end-users to get already prearranged data when calling it from the database. This second approach was chosen for the project, and the database needed to be designed accordingly – the table content had to be arranged in a way that the processed data could be loaded into it.

3.2.3 Extract Transform Load (ETL) Process

Next step was to find a way to fill the designed database with the data from the custom reports in the SAP system. To perform such an action, the following steps needed to be implemented:

1. Fetch the data from the SAP system.
2. Format and arrange the data into the preferred format.
3. Apply the business logic calculations needed for the performance indicators.
4. Load the processed data into the designed database.

In order to execute these activities automatically, a script needed to be developed that had to perform the whole Extract-Transform-Load activity, an automated ETL-Process, as already mentioned in the literature study (Kopčeková, Kopček & Tanuška, 2013).

The first challenge was the automation of the extraction of the reports from the SAP system. There were multiple options at this point as well as many times before. One was to set up a mail address in the system. The data could be sent there when the reports finished running. However, a different option was chosen. There is a built-in application programming interface (API) in the SAP system. This API allows an external program to connect and perform pre-programmed function calls within the SAP system. The first part of the script that was to be developed had to be a function that could connect to the SAP system and called a task that extracted and saved the reported data in a preferred format to a predefined location on a shared drive.

Another important demand from the solution was that it had to be flexible. In practice, this meant first of all that reporting specialists, even without programming knowledge, should be able to create or change the measurement methodology. Hence the ETL-process automation needed to be developed in a way that was easily changeable. In other words, the option of adding and removing data fields or updating of the calculation methods should be possible to perform without any intervention in the script's source code. To allow this, an additional function was added to the design. It was a formatting template, where the reporting specialists could maintain the report layout, the formatting and calculation methods. The script had to be developed in a way that all the formatting and calculation rules were taken from such templates. This way, the change of a calculation method could be done by updating the formatting template and data fields could be added or removed by updating the custom reports in SAP.

The final issue that had to be solved was that the data in the database had to be synced with the changes happening in the SAP system. It was required to design additional reports, based on the changes made in the SAP system. Because of this, the database loading methods also needed to be flexible – not just being able to add, but also to check, to update, or, to remove data already loaded into the database. The data loading rules of the database was also designed in a way that made it possible to maintain this function through the formatting templates.

3.2.4 User Interface Design

The last challenge regarding the design was the end-user interface. This interface had to be a platform where the end-users could review performance status and perform analysis of the data in the database. The operational dashboard approach has been mentioned in the literature study (Rasmussen, Chen & Bansal 2009), and a similar solution was chosen for this part of the project. A user template that would be available for all the team members and

management had to be created. On this template, end-users could choose the required performance indicators and a time interval over which they should be examined. The template would then, with the help of a script, connect to the database, download the relevant data and display it in an easy to understand, dynamic chart system. These charts had to show the actual standing of the performance and the trends in a daily, a weekly, or even in a monthly resolution. Additionally, it also had to give the users an option to scale or to filter the data. Even to perform data analysis on a transaction or process log level. This template had to be able to do all this, and also, it had to be able to handle the changes in the data fields or calculation methods without a need of any modification of the original source code.

3.3 Change Management Strategy

The literature suggests that the success of any attempt of improving business performance results depends on the behavior of the end-users, depends on how the employees use the new information delivered by the performance indicator measurement system (Prahalad & Krishnan 2002).

There were some promising circumstances in regard to this aspect of the project. The employees of the company already had some experience with performance indicators and meeting targets set on them. Already since many years, every employee got a couple of performance indicators and target values. These targets had to be reached throughout the year. The actual results compared to these target values would serve later as the base of the yearly bonus calculations.

As the new performance measurement system was completely developed in-house, there was no need to hire external professionals to write a user manual or the technical documentation. The creation of the training material and the organization of training sessions could be sorted out in-house.

These training sessions would introduce the end-users to the system and its functionalities. – The reporting analysts to the technical design and documentation, to enable them to perform future changes of the performance measurement system if such need arises.

4 Implementation Results

This chapter describes the outcome of the implementation. It will introduce the reader to how the approaches described in previous chapters are working in practice, what was possible to achieve with the application of them. It will present the exact indicators that were finally chosen to be measured. Step by step, the building of the automated solution will be described – also, how it was used by the employees and the management.

4.1 The Performance Indicator Matrix

In chapter 3.1, it has been already mentioned that a workshop was held in order to make an effective choice regarding the performance indicators. Here, the outcome of that workshop, the list of the chosen performance indicators in the scope of the project, will be discussed in detail. According to the guideline, to the five procurement priorities, there were eight different indicators assigned. These were grouped up into three different categories, type of measures that have an impact on: Customer Satisfaction, Process Efficiency and Process Defects.

Measures Impacting Customer (Requestor) Satisfaction

- *Purchase Requisition to Purchase Order conversion SLA* – (unit: percentage) the rate of purchase requisitions converted into purchase orders within the agreed time-frame combined with the extent of delay compared to the agreed time-frame
- *On time Delivery* – (unit: percentage) the rate of ordered goods and services arriving on time, taking into account the original request and the supplier's promise regarding the deadline

Measures Impacting Process Efficiency

- *Purchase Requisition to Purchase Order Automation* – (unit: percentage) the rate of purchase orders that could be created and sent automatically + Split between different purchase order types
- *Order Follow up* – (unit: percentage) the rate of order confirmations received with a date of delivery, quantity, and price clearly listed in the request
- *Electronic Invoicing*– (unit: percentage) the rate of invoices received via an electronic channel

Measures Impacting Process Defects / Compliance

- *Procurement Coverage* – (unit: percentage) the rate of purchase orders where procurement was involved in negotiations and supplier selection
- *Purchase Order Changes* – (unit: percentage) the rate of purchase orders changed after their sending combined with the type of changes that altered the purchase orders
- *Invoice Mismatch* – (unit: percentage) the rate of invoices with a price or quantity mismatch

4.2 The Automated Performance Measurement System

In chapter 3.2 the possible approaches of building a performance measurement system were presented. This sub-chapter holds more specifics on how the automated solution was built and how it actually works.

4.2.1 Data Gathering

The calculation methods for the performance indicators introduced in the previous chapter were designed in way so they could be calculated from the SAP table data. The crucial question was how to cover all the chosen performance indicators with such data? Finally, four custom SAP reports were created. Their combination covered all the required data fields with the appropriate selection parameters. The four reports and their selection parameters were the following:

- Purchase requisition and purchase order data – based on purchase order creation date
- Purchase order and delivery data – based on delivery confirmation date
- Purchase order change data – based on purchase order change date
- Invoice data – based on when the invoice was entered into the system

To be able to handle the measurements automatically, the four custom reports were scheduled to run daily right after midnight – they contain the relevant data accumulated throughout the previous day in the SAP system. The data from these reports is saved within the SAP system.

4.2.2 The Extract Transform Load (ETL) Program

The extract transform load (ETL) program was developed in visual basic for applications (VBA), an event-driven programming language from Microsoft.

The extraction function module of the actual ETL program connects to the SAP system and searches for the saved data by inspecting all custom reports and accessing only those that have a name starting with the word "DORA". Then it extracts the data, formats and saves it in an Excel file in a designated folder on a shared drive. In short, it is enough to create additional custom SAP reports to gather the required data – this simple VBA script will extract the data from the reports labeled as DORA.

The transformation function module of the ETL opens the formatting templates – all files in Excel – and completes the steps of the sequence described on a worksheet. These formatting templates also include sheets designed as the final report layouts including the business logic calculations as simple Excel functions – making it easy to change, add or delete calculation methods. The function module contains four types of generic sequence steps listed below:

- Add_Data (LayoutSheet, SourceFile) – Opens the file highlighted as source file, copies the data column by column, and pastes it into the right columns in the report layout sheet
- Calc_Data (LayoutSheet) – Performs the business calculations based on the excel functions maintained on the report layout sheets
- Save_Data (LayoutSheet, OutputFile) – Saves the content from the report layout sheet into an excel file on a defined location with the name highlighted as output file

- Del_Data (LayoutSheet) – Deletes all data on the given report layout sheet

These sequence steps were completely generic, so even if a new custom report is added, or fields are added or removed from one of the existing custom reports, or the calculation methods need to be changed at any point, it can be done in the formatting templates, there is no need to perform any changes in the script itself.

However, some of the performance indicator calculations requires additional checks. For example, to calculate an accurate PR to PO lead-time, certain PR data has to be double checked. Because of this, the SAP system's change history data has to be searched and it has to be verified whether any particular change had been done that effects the lead-time calculations. To be able to handle these, an extra sequence step was added:

- Extra (LayoutSheet) – Does these required additional checks

As these additional checks are very specific, this sequence step could not be developed like the other generic sequence steps. If a change is required regarding this step, unfortunately the script has to be changed.

The loading function module of the ETL program opens the output files generated by executing the previously mentioned sequence steps. The files are already arranged and contain all the business logic. – Which were maintained in the formatting template. They are also saved with a standard naming convention (also maintained in the formatting templates). By reading the file name, the function module can decide on how the SQL query should be generated. Which database table should be edited and how the data in the file should be loaded. – Just add it as new entries, or if it should update/delete existing entries in the database. The database is then called with the generated SQL query.

The ETL program is scheduled to run on a daily basis on a desktop computer via the Windows Task Manager. Every day at 1 am in the morning, after the custom reports have finished running in the SAP system, the ETL program extracts, transforms and loads the data generated from the day before into the database. So, as the database remains up-to-date – the performance indicators that have to be displayed remains up-to-date, too.

4.2.3 The Database

The database that accumulates and stores the daily data extracts was built with Microsoft Access. The database was built on a dedicated location shared drive. The structure and the format of the database tables and fields were set up to match the structure and the format of the output files, generated by the formatting templates.

As all the decisions are made by the ETL program, based on the data maintained in the formatting templates. – What to load and how to load it. There were no need for any script development in the database itself. Almost any kind of change can be made as long as the database and the output file have the same layout. If a new field is added in the formatting template, it has to be updated in the database as well. – No other change is needed, for the process to remain automatic.

4.2.4 The User Interface

The templates displaying the performance indicators to the end-users were also made in Excel. One Excel file per database table – there were four files altogether. The reason for dividing the presentation of the performance indicators was to decrease the response time when users are performing activities. These files contains several tabs. One tab for the selection of the desired date interval to be analyzed. A second tab to hold the data extracted

from the database (it has the same layout as the database table). The rest of tabs are there for the performance indicator charts (the actual number of the tabs depends on the number of performance indicators calculated from the database table).

Additionally, they also have a basic script included. It handles the download and the filling of the data tab with the information located in the database. When users choose a date interval, the scripts generate an SQL query based the data tab and the date interval selected, connects to the database, downloads the corresponding data and updates the data tab with it. Hence, when a field is added to the database it has to be added to the template serving as the user interface as well. But other than that, no change needs to be made, the script will be able to cope the new field completely by itself. In other words, the user interface remains totally flexible, changes can easily be made without any extensive programming knowledge.

The graphical charts to visualize the PI-s, are updated with normal Excel functionality. They are connected to pivot tables which are connected to the content of the data tab. So, when the data tab content is updated, the pivot tables get updated, too – and that updates the graphical charts. Using Excel's pivot table functionality also held other advantages: users could perform data filtering, choose if they wanted to see the relevant performance indicators on a daily, weekly, or monthly, basis. Additionally, it also allowed the users to perform in-depth transaction based analysis by double clicking in on the number in the pivot table. Hence no programming knowledge is needed to perform changes in the graphical chart layouts, either.

4.3 Performance Measurement System Usage

As the literature mentions, the usage by the end users is key for a successful performance measurement system implementation (Marchand, Davenport & Dickson 2000). Therefore, the promotion of the new system had started already during the development. Regular updates and presentations on the progress of the project were provided. During the monthly review meetings, the upcoming functionalities and possible benefits of the functionalities were highlighted to the team. That created a certain kind of curiosity and increased awareness among management and employees long before the system was ready to be launched.

The finished system was first presented on a meeting with the management. After a demo was presented, the management made a decision that team leaders will schedule regular weekly meetings with their team. This to introduce the new system and make sure that it was going to be inserted into the daily practice. On the first meeting the project team was also present. The training material created for the end-users was handed out. The various functions of the system were demonstrated and any question raised by the end-users, were answered. To further emphasize management support, a commitment were made in regard to that in the future, some of the team members' performance measures used in the yearly bonus calculations will be based on the measures introduced by the new system.

On top of all this, the technical documentation describing the whole system was prepared and handed over to the reporting analysts. So, they could understand the technicalities of the system and would be able to perform future changes. As a tiny part of the script that handled the necessary extra checks (mentioned in chapter 4.2.3) could only be altered with programming knowledge, some basic programming (VBA) trainings were held as well for the reporting specialists in order to make them be able to understand the code and make the necessary minor changes if and when such an alteration of the original script is needed.

5 Discussion

This chapter is a review – it is going to serve as a comparison between the goals that were set, the suggestions that were made by the literature and the actual outcome of the project in practice. It will mention some areas where further development of the performance measuring system could be made. Also, it will provide some additional insight regarding the underlying reasons behind the decisions which were made throughout the project.

5.1 The Performance Indicator Matrix & Data Collection Method

"Good performance" is an elusive conception, it is vague and broad, it is not at all straightforward what it should mean. And as such, there is no single "right" way to measure performance and declare it as good. On the other hand, by defining some clear goals and objectives in a given situation and then specifying some measurable indicators that might imply whether the way a team performs moves the business closer to these goals and objectives, or the other way around, it moves farther away from them – it is an approach that is both sensible and a lot more accurate than just aiming at a "good" level of performance.

In the actual project there was a combination of two approaches used – these were both mentioned in the literature study and came from the study conducted by Bourne, Neely, Mills & Platts, (2003). First, the team developing the new performance measurement system looked at the situation with the needs- and the audit-led approaches. Using them, it was possible to prioritize some clear goals and objectives. A set of performance measures could be defined that covered the full end to end process, and in the same time not only showed how efficiently the department was working, but also included some variables implicating customer end values, such as the satisfaction of the requestors or the number of defects and incompliances within the process.

As it must be apparent, financial measures, such as making some savings or the generation of cash, were completely excluded. It might seem as a very inappropriate move, still, there was a clear reason for doing so. As the literature mentioned, these are traditional measures which most companies (Taticchi, Tonelli&Cagnazzo, 2010) have a mature, trusted, and centralized way to measure. The company where the project was conducted was not different – they did not need any new performance indicators based on financial results.

There must be some further explaining made in regard to the choice of the data collection method. To gather the relevant data from the existing ERP system proved to be an excellent choice, most of all because it was always generated in the same format structure. That made it especially easy for the automated scripts to handle the data. Additionally, it was also in line with the other goal, namely, to gather reliable data for the performance indicators without any additional effort or cost implications for the department. Using other data sources like surveys or tracking the significant files with manual entry, would have been hard to automate and would have implicated additional effort or cost for the department.

5.2 The Automated Performance Measurement System

The automated performance measurement system was built on a BI methodology as it was suggested in the literature (Tonchia & Tramontano 2004) – even if the department lacked a sophisticated BI system. The choice of running small but frequent reports, only containing

data from the previous day, and then downloading and aggregating them in a standalone database during the night was made to minimize the impact of the new performance measurement system on the ERP system during the day – in other words, to make it sure that the ERP will keep running smoothly throughout the busy business hours. During business hours there was already a heavy load on the ERP system and the most processing resource demanding part of the new performance measurement system was this collecting and downloading part. During the day, the end-users could still do their analysis. They could check their standings and the trends with yesterday's data already available in the system. So the solution had not only provided up-to-date data on a constant basis, but made as little impact on the ERP system's performance as possible. An interesting problem is presented if the frequency of the reporting is desired to be increased even further. To feed the performance measurement system with "real-time" data would have demanded a lot more complex solution. And, no questions on this account, it would have had a serious impact on the performance of the ERP system – there would have been no other way but to keep downloading the data to the database during business hours. As such, the present solution appears to be sensibly balanced – any further attempt to make the data used for the calculations even more up-to-date would have resulted in unwanted cost and effort demands.

The timing of the application of the business logic calculations and the arrangement of the data loaded into the database was debated several times during the project. The chosen approach which did it before loading it into the database resulted in some extra workload for the reporting analysts in case of changes in the calculation methods were required. In such a case, the data, which was already present in the database, had to be extracted and recalculated and then reloaded into the database again. Storing the raw-data and doing the arrangements and calculations only when the end-users were fetching the data from the database would have been a lot more convenient when looking at the problem from this respect. Some work could have been spared on the end of the reporting analysts. However, it would have seriously prolonged the response time when end-users were attempting to download data from the database. It might have risked causing dissatisfaction among the end-users, which might have resulted in that the system would not be used on a regular basis. Such an outcome would have completely eliminated all the benefits of having up-to-date data, of performing the daily updates.

The choice of tools used for the development of the system was a simple one. They all had to be available and free of charge: the only possible option was to use Microsoft Office, more particularly, Excel and Access. Using them had some additional benefits, though. They had a built in scripting (VBA) and graph drawing functionality. That made it easy to automate the tasks and to present the data in an easily readable, visual format. Also, the department members were already familiar with these systems, they knew their way around with them without any additional training. Also, they made it possible that the data arrangements and the business logic calculations could be done with simple Excel functions – it made future maintaining easy for the reporting analysts who would operate the system.

To keep the system flexible was one of the project's original, important goals. Unfortunately, to enable reporting analysts without programming knowledge to perform changes was only partly achieved. Most of the changes could be done by anyone knowing how the SAP system, Microsoft Excel, and Access worked. However, due to the specific extra checks mentioned in chapter 4.2.3, the scripts couldn't be developed in a way that all changes could be performed without the changing of the source code of the performance measurement system. However, a simple VBA training for the reporting analysts had to be arranged only. After the training, they would be able to cope with any challenge raised by a desired alteration of the system. And the benefits of the training they received were not beneficial only in regard to the maintaining of this new reporting system – they could also use

the knowledge gained in these sessions to optimize and automate other parts of their daily work.

An area for further improvement in regard to the new performance measurement system was the building in of an automated function that would indicate and send alarm signals when, based on the indicators, there was a risk underlying process stability or a negative trend was unfolding. The evaluation of the new information provided by the system is done manually by the management and the team members at the moment. With introducing some statistical control methods, measuring the variation and mean values on the indicators, the system could do this automatically. The building in of such a function was however left out from the scope of the project because of the limitations regarding time and resources.

5.3 The Performance Measurement System Usage

As it has been already mentioned, the success of the new performance measurement system depends heavily on how regularly the end-users turn to it for information and how well they use that new information it provides. If it is not used, all the benefits gained would just simply vanish. Because of that, there was a huge focus on promoting the system and on emphasizing its possible importance towards the team members – this had been done both by the team developing the project and the management of the department.

To ensure that the usage of the system became a daily practice, the yearly bonus calculations were made to be based on the performance indicators in the system. Also the team leaders were asked to gather on a meeting every week where they reviewed the information provided by the new system. Team members had to come to these meetings with already prepared analysis on the current performance trends. They were asked to identify possible causes and suggest relevant actions for improvement. These identifications and suggestions were then further analyzed and discussed in the group during these weekly meetings – it was expected that this was going to enlighten the team members about their possible personal benefits of using the system. As soon as the usage of the system had become part of the daily practice, these meetings would be no longer necessary.

Another reason of having the end-users gathered together regularly was that the evaluation and improvement of the performance management system should have remained a continuous process. On these weekly meetings, the team members were encouraged to criticize and suggest possible areas of further improvement of the new system – after all, it is them who know best how to get out more benefits of the system – the system was implemented for them to use.

6 Conclusion

The aim of the project was to design a fully automated solution to measure and present the department's performance on a daily basis without additional effort or cost implications. The implementation of the new system was a success – taking everything into account, the main goals of the project were achieved – there had to be made only a small compromise.

The new performance indicator measures were designed and prioritized to cover the most important goals and aspects of the end to end operational process. It is giving a much more accurate and up-to-date overview on the department's performance than the previous way of reporting was.

The automated performance measurement solution was built without additional investments, only using the available tools and resources of the department. It gathers, processes, and presents the data in the desired visual chart format for all the members of the department on a daily basis – and it does all these totally automatically. There is no need for any human intervention apart from if a change needs to be done. Most of the changes – the adding or removing fields, the upgrading of the calculation methods, and the alteration of the visual charts – can be done by the reporting analysts without programming knowledge. The bit parts that require programming knowledge to alter were covered with the training sessions held for the reporting analysts.

The handover of the new performance measurement system was done – all the relevant trainings and technical material were provided to the members of the department – they all should be aware of the benefits of the new system. The promotion of the system has been done as well. The team members are not simply encouraged to use the system – they are expected to make or at least to ask for alterations to make regarding the system – to improve it continuously according to their needs.

However, as very little time has passed between the implementation of the system and the preparation of this report, the full scale impact of the new performance measurement system in the life of the department cannot be accounted for, just yet. The ultimate question: If the system actually will help the department to improve their results and performance? - Remains for the future to deliver an accurate answer.

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