

Business process optimization using data analysis methods and health monitoring

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Abstract

Large enterprises all over the world are already successfully applying various methods and available commercial solutions for reporting and analysing their business data. The concept of business intelligence provides valuable and useful techniques for optimizing business processes and supporting management decisions in order to increase efficiency and profit. In recent years also small and middle sized companies have shown more and more interest in such techniques. However, most companies have not yet done the necessary preparations. All business data has to be continually recorded in an appropriate way and format, otherwise it will be difficult to obtain useful and comprehensive analysis results. This important task has been recognized as a main challenge not only in the company FMG GmbH (FMG) but also in other small and medium enterprises (SME).

The implementation of an electronic work flow system is a good starting point for acquiring, collecting, processing and managing all business data and documents. An IT-based work-flow also supports the concept of the paperless office by applying electronic forms and document, and hence supports the governance of rules and laws within the company. In this paper, the work-flow system *fLARE[®]* (*flare*) will be introduced, which has been developed with the two main aims: (1) handling a tremendously increasing amount of various business data and documents electronically in a most cost transparent way, (2) global accessibility by applying web-technology and newly evolving standards. *Flare* allows an achievement-orientated accounting by acquiring all actually executed work and services in detail by its work items, locations and amounts on a daily basis. Attached with their actual labour, material and other cost, the company management can carefully monitor the progress of all running projects and work, and intervene in case of critical situations, such as bad finances or exceeding deadlines. This way of cost transparency can help managing service-orientated business very well because the wage share of the total turnover is usually higher in the service sector, and hence the wage plays a major role.

The high degree of details in the work data has been considered as a special feature of the business data leading likely to better analysis results and novel knowledge in service businesses. Especially in order to improve the accuracy of prediction algorithms, more detailed source data are needed and provided by *flare*. Various analysis methods from statistics, data mining and knowledge discovery will be carried out in order to obtain a new level of knowledge about this complex data. One major analysis object will be the evaluation of how to distinguish typical from atypical projects, achievements or services, so that certain properties of currently running business operations that are too complex for humans to overlook, can be shown by an intelligent information system. Furthermore, due to the fine-grained data, the work items and services can be better analysed among each other. All useful analysis results, data models and knowledge will then be stored in an experience database, so that this valuable information can be applied in future during work and resource planning.

As a new kind of input data, the level of physical activity during the actual work as well as the degree of the staff's healthiness will be taken into account for optimization. The physical as well as the mental capacity depends highly on the physical condition and hence must be considered as an additional parameter for further optimization and efficiency improvement. This positive effect of physical exercises on the humans' fitness has been shown long time ago, however the evidence by numbers or analysis of how actually good fitness maintains or increases the performance of businesses has been still a difficult task.

Keywords: business process optimisation, data analysis, data mining, work-flow, business intelligence, paperless office, corporate governance, achievement-orientated accounting, motivation, efficiency

improvement, cost transparency, financial monitoring, business continuity management, business traceability, experience management, experience factory, intelligent information system, enterprise resource planning, information infrastructure, clustering, decision tree techniques, association rules, neural networks, prediction, forecast, prediction accuracy, physical activity, health monitoring, health analysis, physical condition, physical capacity, mental capacity, service-orientated business, service industry

Introduction

In Germany, 70 percent of all employees are working in SMEs and create 49 percent of the gross national product. 46 percent of every capital investment is performed by SMEs [1]. The attention for business process optimization should therefore focus on them. Furthermore, a current trend is that companies are now changing their paradigm from cost reduction to growth [7], which leads typically to more business data and documents. Affordable and high-performance IT-systems allow promising analysis techniques to be practically applied. Another aim of executives is more transparency with regard to the managements' actions and their actual benefits in order to assure the highest possible degree of efficiency [7]. More transparency also demands better accounting and information which is good for data analysis. Similar to Germany, SMEs play a major role in Japan. More than 90% of the Japanese companies are SMEs and employ more than 70% of the working population [8].

Telecommunication and engineering services company

The telecommunication and engineering services company FMG GmbH (FMG) with its principal businesses in the areas of planning, selling, assembling, installing and maintaining of telecommunication equipment is a typical SME with about 100 employees. Its clients are major telecommunication, media and energy suppliers as well as internet carriers from all over Europe. A few years ago, FMG had faced the problem of handling and processing a tremendously increasing amount of various business data and documents such as customer's orders, confirmations, accounting sheets, subcontracts, material orders, invoices etc. Furthermore the management was thinking of implementing methods to increase the competitiveness and profit through more cost transparency and higher employee's motivation which had been recognized as one major step towards a successful future. The in-house wage accounting system had been changed from a temporal base to an achievement-orientated one which could finally lead to more encouraged workers, better project accomplishments and an entirely transparent work-flow beginning from the customer's order, through the employees' work and accounting to the final billing containing every details of each projects. This significant change in the company's overall work-flow and accounting system demanded for a reliable IT system as the company's backbone. Accessible form anywhere and at any time in order to guarantee the availability of retrieving, inputting, modifying and displaying all necessary data serving as the platform ensuring all operation to run without interruption.

***flare* Work-flow**

The newly developed business information system software *flare* with its main feature of a fully transparent billing and wage accounting has been already tried and tested in real business life and serves as the appropriate platform for small and middle-sized companies. Even though *flare* can be extended for use in production, it is best suited

for service orientated businesses since customers are charged usually for their consumed services on top of basic fees. Since all available services or partial services are registered and attached with their labour, material and others expenses in our system, a total cost transparency and an easy and quick billing system has been realized.

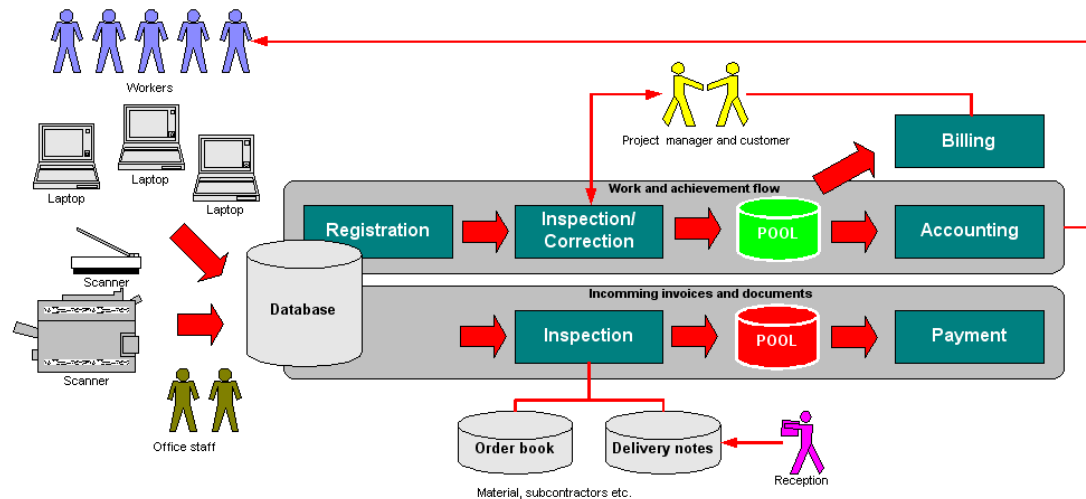


Illustration 1: flare work-flow

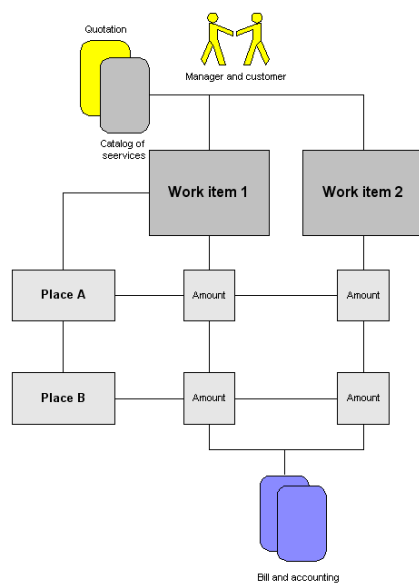


Illustration 2: Data structure

As Illustration 1 and 2 show, the workers input their actual work into the system. In the next step the project managers check the registered work according to their projects and wait for the confirmation from the customer. After acceptance, the managers then release the registered work going into a pool. The billing and accounting section then picks up the work and creates invoices to the customer (billing) and does the wage accounting. In parallel, the office staff scans and registers all incoming invoices and other documents, allocates them to the appropriate projects and inspects them for existing order and delivery notes. If everything is fine, the invoices and documents wait in a pool for payment or other processing.

Issues from the service industry

FMG has got already positive experiences and is convinced that a more flexible work scheduling where the company's working hours comply with the customer's or projects preferences, can support any service business. In many businesses this is even indispensable. However there are many businesses running with fixed working hours. A new innovative work scheduling can prevent under-workload of the stuff since not working at full load capacity leads to increasing labour cost. Hence, changing from traditional working hours to customer orientated work schedules increases the market

share and profit. Moreover, this scheme can be further supported by an achievement-orientated wage accounting when all work items and services are registered and attached with their labour cost. Visible to the employees as bonus points or even as the actual wage share, this additional numbers has to be defined by the management. Knowing the work item's wage shares and how much it contributes to their monthly salary, the workers become more motivated and organises themselves and their work better in order to obtain the best available efficiency.

The following three points are major issues and possible solutions for improvements of the steadily increasing service industry, such as handicraft, installation and maintenance businesses, after-sales services, outsourcing, Internet e-services or even elderly nursing homes and medical services:

- customer oriented work schedules for more satisfied customers and increasing market share and profit
- avoiding under-workload which leads to increasing labour cost
- transparent performance/achievement-orientated wage accounting for higher motivated employees and better efficiency
- in the service industry, the wage share of the total turnover is usually higher than in other industry sections, and hence the carefully management of the labour cost is critical for a successful business [2]

Those points can be implemented when the *flare* work-flow is applied.

The following picture shows the basic structure of the system's database. The red framed box is the measurement of quantities containing the actual work or service item based on a catalogue/specification of possible work items, it places and amounts. Based on these measurements, the outgoing invoices and the wage accounting are generated.

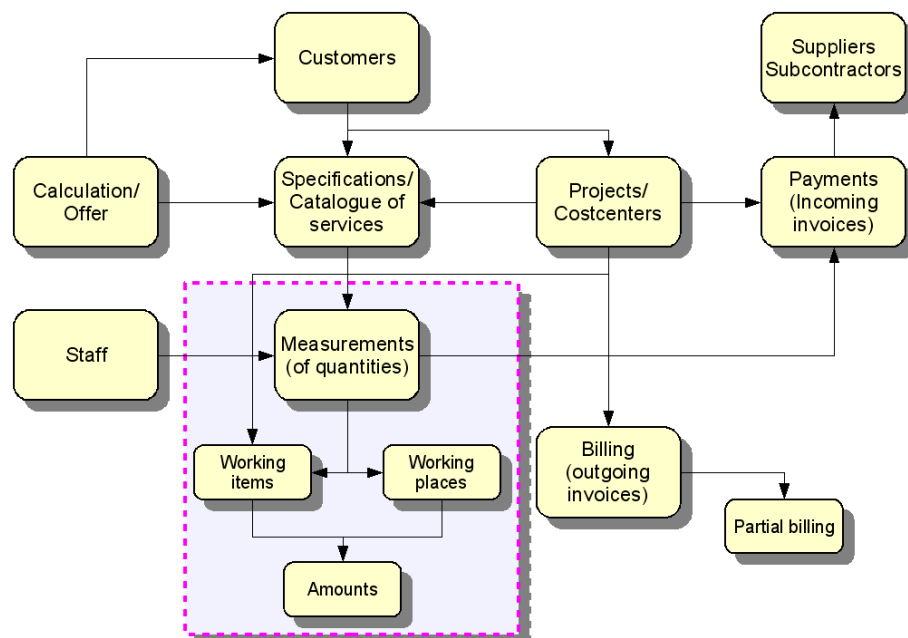


Illustration 3: Basic company structure

Financial monitoring

Besides the above mentioned issues and possible solutions of the service industry, one major general threat of all small and middle-sized companies with often thin financial ceiling is that their liquidity is suddenly seriously going down due to many possible reasons which occur in real life. Hence, they face the problem of not being able to pay their payment obligations: a worst-case scenario. Due to this fear a financial management is crucial to planning ahead and avoiding potentially critical situations. But how can this be done if all costs, especially the high labour cost, are not fully transparent? One possible solution would be to keep everything cost-transparently and track all work continuously in detail over time, as it is currently being done by *flare*. This then allows always an accurate overview of all cost, queuing and expected payments as shown in the financial monitor. In addition, by applying past experiences and analysis results, a forecast system is being developed for well determining the future financial situation and progress.

The main steps are as follows:

1. Preparations:
 1. Classify/cluster past projects, store them attached with their financial progress over time and other properties
 2. Search for typical patterns at representative situations, such as project delay, lack of material, vehicles or human resources, positive or negative financial situation/progress
2. Real-time analysis of current projects, look-up in database and give statements/advice about possible threats or other risks
3. Finding typical patterns and make conclusions
4. Forecasting of current projects

Health monitoring and analysis

For many companies, human resources are their true capital, like in the case of telecommunication and installation service businesses. Hereby healthy employees mean not only reduced days of illness but motivation, higher quality of work, friendliness to clients and co-workers, or even extra hours because of fun at work. Studies have shown that stress can be reduced by sport or physical activity [4]. Physical exercises also avoid overweight, metabolic diseases, hypertension or cardiac insufficiency. To maintain the human resource in good condition should therefore be a high priority issue for the management. But how to motivate the staff that they work and live healthy? One possible solution similar to achievement-orientated wage accounting can be a system calculating and showing “health bonus-points” with associated benefits within the company. Supported by the fact, that many insurance companies have already introduced bonus programs and various benefits for their customers, the company's “health-bonus” can even be connected to those insurance's programs. Some companies with homogeneous work conditions, such as Call-Centres have already applied incentive programs for their employees and share the costs for fitness-companies.

Due to the fact that there is a proven connection between healthiness and physical exercises, the basic approach will be to deduce the level of physical activity over a workday from the actual executed work items. This requires measuring and analysing the degree of movement and physical effort of all items in advance, which in practice is usually a too complex task. In order to reduce this task, work items and services have to be analysed with respect to their content and motor activity, respectively, in

order to find clusters and groups of similar items. In the beginning, those estimations will merely be rough, but it will be a starting point. The business process optimization will be supported by the new parameter of activity, and the project's as well as humans efficiency can now be analysed even in contrast to their physical activity.

For the measurement and analysis of the physical activities, the convenient and easy to use tool *MotionSensorBoard* developed by the Fraunhofer Institute[4] will be applied. Specially selected employees will wear this lightweight and small sensor during their work and provide the input data for further processing and optimization.

The intended

Acquiring all work data and services

The introduced work flow requires a slightly increased overhead of inputting all work items with its places and amounts into the IT system. FMG is currently practising this on a daily basis compared to a weekly base in the past, which let to a faster accounting and billing. Due to the achievement-based accounting, the stuff is interested more than ever in completely registering all their executed work items, and hence no work that can be charged from the customer, gets lost anymore. The correctness of the data will be finally checked and accepted by the customer or the inventory system and can prevent from misrepresentations.

By applying the most up-to-date IT technology, such as mobile computers and high-speed public data telecommunication networks, retrieving project information and inputting the finished work into the information system is now totally independent from location. The actual project work is transmitted on a daily base to the central database allowing the management to track and monitor the progress of all projects in real-time. The discrepancy between the planned and the actual project's progress can be seen and analysed easily without additional communication overhead. Since all projects are electronically reflected in the computer system with only a short time-delay, the business activities can be continuously monitored and analysed in real-time. The high degree of mobility is very important for service businesses, especially such as telecommunication installation and maintenance. Therefore we are putting effort in continuously improving the interaction and communication between the workers outside and the company's headquarters. Very similar to the AGnES-Soft project [6], where particularly educated nurses, called "Tele-Nurse", are linked to the doctor and help him to remotely treat the patient through electronic communication equipment, the stuff at the project's site shall be linked persistently to the computer system, feeding it with actual data, and providing them with supporting information.

Experience management

Basically, any company wants to improve its businesses and products. Especially service-orientated businesses carried out by humans depend less on machines and equipment as in production, rely very much on good and efficient work scheduling and planning. In order to improve and maintain a good level of efficiency and customer's satisfaction, it is necessary to acquire knowledge and experiences about all services and projects which have been carried out, and store them in an appropriate way in order to make it accessible in the future and to share among the employees. Basically, the reasons why projects do not go well according to their original plans, or why customers were not satisfied, become the valuable experiences and help for better services and project management in the future. Those knowledge becomes a critical factor for the success of any business.

One major part of optimizing our business will be the extensive use of such

knowledge. Therefore, we are now evaluating concepts for intelligent information systems including the idea of the “Experience factory” for acquiring, maintaining, improving and properly applying of experiences.

Resource scheduler

We then want to use this electronically stored experience knowledge for our future project and resource planning and scheduler system. Based on a vast amount of past experiences, we suppose that our projects will be better and more realistically planned. Furthermore, by modelling recurring services and business operations in an appropriate business language, we want to simulate many possible plans and schedules of all future projects together with the running projects in order to find out the best combination which then will be applied in the practice.

Data analysis and knowledge discovery

Over more than one year, the *flare* system had been successfully established as the overall communication platform, and hence gathering of business data as the basis for data analysis are fulfilled now. Since all services, projects and other business data are being consistently acquired and stored in a detailed manner into the database, we are convinced that we will obtain well applicable results when applying analysis methods. The analysis of the work items or services, and its work places and amounts will play the central role in our analysis. The results and its interpretation will serve as the foundation of monitoring the finances and the progress of all running projects in contrast to the origin plans and schedules in real-time. Finally, this new knowledge and information will be evaluated and stored as new experiences or update existing experience knowledge in the system. The data will be analysed by classical statistical techniques as well as data mining techniques, such as clustering, classification (for instance decision tree techniques), association rules and neural networks [9, 10]. Statistical methods will be applied in order to get information about distributions and various quantities of different data. As the following examples show,

- distribution of services: how many times has a certain service been ordered by a customer or executed by the staff
- what are the most delivered services and what is their share of the total turnover or the turnover of a project
- how was the work load share over time; has there been bottlenecks or under-workload; what types of services depending on the work content are affected
- what are the most profitable services and projects, and what services are not profitable at all
- which workers prefer what kind of services to do; who are working often together in a team and carrying out good performance work
- creating an appropriate “performance index” for each employee in order to compare them relatively to each other
- distribution of work places

If the above information is easily available, optimization in very different ways becomes possible. For instance, information about the distributions of the services and its share of the project's turnover can help to optimize the price structure, which has been recognised as a major issue for today's executives [7].

We want to classify and cluster the projects and services with regard to different

aspects, such as work or service content, temporal and regional factors, or material, personal and financial effort, in order to find similar or different characteristics. In the following there are some questions for which we want to find answers:

- how was the progress of the single work items
- how was the actual project compared to the original planned
- has the deadline been exceeded or not
- how was the management and customer: work had been quickly approved, customer had complained, changes had to be done
- how was the billing
- financial progress of incoming and outgoing payments

If we find some meaningful clusters or groups, we want to apply these classification methods on the current data for real-time analyses.

We want to find typical patterns or models for projects which exceeded their deadline.

Education

In addition, it is planned to evaluate the idea of a simulation game for educational purposes based on all technical and market information as well as the acquired business data in the telecommunication services area. The player has to successfully manage its company and run the business against other competitors. All the experiences in this business are gathered in the game and are provided to the player for individual e-learning. Based on all electronically available data and their analysis results, current technologies for artificial intelligence will be applied in order to realize automated competitors controlled by the computer. This tool will then be applied for education of new stuff and project managers acquiring valuable skills for project management and solving difficult real-world problems.

Another aim is, that besides the economical success the player becomes aware of the importance of healthy workers in his company as a key for persistently lasting competitiveness and success. This idea of educational game can be extended to the whole service industry, starting from network carriers and providers to content or delivery services. In this age of the world-wide internet, it is assumed that such a e-learning game will find wide interest.

Conclusion

We developed a concept for an “intelligent company”, based on the existing system *flare*. The essential part of this concept is high-level data analysis. The aim is to implement an IT-based assistant for the management and executives, wrt. to several aspects as for instance controlling and health monitoring.

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